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United States Department of Energy

Remedial Action Plan for the Codisposal and Stabilization of the Monument Valley and Mexican Hat Uranium Mill Tailings at Mexican Hat, Utah

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Text

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February 1993

Appendix B of the
Cooperative Agreement
No. DE-FC04-83AL16258

Uranium Mill Tailings Remedial Action Project

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REMEDIAL ACTION PLAN
FOR THE CODISPOSAL
AND STABILIZATION
OF THE
MONUMENT VALLEY AND MEXICAN HAT
URANIUM MILL TAILINGS
AT
MEXICAN HAT, UTAH

FEBRUARY 1993

APPENDIX B TO THE COOPERATIVE AGREEMENT

NO. DE-FC04-83AL16258

URANIUM MILL TAILINGS REMEDIAL ACTION PROJECT OFFICE

ALBUQUERQUE OPERATIONS OFFICE

DEPARTMENT OF ENERGY

ALBUQUERQUE, NEW MEXICO 87108

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ATTACHMENT 1

Executive Summary

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EXECUTIVE SUMMARY

INTRODUCTION

The Mexican Hat tailings site is in San Juan County, Utah, two road miles southwest of the town of Mexican Hat on the Navajo Reservation. The Navajo community of Halchita is approximately 0.5 mile southwest of the site. The mill at the Mexican Hat site was operated from 1957 to 1965 by Texas-Zinc Minerals Corporation and the Atlas Corporation. Originally, two irregularly shaped tailings piles were located in the northeastern portion of the site. They occupied approximately 69 acres of the 235-acre designated site and contained approximately 2,575,000 cubic yards (cy) of tailings. The total amount of materials, including the tailings and windblown and waterborne materials, is estimated to be 2,810,000 cy.

The Monument Valley tailings site is on the Navajo Reservation in Arizona, 17 road miles south of the Mexican Hat disposal site. The mill at the Monument Valley site was operated from 1955 to 1968 by Vanadium Corporation of America and its successor, Foote Mineral Company. The mill buildings and milling equipment have been removed from the site; two tailings piles, concrete building foundations, and debris remain at the site. The two irregularly shaped tailings piles occupy approximately 28 acres in the center of the 100-acre designated site and contain 1,030,000 cy of tailings. The total amount of materials, including the tailings, contaminated soils beneath and around the tailings, and other contaminated materials, is estimated to be 1,100,000 cy.

REMEDIAL ACTION

Under the proposed action, the tailings and other contaminated materials from the Mexican Hat and Monument Valley sites would be consolidated into a single embankment at the Mexican Hat site. The stabilized pile would then be covered with a two-foot-thick radon barrier consisting of silty sands amended with 10 percent sodium bentonite, a six-inch layer of filter and bedding material, and an eight-inch-thick layer of small diameter rock for erosion protection. The consolidated tailings and contaminated materials would have sideslopes of 20 percent. The topslope would be two percent. The stabilized embankment would cover approximately 60 acres, measuring 2200 feet long in the east-west direction and 1500 feet wide in the north-south direction. The embankment would average approximately 30 feet above the surrounding terrain to the north, east, and west. A ditch would be constructed to divert surface water runoff into an existing arroyo near the embankment. The arroyos on the northeast and east sides would be armored with rock to prevent their advancement toward the stabilized pile.

The buildings and other structures associated with the former milling operations at Mexican Hat were demolished as part of Phase I site construction activities. Phase II remedial activities were to consist of consolidation of all Mexican Hat and Monument Valley contaminated materials in the disposal cell at Mexican Hat. The debris from the demolished structures was consolidated with the tailings and other contaminated materials prior to suspension of Phase II construction. In addition, the upper tailings pile and most of the windblown/waterborne contamination at Mexican Hat were stabilized on the original

lower tailings pile prior to suspension. Only 40,000 cy of contaminated materials from Monument Valley were hauled to the Mexican Hat disposal cell prior to Phase II construction suspension.

COMPLIANCE SUMMARY

Pursuant to the requirements of the Uranium Mill Tailings Radiation Control Act (UMTRCA), the proposed remedial action plan (RAP) will satisfy the U.S. Environmental Protection Agency (EPA) standards (40 CFR 192) for cleanup, stabilization, and control of the residual radioactive materials (RRM) at the Monument Valley and Mexican Hat sites. The requirement for control of the tailings (Subpart A) is predicted to be satisfied, with reasonable assurance, by the construction of a discrete engineered disposal cell. The cell will be covered with a radon/infiltration barrier composed of controlled compacted bentonite-amended soils, a bedding (filter) layer of sand, and a rock erosion barrier (Section E.2.3). The surface will be contoured to provide proper drainage, thereby minimizing infiltration through the tailings. This cover system will also limit the release of radon-222 from the tailings to below the standard of 20 picocuries per square meter per second (pCi/m^2s).

All materials chosen will meet the U.S. Nuclear Regulatory Commission (NRC) requirements applicable to the Uranium Mill Tailings Remedial Action (UMTRA) Project, will be as durable as is reasonably achievable, and will be placed to promote their long-term performance in the absence of maintenance. The pile morphology has been designed to provide slope, settlement, and deformation integrity. Therefore, the need for maintenance is reduced to a minimum.

Compliance with the proposed groundwater portion of the EPA standards will be accomplished through the implementation of the groundwater protection standards in 40 CFR 192.02(a)(3). Compliance is predicted by an advantageous hydrogeologic setting and negligible long-term seepage rate from the disposal cell (Section E.3.2). Seepage of tailings fluids into the Honaker Trail Formation is precluded by the lower Halgaito Shale Formation and the upward hydraulic gradient between the Honaker Trail Formation and the Halgaito Shale Formation. This upward hydraulic gradient is artesian in the vicinity of the tailings disposal cell.

The disposal cell is designed to minimize infiltration. Studies have been conducted recently on infiltration through radon barriers with cover components similar to that proposed for the Mexican Hat site in areas with similar climates. These studies suggest that the radon barrier will remain unsaturated and that the infiltration rate will be negligible (Section E.3.2).

The U.S. Department of Energy (DOE) is required to prepare a performance assessment monitoring and surveillance plan. The DOE has compiled an UMTRA Project long-term surveillance plan (LTSP). That document constitutes the basis for the site-specific surveillance and performance monitoring program to be undertaken at the stabilized site. There is no need for post-closure monitoring of groundwater at the Mexican Hat site because of its advantageous hydrogeologic setting. Water quality impacts in the Honaker Trail Formation have not been observed, even though processing activities began over 30 years ago.

Groundwater in the vicinity of the Mexican Hat tailings site has never been used as a water resource due to the naturally poor quality and limited yield. Based on the historic record of groundwater use and the present and future availability of alternative water supplies, groundwater is not projected to constitute a viable water resource in the area (Section E.3.6). After remedial actions are completed at the Mexican Hat disposal site, groundwater within the Halgaito Shale Formation will disperse in an unknown, but finite, time. Eventually, recharge to the Halgaito Shale Formation will be governed by infiltration from precipitation, which will result in a return to unsaturated conditions, as was likely the case prior to uranium milling operations.

With the exception of the groundwater contamination at the Monument Valley site, the standards for cleanup of the site under Subpart B of 40 CFR 192 will also be satisfied with the proposed RAP. Cleanup of the tailings piles and windblown materials at both the Monument Valley and Mexican Hat sites will be accomplished by consolidating the materials into one disposal cell at Mexican Hat. Groundwater cleanup at the Monument Valley site under Subpart B can be decoupled from the effects of the remedial action associated with Subpart A, because the tailings will be relocated to Mexican Hat. Verification of cleanup to standards (as defined in Subpart B) will be performed. The issue of groundwater cleanup at both Monument Valley and Mexican Hat will be addressed in a separate process under Subpart B of UMTRCA.

DOCUMENT ORGANIZATION

This document is a revision of the original Mexican Hat RAP and RAP Modification submitted in July 1988 and January 1989, respectively, along with updated design documents. The NRC's Standard Format and Content guide was not followed in preparing this RAP because the original document format was kept. The text is primarily a summary of the characterization of the sites and the proposed remedial action design; other supporting activities are also described. Appendix A consists of the characterization data, analyses, and design drawings that supported site activities performed prior to suspension of Phase II construction (from October 1988 to January 1990). These actions were conducted under conditional NRC and Navajo Nation concurrence. The design drawings, subcontract documents, information for bidders, and design calculations in support of the proposed remedial action are found in Appendix B. Appendix C consists of the Radiological Support Plan (included in the previous RAP format). Appendix D contains the site characterization, including detailed descriptions of the geology, hydrogeology, and pre-existing conditions of the sites. It also contains (in addenda) characterization data that supported the previous design and remedial activities completed to date at Mexican Hat. Appendices E and F contain detailed discussions of the groundwater compliance strategy and supporting analyses and calculations.

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1.0 INTRODUCTION

1.1 PURPOSE

This RAP has been developed to serve a two-fold purpose. It presents the activities proposed by the DOE to accomplish long-term stabilization and control of the RRM from Monument Valley, Arizona, and Mexican Hat, Utah, at the Mexican Hat disposal site. It also serves to document the concurrence of both the Navajo Nation and the NRC in the remedial action. This agreement, upon execution by the DOE and concurrence by the Navajo Nation and the NRC, becomes Appendix B of the Cooperative Agreement.

1.2 RESPONSIBILITIES

In 1978, Congress passed Public Law 95-604, the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, expressly finding that uranium mill tailings located at inactive (and active) mill sites may pose a potential health hazard to the public. Title I to the UMTRCA identified 24 sites to be designated for remedial action. On November 9, 1979, the sites near Mexican Hat and Monument Valley were designated as two of these 24 sites.

The UMTRCA charged the EPA with the responsibility for promulgating remedial action standards for inactive mill sites. The purpose of these standards is to protect the public health and safety and the environment from radiological and nonradiological hazards associated with radioactive materials at the sites. The final standards were promulgated with an effective date of March 7, 1983.

The DOE will select and execute a plan of remedial action that will satisfy the EPA standards and other applicable laws and regulations. Under the UMTRCA, the DOE and the Navajo Nation entered into a cooperative agreement effective October 7, 1983, for remedial action at the Mexican Hat and Monument Valley sites. The DOE will fund 100 percent of allowable costs.

It is the intent of the DOE, as required by UMTRCA, to comply with EPA regulations in Subparts A through C of 40 CFR 192 in the preparation of this RAP. All remedial action planning and design considerations contained herein reflect the incorporation of this regulatory guidance. Therefore, by performing all remedial action activities in accordance with the design presented in this RAP, the DOE will meet the standards of 40 CFR 192.

All remedial actions must be selected and performed with the concurrence of the NRC. In conformance with the UMTRCA, the required NRC concurrence with the selection and performance of proposed remedial actions and the licensing of long-term surveillance and maintenance of disposal sites will be for the purpose of ensuring compliance with the standards established by the EPA. Therefore, the RAP constitutes the initial document in the licensing process.

1.3 SCOPE AND CONTENT

This document has been structured to provide a comprehensive understanding of the remedial action proposed for the Monument Valley and Mexican Hat sites. It includes specific design and construction requirements for the remedial action. Pertinent information and data are included with reference given to the supporting documents.

Section 2.0 presents the EPA standards, including a discussion of their objectives. Section 3.0 summarizes the present site characteristics and provides a definition of site-specific problems. Section 4.0 is the site design for the proposed action. Section 5.0 presents the water resources protection strategy. Section 6.0 summarizes the plan for ensuring health and safety protection for the surrounding community and the on-site workers. Section 7.0 lists the responsibilities of the project participants. Section 8.0 describes the features of the long-term surveillance and maintenance plan.

Attached as part of the RAP are appendices that describe various aspects of the remedial action in more detail.

Appendix A, Phases I and II Subcontract Completion Report (three volumes), describes the remedial activities completed at the sites (to May 1990) with supporting characterization data and calculations.

Appendix B, Specifications, Design Drawings, Calculations (five volumes), and Information for Bidders (three volumes) contains detailed information on the remedial action design.

Appendix C, Radiological Support Plan, describes the procedures used to characterize the present radiological condition of the site and the procedures to be used to control and verify the results of remedial action activities.

Appendix D, Site Characterization, includes additional information and data supporting the design of the proposed remedial action.

Appendix E, Water Resources Protection Strategy, describes how the remedial action will be in compliance with the proposed EPA groundwater standards.

Appendix F, Groundwater Hydrology Calculations, contains calculations supporting the groundwater hydrology assessment and the water resources protection strategy.

1.4 COLLATERAL DOCUMENTS

The Mexican Hat Environmental Assessment (EA) (DOE, 1987) describes existing conditions and the impacts of stabilizing the Mexican Hat contaminated materials at the Mexican Hat disposal site. The Monument Valley EA (DOE, 1988) describes the conditions at the Monument Valley site and the proposed remedial action of codisposal of the Monument Valley and Mexican Hat contaminated materials at the Mexican Hat disposal site. The Monument

Valley EA also addresses the alternatives considered, the environmental impacts at the Monument Valley site, and those impacts at the Mexican Hat site that result from the proposed action.

An additional supporting document is the Technical Approach Document (DOE, 1989a). This document describes technical approaches and procedures used in the UMTRA Project. It includes discussion of major technical areas; design considerations; surface-water hydrology and erosion control; geotechnical aspects of pile design; radiological issues (the design of the radon barrier, in particular); and protection of groundwater resources.

Copies of these documents are on file in the UMTRA Project Office in Albuquerque, New Mexico.

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2.0 EPA STANDARDS

The requirements and considerations for long-term isolation and stabilization of tailings, radon control, cleanup of land and buildings, and protection of water quality have been discussed and published in the Plan for Implementing EPA Standards for UMTRA Project Sites (DOE, 1984a). That document was used as a guide in the development of the RAP and is the basis for the following discussion of the EPA standards.

2.1 GENERAL

Pursuant to the requirements of the UMTRCA, the EPA has promulgated health and environmental standards to govern cleanup, stabilization, and control of RRM at inactive uranium mill tailings sites. The promulgated standards establish requirements for long-term stability and radiation protection, and provide procedures for ensuring the protection of groundwater quality.

In developing the standards, the EPA determined that "the primary objective for control of tailings should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces such as wind, rain, and flood waters," and that "a second objective should be to reduce radon emissions from tailings piles." A third objective should be "the elimination of significant exposure to gamma radiation from tailings piles" (refer to the preamble to Standards for Remedial Actions at Inactive Uranium Processing Sites, 40 CFR 192). These conclusions were based on a determination that the most significant public health risks associated with inactive tailings were posed by exposure to persons living and working in structures contaminated by relocated tailings. The EPA further concluded that the potential for contamination of groundwater and surface water should be evaluated on a site-specific basis.

The EPA standards are discussed in the following paragraphs and are summarized in Table 2.1.

2.2 LONG-TERM STABILITY

Isolation and stabilization of tailings in order to prevent misuse by man and dispersal by natural forces is the primary objective of the EPA standards. Accordingly, long-term stability was emphasized in the development and promulgation of the standards. This is consistent with the guidance provided by the legislative history of the UMTRCA, which stresses the importance of avoiding remedial actions that would be effective only for a short period of time and that would require future Congressional consideration.

The EPA standard-setting process distinguished "passive controls" (such as thick earthen covers, below-ground disposal, rock covers, and massive earth and rock dikes) from "active controls" (such as semi-permanent covers, fences, warning signs, and restrictions on land use). Active cover controls could be expected to need frequent replacement or other major repairs requiring the appropriation and expenditure of public

PART 192 - HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

SUBPART A - Standards for the Control of Residual Radioactive Materials from Inactive Processing Sites

192.02 Standards

Control shall be designed to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average release rate of 20 picocuries per square meter per second, or
(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

SUBPART B - Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than -

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and
(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building -

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and
(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

SUBPART C - Implementation (condensed)

192.20 Guidance for Implementation

Remedial action will be performed with the "concurrence of the Nuclear Regulatory Commission and the full participation of any state that pays part of the cost" and in consultation as appropriate with other government agencies.

192.21 Criteria for Applying Supplemental Standards

The implementing agencies may apply standards in lieu of the standards of Subparts A or B if certain circumstances exist, as defined in 192.21.

192.22 Supplemental Standards

"Federal agencies implementing Subparts A and B may in lieu thereof proceed pursuant to this section with respect to generic or individual situations meeting the eligibility requirements of 192.21."

(a) ". . .the implementing agencies shall select and perform remedial actions that come as close to meeting the otherwise applicable standards as is reasonable under the circumstances."

(b) ". . .remedial actions shall, in addition to satisfying the standards of Subparts A and B, reduce other residual radioactivity to levels that are as low as is reasonably achievable."

(c) "The implementing agencies may make general determinations concerning remedial actions under this Section that will apply to all locations with specified characteristics, or they may make a determination for a specific location. When remedial actions are proposed under this Section for a specific location, the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments. The Department of Energy shall provide any such comments to the other implementing agencies [and] shall also periodically inform the Environmental Protection Agency of both general and individual determinations under the provisions of this section."

Ref: Federal Register, Volume 48, No. 3, January 5, 1983, 40 CFR Part 192.

TABLE 2.1
EPA STANDARDS

funds. In setting the standards, the EPA called for designs that rely primarily on passive controls.

The standard is framed as a longevity requirement that recognizes the difficulty in predicting long-term performance with a high degree of confidence. In establishing the longevity requirement, the EPA concluded that existing knowledge permits the design of control systems that have a good expectation of lasting at least 1000 years. Therefore, a design objective of 1000 years was established to be satisfied whenever reasonably achievable, but in any case, with a minimum performance period of 200 years.

The standard recognizes the need for institutional controls (e.g., custodial maintenance, monitoring, and contingency response measures). In its preamble to the standards, the EPA calls for such controls to be provided as an essential backup to the primary passive controls.

2.3 RADON EMISSIONS CONTROL

The EPA identified a reduction of radon emissions from tailings piles as the second objective in its standards for the control of tailings. In developing the standards, the EPA considered several alternative approaches and selected an emission limitation as the primary form of the standard. Radon-222 emissions from the remediated tailings piles will be less than 20 pCi/m^2s (40 CFR 61 and 40 CFR 192.02(b)(1)). In addition, a concentration limit was established by the EPA as an alternative form of the standards for use in cases where the DOE determined that the alternative was appropriate.

In establishing the emission limitation for tailings piles, the EPA sought to reduce both the maximum risk to individuals living near the sites and the risk to the population as a whole. The radon standard will limit the increase in radon concentration attributable to a pile to a small increase above the background radon level near the disposal site. Both radon standards are design standards with compliance to be determined on the basis of predicted rather than measured emission rates and concentrations. The EPA states that "post-remediation monitoring will not be required to show compliance, but may serve a useful role in determining whether the anticipated performance of the control system is achieved."

In establishing the radon standard, the EPA determined that the emission limitation could be achieved by well-designed thick earthen covers, and that such control techniques would be compatible with the requirements of the EPA longevity standard.

2.4 WATER RESOURCES PROTECTION

The proposed EPA groundwater standards require characterization of the hydrogeologic regime at inactive uranium mill tailings and processing sites such as the Monument Valley and Mexican Hat sites (40 CFR 192). These regulations state that "judgments on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in the EPA's hazardous waste management system (47

FR 32274)." The EPA standards (40 CFR 192) were published on January 5, 1983, and became effective on March 7, 1983. However, on September 3, 1985, the U.S. Tenth Circuit Court of Appeals remanded the groundwater standards, 40 CFR 192.2(a)(2)-(3). The EPA issued proposed groundwater standards on September 24, 1987.

Under the UMTRCA, the DOE must comply with the proposed standards until final standards are promulgated. The design for the codisposal of the Monument Valley and Mexican Hat contaminated materials at the Mexican Hat disposal site has been formulated to comply with the requirements of the proposed standards. Codisposal at the Mexican Hat disposal site would not preclude subsequent design enhancements at the disposal site, if needed, to achieve compliance and would not limit the selection of reasonable groundwater restoration methods that may be necessary when final standards are promulgated.

When the final EPA standards are promulgated, the DOE will reevaluate its groundwater protection plan for the Mexican Hat disposal site and undertake such action necessary to ensure that the final standards are met. The need for and extent of aquifer restoration at both the Mexican Hat and Monument Valley sites will be evaluated in a separate National Environmental Policy Act (NEPA) decision-making process.

2.5 CLEANUP OF LANDS AND BUILDINGS

The EPA evaluated the risk associated with the dispersal of tailings off the site and concluded that the principal risk to man was the exposure to radon daughter products inside buildings. The EPA therefore stated that the objective of tailings cleanup from around existing structures was to achieve an indoor radon daughter concentration (RDC) of less than 0.02 working level (WL). For open lands, the purpose of removing the contamination is to remove the potential for excessive indoor RDCs that might arise from new construction on contaminated land.

A standard of 5 picocuries per gram (pCi/g) and 15 pCi/g radium-226 (Ra-226) concentration limits for 15-centimeter (cm) surface and subsurface layers, respectively, were considered adequate to limit indoor RDCs to below 0.02 WL. Likewise, concentration limits for 15-cm surface and subsurface layers are 5 pCi/g and 15 pCi/g for Th-232. A secondary concern was to limit human exposure to gamma radiation.

The standard requires that RRM be removed from buildings exceeding 0.03 WL. In cases where levels are between 0.02 and 0.03 WL, the Federal government will have the flexibility to use measures such as sealants, filtration devices, or ventilation devices to reduce concentrations to below 0.02 WL.

3.0 SITE CHARACTERIZATION SUMMARY

This section summarizes the preconstruction conditions of the Mexican Hat and Monument Valley sites, with emphasis given to radiation, geology, and groundwater due to their importance in the remedial action design. The detailed characterizations of the Mexican Hat disposal site and Monument Valley tailings site are found in Appendix D, Site Characterization.

3.1 SITE DESCRIPTIONS

Monument Valley site

The Monument Valley tailings site is on the Navajo Reservation in Arizona, 17 road miles south of the Mexican Hat disposal site (Figure 3.1). The tailings are on the west side of Cane Valley at an elevation of approximately 4900 feet above mean sea level. The climate is arid, with an average annual precipitation of six inches. Vegetation along the sides of Cane Valley is sparse, consisting of plant species adapted to the dry environment. Vegetation in the valley bottom is somewhat more lush, especially along the ephemeral Cane Valley Wash where small springs and seeps are scattered.

The mill at the Monument Valley site was operated from 1955 to 1968 by Vanadium Corporation of America and its successor, Foote Mineral Company. All of the mill buildings and most of the milling equipment have been removed from the site. The two tailings piles, the concrete building foundations, and debris remain at the site (Figure 3.2). The two irregularly shaped tailings piles occupy approximately 28 acres in the center of the 100-acre designated site and contain 1,030,000 cy of tailings. The total amount of contaminated materials, including the tailings, soils beneath and around the tailings, and other contaminated materials, is estimated to be 1,100,000 cy.

Four Navajo residences are located within 0.25 mile of the tailings piles.

Mexican Hat site

The Mexican Hat site is approximately eight miles north of the Utah-Arizona state line and two road miles southwest of Mexican Hat, Utah. It lies within the Navajo Reservation (Figure 3.1). The area is situated in an arid region with desert terrain. Major topographic features of the area include the San Juan River to the north and Alhambra Rock to the west. The land is mainly used for livestock grazing and residences.

The 235-acre designated site (Figure 3.3) consisted of two tailings piles covering 69 acres. Several of the original mill buildings and structures and concrete pads for the former mill building and trade school building remained in place until they were demolished by the DOE during Phase I remedial action in 1987. A former mill building was decontaminated

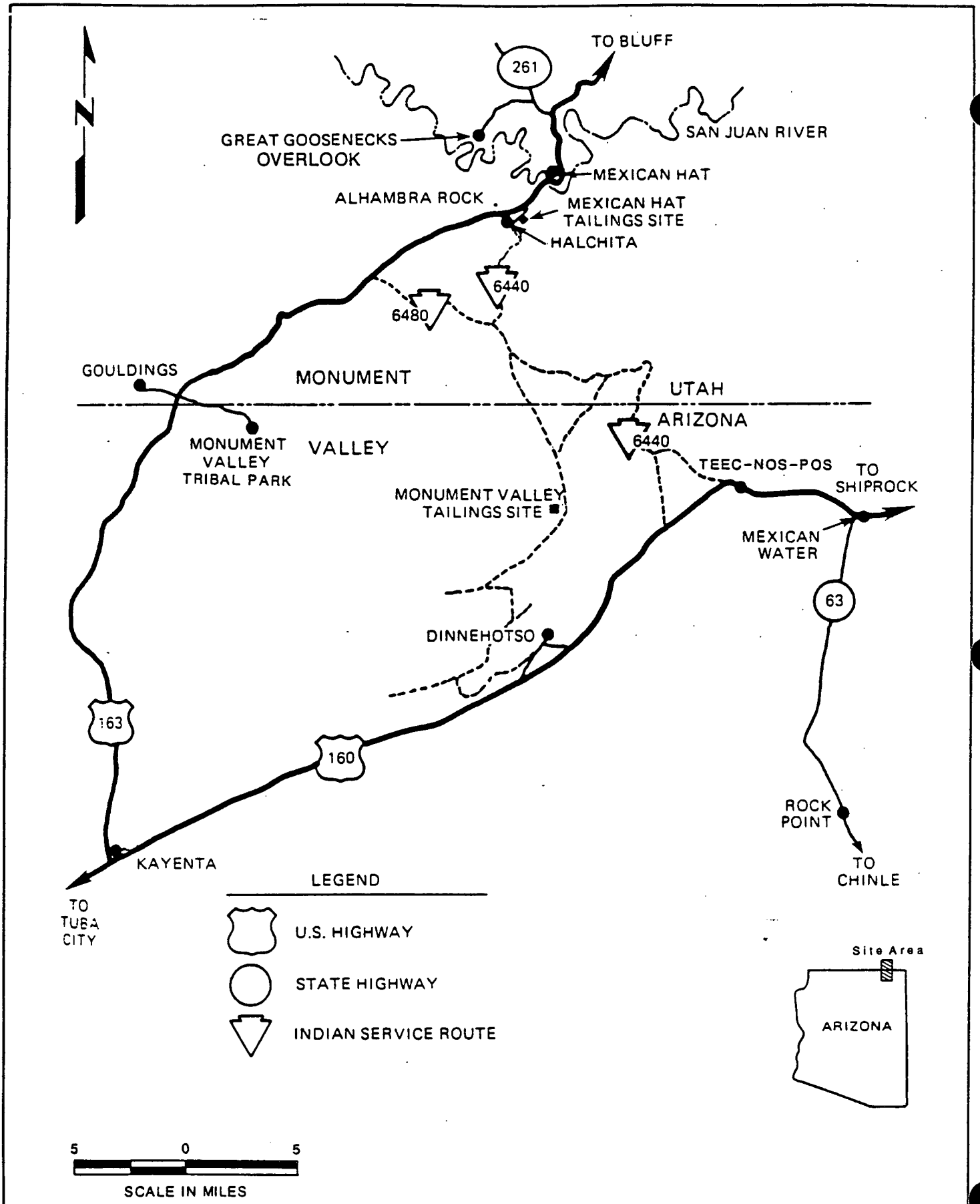
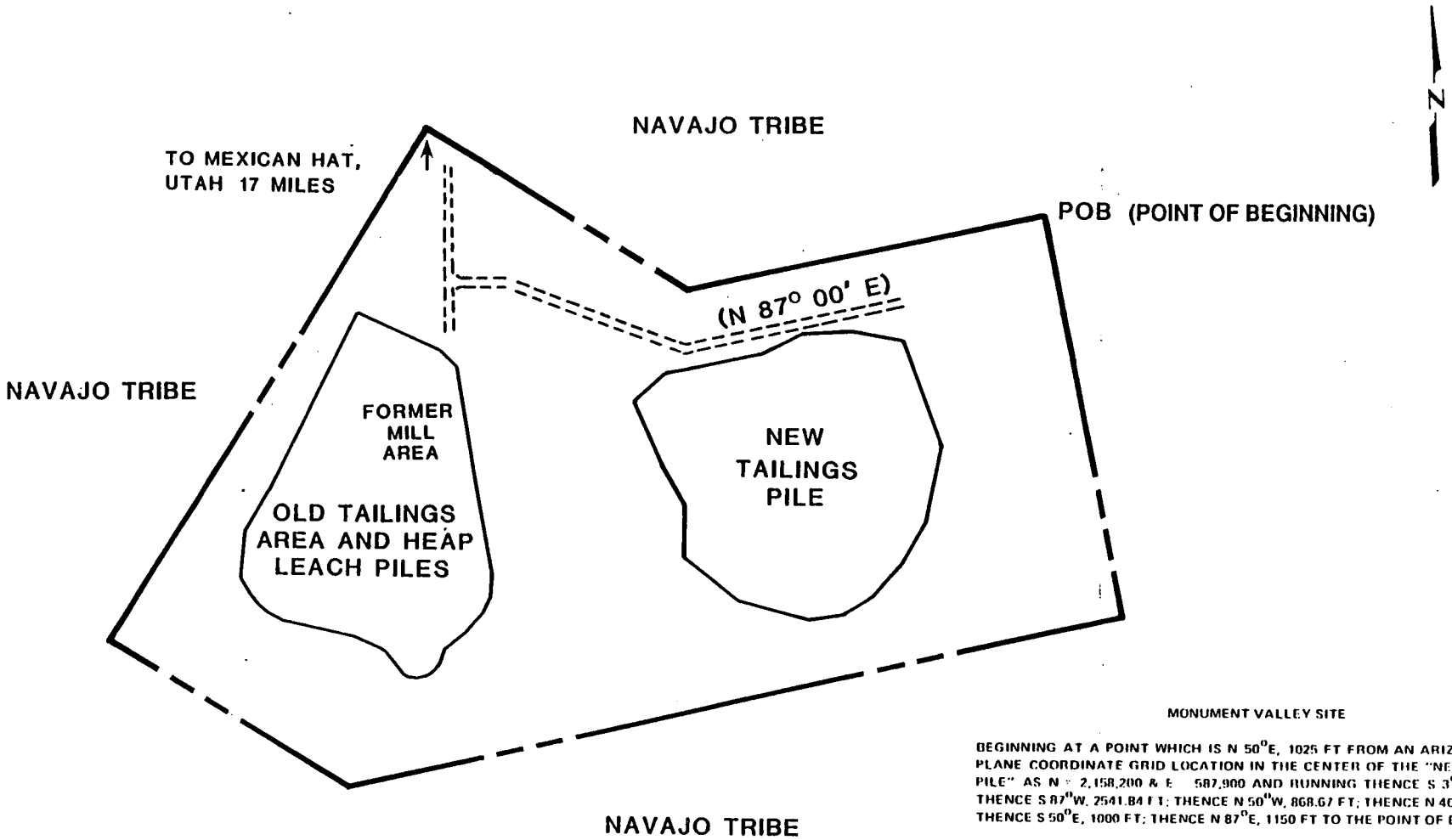


FIGURE 3.1

LOCATIONS OF THE MONUMENT VALLEY AND MEXICAN HAT SITES



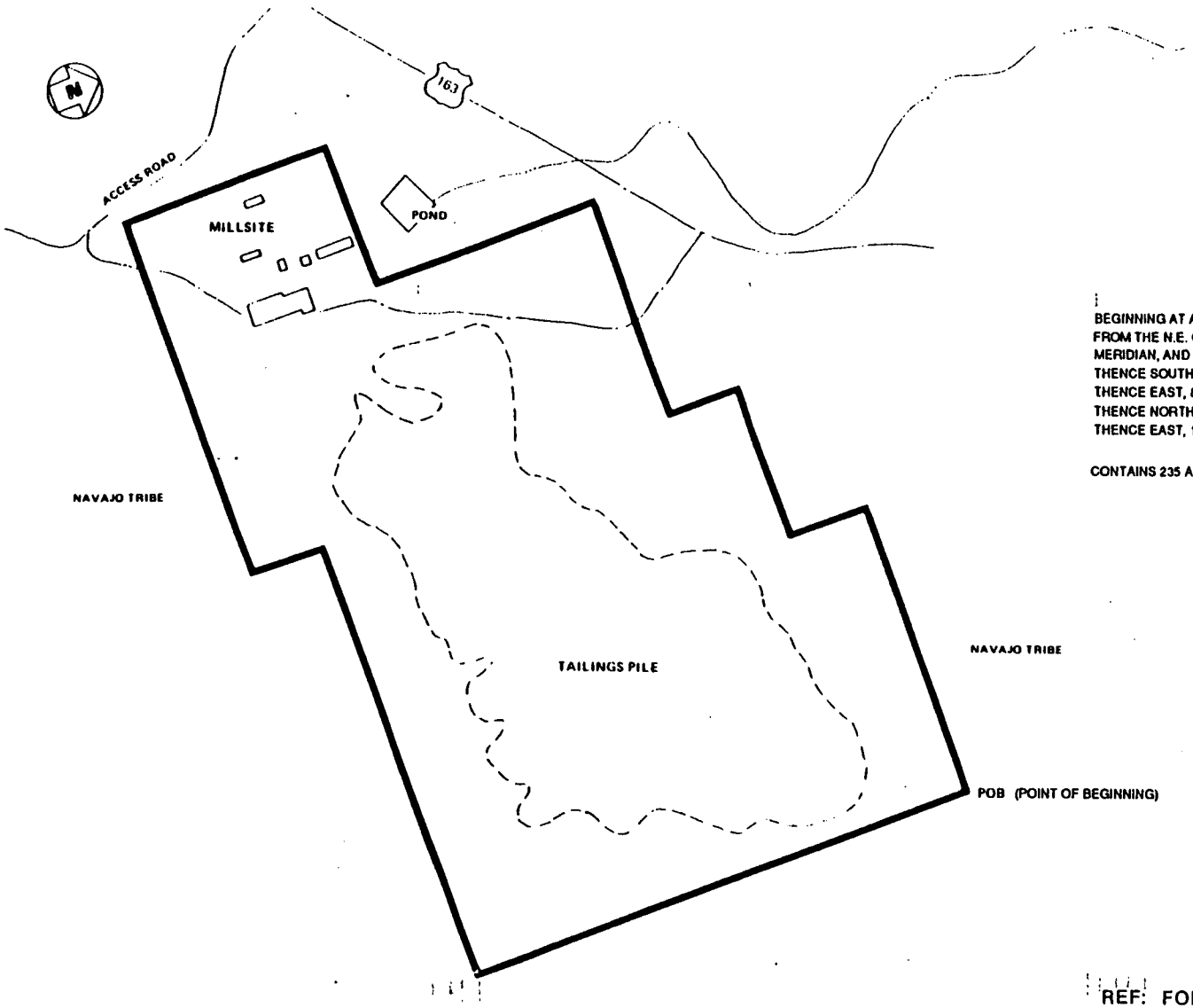
MONUMENT VALLEY SITE

BEGINNING AT A POINT WHICH IS N 50°E, 1025 FT FROM AN ARIZONA STATE PLANE COORDINATE GRID LOCATION IN THE CENTER OF THE "NEW TAILINGS PILE" AS N = 2,158,200 & E = 587,900 AND RUNNING THENCE S 3°E, 1300 FT; THENCE S 87°W, 2541.84 FT; THENCE N 50°W, 868.67 FT; THENCE N 40°E, 1900 FT; THENCE S 50°E, 1000 FT; THENCE N 87°E, 1150 FT TO THE POINT OF BEGINNING.

CONTAINS 101 ACRES (MORE OR LESS)

NO SCALE

FIGURE 3.2
MONUMENT VALLEY SITE DESIGNATION



MEXICAN HAT SITE

BEGINNING AT A POINT WHICH IS SOUTH 6899.96 FT. AND EAST 6746.01 FT. FROM THE N.E. CORNER OF SECTION 7, T42S, R19E, SALT LAKE BASE AND MERIDIAN, AND RUNNING THENCE SOUTH, 2800 FT.; THENCE WEST, 2400 FT; THENCE SOUTH, 400 FT; THENCE WEST, 2000 FT; THENCE NORTH 1200 FT; THENCE EAST, 800 FT; THENCE NORTH, 1200 FT; THENCE EAST, 1200 FT; THENCE NORTH, 400 FT; THENCE EAST, 800 FT; THENCE NORTH, 400 FT; THENCE EAST, 1600 FT; TO THE POINT OF BEGINNING.

CONTAINS 235 ACRES (MORE OR LESS).

NO SCALE

REF: FORD, BACON & DAVIS UTAH, INC., 1981a.

FIGURE 3.3
MEXICAN HAT SITE DESIGNATION

and is used as the Halchita Health Clinic. An elementary school and the housing area are approximately 0.3 and 0.6 mile southwest of the former mill site, respectively.

The mill was constructed and operated from 1957 to 1963 by Texas-Zinc Minerals Corporation. The plant was then sold to Atlas Corporation and operated until 1965. During operation, approximately 2.2 million tons of ore were processed to produce 5700 tons of uranium oxide (U_3O_8) concentrate.

Phase I remedial action was completed in 1987. It consisted primarily of demolishing the remaining mill buildings (except the sheet metal shop), constructing a vehicle decontamination pad and retention basins, and fencing the site.

Partial Phase II remedial action was completed in 1990. It included the placement of demolition debris in the disposal cell (the lower tailings pile), removal and disposal of upper tailings and windblown and waterborne materials in the disposal cell, and incorporation of permanent drainage features.

3.2 RADIATION

This section summarizes the characterization of radioactive materials at the Monument Valley and Mexican Hat uranium mill tailings sites. The details of the characterization investigations and of the calculations leading to the summary values for the Mexican Hat disposal site are contained in Appendix D, Site Characterization.

Radiological data from the vicinity of the sites have been collected in numerous investigations since 1961. The radiological data summarized here describe background radiological conditions, increases of radiation above background due to the tailings, the extent and degree of the contamination on the site and in its vicinity, and the volume and average radioactivity of the contaminated materials.

3.2.1 Background radiation--Monument Valley and Mexican Hat sites

Background radioactivity data provide a reference to which levels of contamination can be compared in assessing the extent of contaminated areas requiring cleanup and the magnitude of radioactive releases from the site. Radioactive elements occur naturally throughout the earth's air, water, and soil. The concentration of these elements varies greatly throughout the United States. Background soil radioactivity averaged 1.0 pCi/g at the Monument Valley site and 1.1 pCi/g at the Mexican Hat site for Ra-226.

The average background gamma radiation exposure rate from both terrestrial and cosmic sources measured at three feet above the ground is 11 microroentgens per hour (microR/hr) at both the Monument Valley and Mexican Hat sites. Quarterly average measurements for background radon-222 (Rn-222) were made at various locations around both sites for an entire year using integrating film-type radon detectors. The annual average background Rn-222 concentrations at the Monument Valley and Mexican Hat sites were 0.37 and 0.61 picocuries per liter (pCi/l), respectively.

3.2.2 Preconstruction conditions

The radioactive materials at the Monument Valley and Mexican Hat sites cause the ambient radiation to be above natural background. Measurements of on-site gamma exposure rates, airborne particulates, and radon concentrations in air are summarized below. These are important in estimating the radiological hazard produced by the site.

Monument Valley site

- The Ra-226 contamination at the Monument Valley site is of relatively low activity (50 to 60 pCi/g) but is spread extensively across the entire area. Due to the low activity, it is estimated that only 218 curies per year (Ci/yr) of radon are released from all contaminated materials on the site.

- Most of the contaminated materials are very coarse, ranging in size from about a millimeter in diameter to small rocks. This is a result of the upgrading process used, in which the fines were extracted and transported off the site for further processing. Thus, there is very little windblown contamination. Although the material is coarse, airborne particulate measurements on and near the tailings showed thorium-230 (Th-230) levels up to 56 percent of the levels allowed for continuous exposure by the public (4 E-14 mCi/mL of soluble thorium) (DOE Order 5400.5).

- The on-site radon concentration was estimated from six radon monitoring locations around the site perimeter. The annual average concentration at these six locations was 1.6 pCi/l.

Mexican Hat site

- Off-site gamma exposure rate measurements indicate exposure rates elevated above background as much as 2500 feet downwind (east-northeast).

- Contamination has been transported by site runoff down many of the deep arroyos leading off the site. Radionuclides were also dumped into a lateral arroyo during processing.

- Airborne particulates were measured on and near the tailings piles. The maximum permissible concentrations (MPC) for unrestricted releases were not exceeded for Th-230. The 11-day averages reached 17 percent of the MPC for Th-230.

- The on-site radon concentration was estimated from four monitoring locations around the site perimeter. The annual average concentration for the four locations was 7.8 pCi/l.

3.2.3 Contaminant distribution

Monument Valley site

The contaminated areas of the Monument Valley site and its vicinity are shown in the excavation plan in calculation No. 19-332-01-00, pages 26-27, "Site Excavation and Average Contamination," in Appendix B (Volume II). The origin and extent of the contamination are summarized below.

The uranium mill tailings at the Monument Valley site are in six distinct areas, with other substantially smaller volumes scattered around the periphery. The largest volume (about 769,000 cy) is in and beneath the lower pile and pond area. The lower pile is a cone about 1000 feet in diameter and about 60 feet high. An additional 259,000 cy are in and beneath the upper pile and heap leach pads. The material beneath the tailings in the lower pile and leached ore in the heap leach pads is contaminated. However, the contamination extends only about a foot deeper than the physical interface between the tailings and the ground.

The processing of the original material (fines separation) was performed on the ridge leading from the Monument No. 2 Mine, immediately west of the heap leach pad. The coarse sand fraction was stored at the site of the heap leach pads. The ore storage and mill yard area was built up from the original topography with pit run rock, and is referred to as Area E in subsequent discussions.

In October 1964, equipment was installed for batch leaching of the sand fraction. The area of the installation (Area C) was built up and leveled using pit run rock and is located between the upper pile and the lower pile. As a result, approximately 23,700 and 14,000 cy of Areas E and C, respectively, are mildly contaminated. The batch leach operation processed the coarse sand fraction from the area of the heap leach pads. The resulting tailings were used to form what now is the lower pile. A small remnant of the original old pile of coarse fraction material comprises Area D. In addition, remnants of the coarse fraction material lie along the eastern edge of Area E over the steep drop-off to the heap leach pads. After processing virtually all of the coarse fraction in the batch leach plants, the depression beneath the old pile was filled with very coarse low grade ore. This material was heap leached in place and has remained undisturbed.

A small area northeast of the heap leach pads and immediately north of the batch leach area is also contaminated with what appears to be windblown tailings. However, the windblown area north of the lower pile extends only several hundred feet. This indicates that the materials northeast of the heap leach pads are remnant tailings left over from the batch leach operation, and not windblown.

Other areas near the site have small amounts of contamination. About 20 sites north of the former ore storage and mill yard area contain piles (10-foot radius and one foot deep) of rubble that are slightly contaminated. These appear to be associated with housing

(temporary structures) for the mine and mill workers. In addition, roads were constructed for the mine and mill operations throughout the processing site area and from the mine site on the ridge to the west. The roads were built with a brown siltstone overlying a gray-green mudstone that appears to have been taken from the Monument No. 2 mine. The mudstone averages about 50 pCi/g of Ra-226. Pit run rock from the mine was also used for fill where the roads cross the many arroyos around the site.

Table 3.1 summarizes the volumes and Ra-226 concentrations of all major areas on the site. The total volume of contaminated material is about 1,083,000 cy (Appendix B, Calculation 19-332-01-00).

Table 3.1 Summary of volumes and radium concentration of contaminated materials at the Monument Valley site

Area description	Contaminated volume (cy)	Average Ra-226 concentration (pCi/g)
Lower pile	759,964	46.7
Evaporation pond	9,000	219.6
Heap leach pads (upper pile)	258,936	51.2
Area E (ore storage) and miscellaneous area	32,922	66.0
Area C (batch leach yard)	14,036	38.3
Area D (old pile remnant)	1,406	40.0
Rubble piles	4,129	67.8
Roads	3,000	37.3
Total	1,083,393	49.7[a]

[a]Volume-weighted average.

Mexican Hat site

The site is in a wash area that drains toward the north into the San Juan River, approximately 250 feet lower in elevation. To the south and east, the site is bounded by a near-vertical ridge about 100 feet high. The site is cut by numerous dry washes that are 20 to 40 feet deep and up to 100 feet wide. Before the start of Phase II construction, the uranium mill tailings at the Mexican Hat site were in two discrete piles. The lower of the two tailings ponds was constructed by damming one of these washes. As the tailings filled in, the dam height was increased using tailings as the embankment material.

The upper and lower tailings piles were uncovered and averaged Ra-226 contents of 624 and 763 pCi/g, respectively. It was originally estimated that the upper pile contained 883,010 cy and the lower pile contained 1,623,000 cy of tailings. The average depths of these two piles were 21.5 feet (upper pile) and 23.6 feet (lower pile). Maximum depth of the upper pile was 39.8 feet and of the lower pile, 56.1 feet. There was a total of 597 Ci in the upper pile and 1421 Ci in the lower pile.

The material beneath the tailings piles consists of a thin layer of about 1.5 feet of original soil material underlain by Halgaito Formation bedrock. This entire soil layer is contaminated above the EPA standards of 15 pCi/g Ra-226. The average depths from the physical interface to the 15 pCi/g interface (bedrock) were 1.8 and 1.6 feet for the upper and lower piles, respectively.

Other sources of contaminated material on the site include the mill yard, ore storage area, a backfilled trench leading off the site to the north, and areas of windblown and waterborne contamination. All of these represent less than 10 percent of the volume of the tailings piles themselves. Table 3.2 summarizes the volumes and Ra-226 concentrations of all major areas on the site. The estimated volume of contaminated materials at the Mexican Hat site is 2,772,500 cy. The values in Table 3.2 were obtained from Calculations 9-226-03-00, 9-226-02-01, 9-239-05-02, Appendix A, Volume II.

A single exposure rate measurement was obtained from the center of the Health Clinic–Building 8. The reading was near background levels of 13 microR/hr. All other buildings have been demolished except the sheet metal shop, which will be decontaminated and left intact.

Table 3.2 Summary of volumes and radium concentration of contaminated materials at the Mexican Hat site

Area description	Contaminated volume (cy)	Average Ra-226 concentration (pCi/g)
Upper pile	883,000	624
Lower pile	1,623,000	763
Windblown/waterborne	266,500	59
Total	2,772,500	650[a]

[a]Volume-weighted average.

3.3 GEOLOGY, GEOMORPHOLOGY, AND SEISMICITY

3.3.1 Introduction

Detailed investigations of geologic, geomorphic, and seismic conditions at the Monument Valley and Mexican Hat sites were conducted by the DOE. The purpose of the investigations was to obtain site characterization data and identify potential geologic hazards that could affect long-term site stability. Subsequent engineering studies such as the analyses of hydrologic and liquefaction hazards relied on the data obtained in these investigations. The findings of these investigations for the Mexican Hat disposal site are discussed in detail in Section D.4 of Appendix D, Site Characterization.

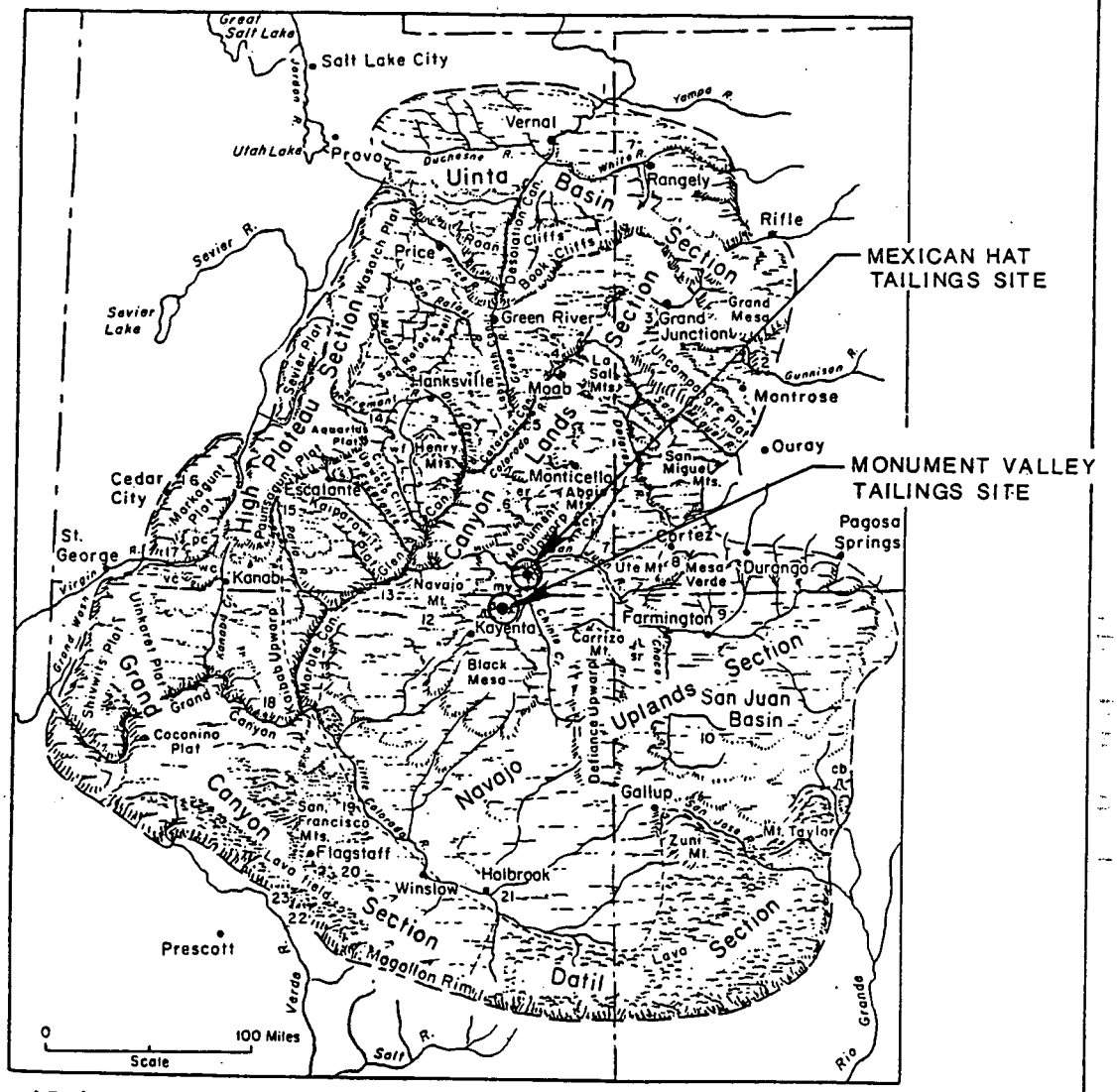
The scope of work performed included the following:

- Compilation and analysis of previous geologic literature and maps.
- Review of historical seismic data.
- Review of site-specific geologic data, including logs of exploratory boreholes advanced in the site area.
- Photogeologic interpretation of existing LANDSAT and conventional aerial photographs.
- Low-sun-angle aerial reconnaissance of the site region.
- Ground reconnaissance and mapping.

3.3.2 Geologic setting

Monument Valley site

The Monument Valley site is located in the northern part of the Navajo section of the Colorado Plateau physiographic province (Hunt, 1967) (Figure 3.4). This area is actually the eroded crest of a large north-south-trending anticline, the Monument Uplift (also referred to as the Monument Upwarp). Over most of the region surrounding Monument Valley, relatively resistant Mesozoic rocks are exposed at the surface. However, within Monument Valley, erosion has breached these resistant units and carved the underlying less-resistant Permian units into a wide array of mesas, buttes, spires, and pinnacles (Stokes, 1973). Many of these monuments seem to have been preserved because underlying rocks have been protected from erosion by a resistant caprock, formed by the Triassic Shinarump Conglomerate Member of the Chinle Formation. The Shinarump is the major source of the uranium-vanadium deposits in the site region, and is also the major unit underlying the existing tailings piles.



National Parks and Monuments

1. Dinosaur Nat. Mon.
2. Black Canyon of the Gunnison Nat. Mon.
3. Colorado Nat. Mon.
4. Arches Nat. Mon.
5. Canyonlands Nat. Park
6. Natural Bridges Nat. Mon.
7. Hovenweep Nat. Mon.
8. Mesaverde Nat. Park
9. Aztec Ruins Nat. Mon.
10. Chaco Canyon Nat. Mon.
11. Canyon de Chelly Nat. Mon.
12. Navajo Nat. Mon. (Betatakin and Kiet Seel)
13. Rainbow Bridge Nat. Mon.
14. Capitol Reef Nat. Mon.
15. Bryce Canyon Nat. Park
16. Cedar Breaks Nat. Mon.
17. Zion Nat. Park
18. Grand Canyon Nat. Park
19. Wupatki and Sunset Crater Nat. Mons.
20. Walnut Canyon Nat. Mon.
21. Petrified Forest and Painted Desert Nat. Mon.
22. Montezuma Castle Nat. Mon.
23. Tuzigoot Nat. Mon.

Escarpments at South End of High Plateaus

pc Pink Cliffs
wc White Cliffs
vc Vermilion Cliffs

Other Prominent Features

wf Waterpocket Fold
er Elk Ridge
cr Comb Ridge
mv Monument Valley
ag Agathla Peak
sr Shiprock
cb Cabezon Peak

REF: HUNT, 1967

FIGURE 3.4

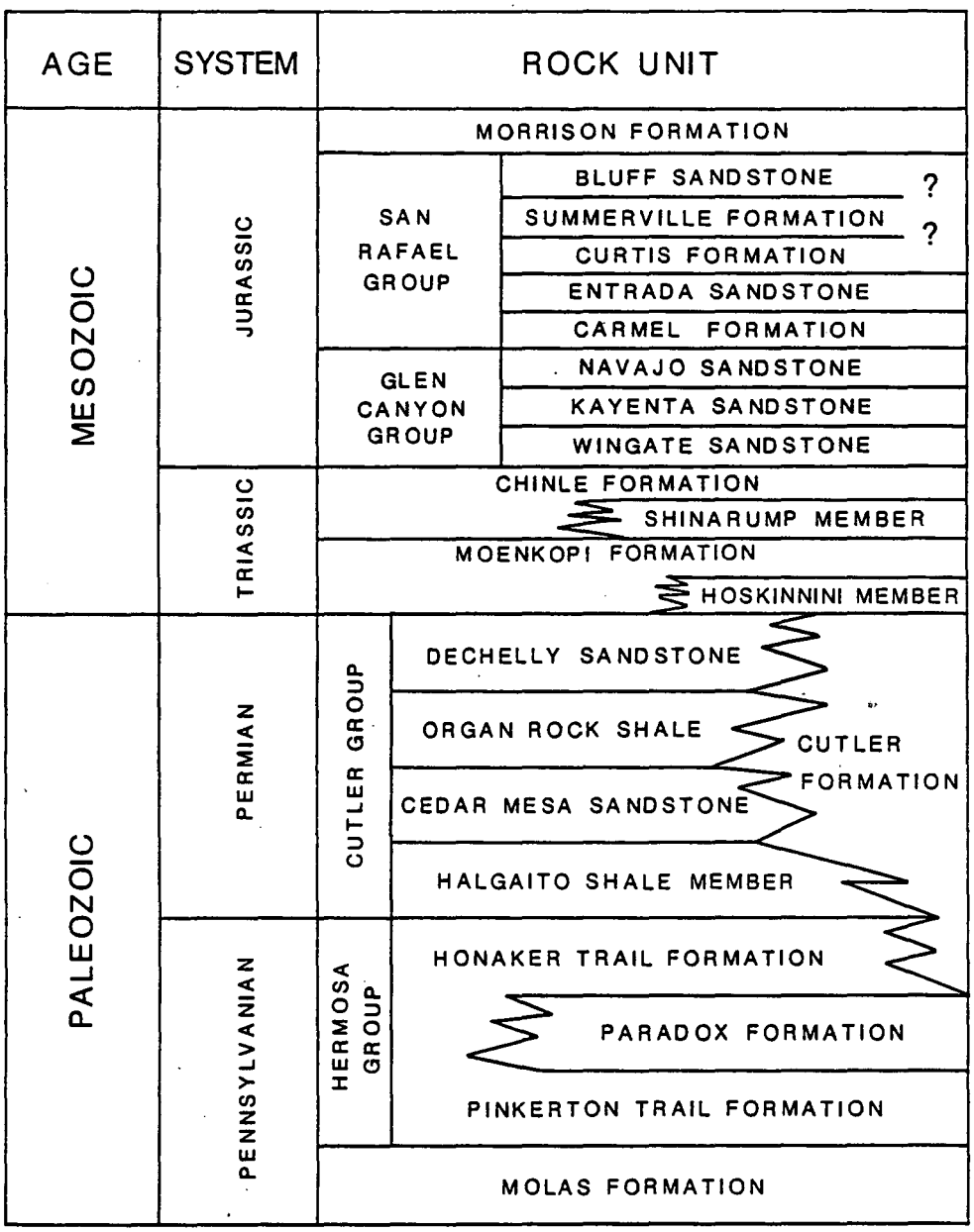
PHYSIOGRAPHIC MAP OF THE COLORADO PLATEAU IN THE REGION OF THE MONUMENT VALLEY AND MEXICAN HAT SITES

Bedrock in the site region consists predominantly of marine to continental sediments ranging in age from Late Paleozoic to Jurassic (Haynes and Hackman, 1978; Hackman and Wyant, 1973; Haynes et al., 1972; O'Sullivan and Beikman, 1963; Witkind and Thaden, 1963; Witkind, 1956) (Figure 3.5). Minor intrusives of Tertiary to Quaternary age are also present. Evaporite deposits are not known to occur in significant amounts in the strata underlying the site. The bedrock units are overlain by unconsolidated materials of Quaternary age, chiefly eolian and alluvial in origin.

In 1951 and 1952, the U.S. Geological Survey carried out a program of geologic mapping and uranium investigations in Apache and Navajo Counties, Arizona. These studies included detailed mapping of the area of the Monument No. 2 mine, which also encompasses the area of the Monument Valley tailings site. Results of these studies were published as bulletins in the U.S. Geological Survey (Witkind and Thaden, 1963; Witkind, 1956) and served as the primary source of published geologic data for this study.

A diagram of the position of the tailings relative to bedrock and surficial units is shown in Figure 3.6. The tailings are distributed in two separate areas, referred to as the upper and lower tailings piles for this study (not shown separately on Figure 3.6). The upper tailings pile is located within a small intermittent wash that drains northeastward into Cane Valley Wash. It is underlain partly by bedrock and partly by unconsolidated alluvium and eolian sand. The exposed bedrock is primarily the Shinarump Conglomerate Member of the Triassic Chinle Formation. Outcrops of the Triassic Moenkopi Formation and the underlying Hoskinnini Tongue of the Permian Cutler Formation, which underlies the Chinle, are not exposed near the piles. However, published maps (Witkind and Thaden, 1963; Witkind, 1956) indicate that they may occur at the original ground surface beneath the upper tailings pile. The lower tailings pile, located just east of the upper pile, lies on eastward-dipping beds of the Shinarump and dune sand that overlies the Monitor Butte Member of the Chinle formation in Cane Valley Wash. The sand dune (as encountered in exploratory boreholes advanced on the site) consists of uncemented, fine- to medium-grained sand with occasional lenses of fine gravel. Its thickness appears to vary from about 20 to 30 feet along the eastern edge of the pile. This material is evidently saturated at shallow depths, possibly to within about three meters of the original ground surface beneath the new tailings pile.

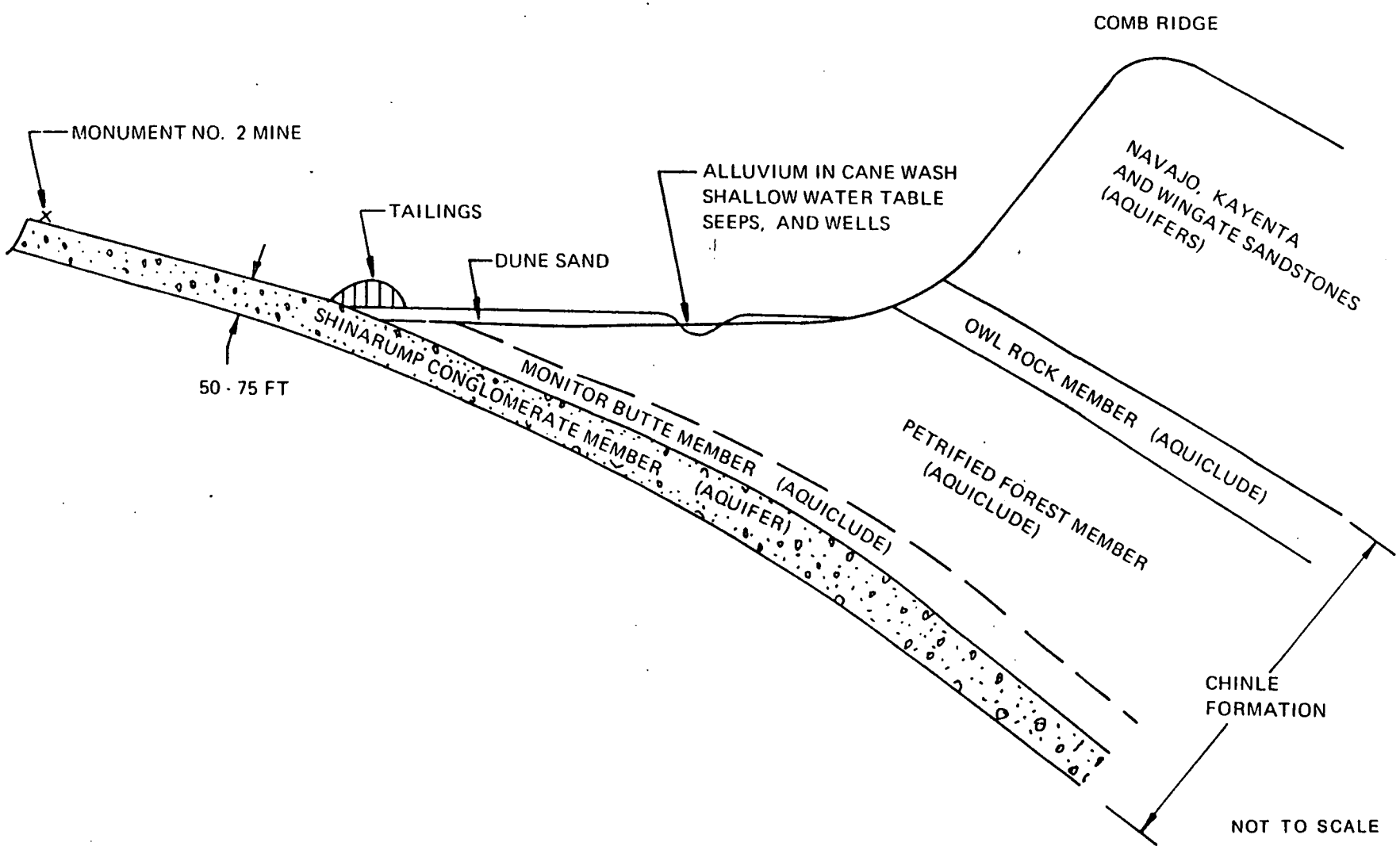
There are no major faults in the site region. Small-scale normal and reverse faults, having displacements of only a few inches or feet, occur most commonly within the Monitor Butte Member of the Chinle Formation, and to a lesser extent in the Moenkopi and Summerville Formations. All exposed formations are cut by joints. The dominant joint sets range from N25'W to N65'W; from north to N15'E; and almost due east. All sets are vertical or nearly vertical.



MODIFIED FROM WOODWARD-CLYDE CONSULTANTS, 1982

FIGURE 3.5

GENERALIZED STRATIGRAPHIC COLUMN AT THE MONUMENT VALLEY AND MEXICAN HAT SITES



FROM: FBDU, 1981b.

FIGURE 3.6
GENERALIZED EAST-WEST STRATIGRAPHIC CROSS SECTION OF THE MONUMENT VALLEY SITE

Mexican Hat site

The Mexican Hat site is in southeastern Utah, within the Navajo Uplands subdivision of the Colorado Plateau physiographic province (Figure 3.4). A portion of the area of investigation is within the adjacent Monument Valley subdivision of the Arizona-Utah region of the plateau. The Monument Valley region is characterized by steep-walled mesas, buttes, and spires rising abruptly from a nearly featureless, stripped erosional surface. Physiographic features prevalent in the Navajo Uplands area include terraced mesas and "slickrock" surfaces cut by deep, steep-walled canyons containing perennial and ephemeral streams. Extensive portions of the mesas are covered with thin sand sheets and dune fields of Quaternary to Holocene age.

Tectonic and erosional processes have exposed strata of Late Paleozoic and Early Mesozoic age throughout most of the study area (Figure 3.5). Early Paleozoic sedimentary rocks lie at depth beneath the site and outcrop to the west in Monument Valley and far to the southeast in Canyon de Chelly. South of the Mexican Hat site area, in the Black Mesa region, abundant exposures of Cretaceous sedimentary strata occur. Pennsylvanian and Permian sedimentary strata outcrop at the tailings site.

Bedrock beneath the Mexican Hat tailings pile consists of the Halgaito Shale member of the Permian Cutler Group and the Pennsylvanian Hermosa Group (Figure 3.7). The sedimentary strata consist of marine and continental limestones, sandstones, siltstones, and shales. Beds are tilted to the east at about six to eight degrees. Thin, sporadic eolian sands occur as surface deposits in the Mexican Hat site area. Minor deposits of fluvial terrace gravels occur along the San Juan River about 1.9 kilometers (km) (1.2 miles) to the north.

Faulting is rare in the Mexican Hat area. The few mapped faults have offsets of a few inches to a few feet, and none are known to offset strata of Quaternary age. Thirty-one faults and fault trace zones examined within a 65-km radius of the site were determined to be non-capable.

Major structural features of the study region include the Monument Upwarp west of the site, the Comb Ridge monocline east of the site, and numerous associated anticlines and synclines. The tailings site is on the western limb of a syncline subordinate to the Monument Upwarp. The dominant structural features of the region probably formed during the Early Tertiary Period. Minimal tectonic activity has occurred since the end of the Eocene Epoch. The latest episodes of volcanic activity occurred during the Pliocene Epoch. There is no evidence of any potential for renewal of volcanic activity in the site area during the 1000-year design life. Economic mineral resources are not present in significant quantities in the site area. Therefore, no impacts on the long-term stability of the remedial action are expected to result from the exploitation of mineral resources in the area.

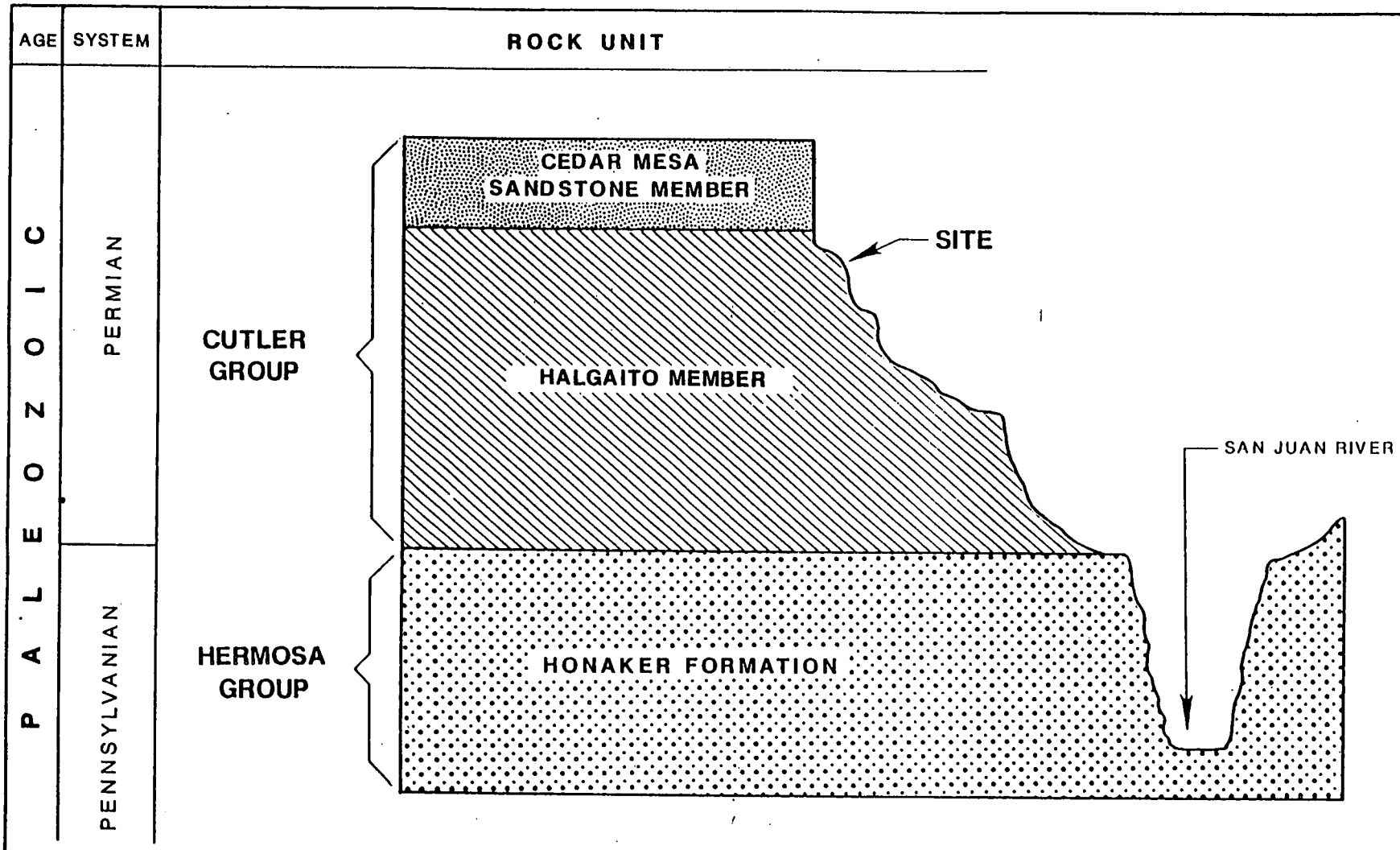


FIGURE 3.7
GENERALIZED STRATIGRAPHIC SECTION FOR THE MEXICAN HAT SITE REGION

3.3.3 Geomorphology

Monument Valley site

Wind erosion has scattered moderate amounts of fine-grained tailings around the area of the upper tailings pile and mill site, and along the north and east sides of the lower tailings pile.

Fluvial erosion of the upper tailings pile is occurring within a deeply incised channel passing through the pile and exiting to the northeast. Removal of the tailings during remedial action will eliminate further erosion hazards from this channel. Lateral channel migration and headward gully erosion within Cane Valley Wash south and east of the lower tailings pile present potential erosion hazards to that pile. Channel migration could shift the bed of Cane Valley Wash to a position adjacent to the tailings pile base, with a stream bed depth of up to 12 feet lower than the current elevation of the tailings pile edge. As with the upper pile, removal of the tailings during remedial action will eliminate further erosion hazards to the existing lower pile.

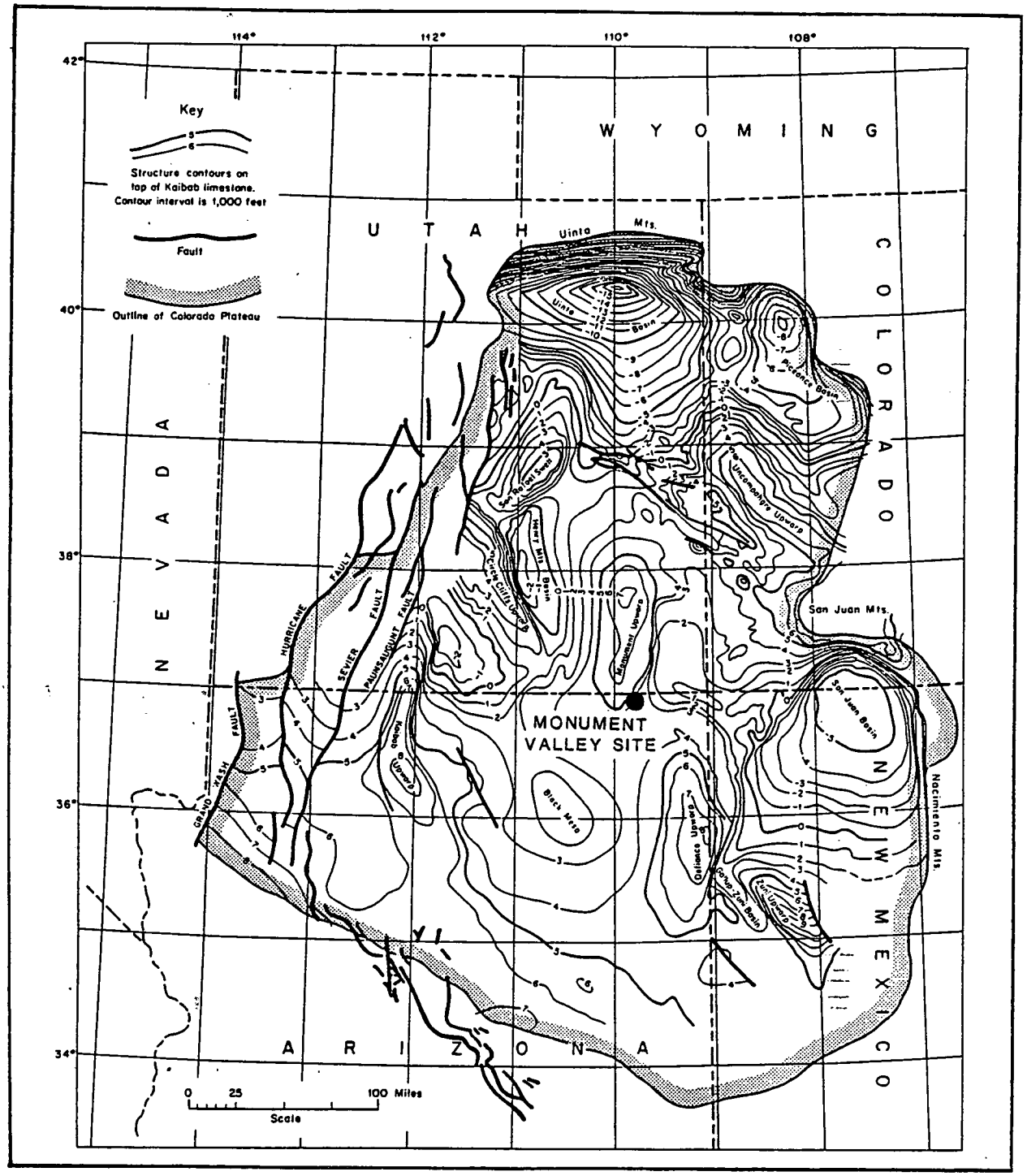
Mexican Hat site

Wind erosion and ephemeral stream channel erosion present the greatest geomorphic hazards to the Mexican Hat tailings site. The prevailing westward winds have removed fine-grained tailings from the existing pile. A fluvial erosion hazard is present from the two ephemeral stream channels near the north and east edges of the tailings pile. Lateral and headward erosion are possible in each of these channels. No hazards appear to be present from slope instability conditions or subsidence.

3.3.4 Seismicity

Monument Valley site

The Monument Valley site is in the central portion of the Colorado Plateau, a stable intracontinental subplate characterized by a thick cover of relatively flat-lying sedimentary rock of Phanerozoic age overlying a complex Precambrian igneous and metamorphic core (Figure 3.8). The central, stable portion of the plateau exhibits characteristics of cratonic areas, while the margins of the subplate exhibit crustal structure similar to more highly active bordering provinces. The plateau is bordered on the east, south, and west by the extensional, block-faulted regime of the Rio Grande Rift and Basin and Range Provinces. Since Late Tertiary time, the plateau has been experiencing gradual uplift at an average rate of about two millimeters per year (Gable and Hatton, 1980). This uplift is regional in character and produces relatively little internal deformation.



(AFTER HUNT, 1956)

FIGURE 3.8

STRUCTURE CONTOUR MAP OF THE COLORADO PLATEAU SHOWING THE MAJOR BASINS AND UPLIFTS AND LOCATION OF THE MONUMENT VALLEY SITE

A map of historical and instrumental seismicity of the southwestern United States is shown in Figure 3.9. The site is within a region that has been characterized by widely separated, low magnitude seismic events during historical times. Geologic evidence for Quaternary fault activity within the Colorado Plateau is rare.

The potential for on-site fault rupture at the Monument Valley site is statistically nonexistent, based on the geologic investigations conducted for this study. There is virtually no hazard at the site from reservoir-induced seismicity or seismically induced landslides. No evidence exists of any potential for volcanic activity in the site area.

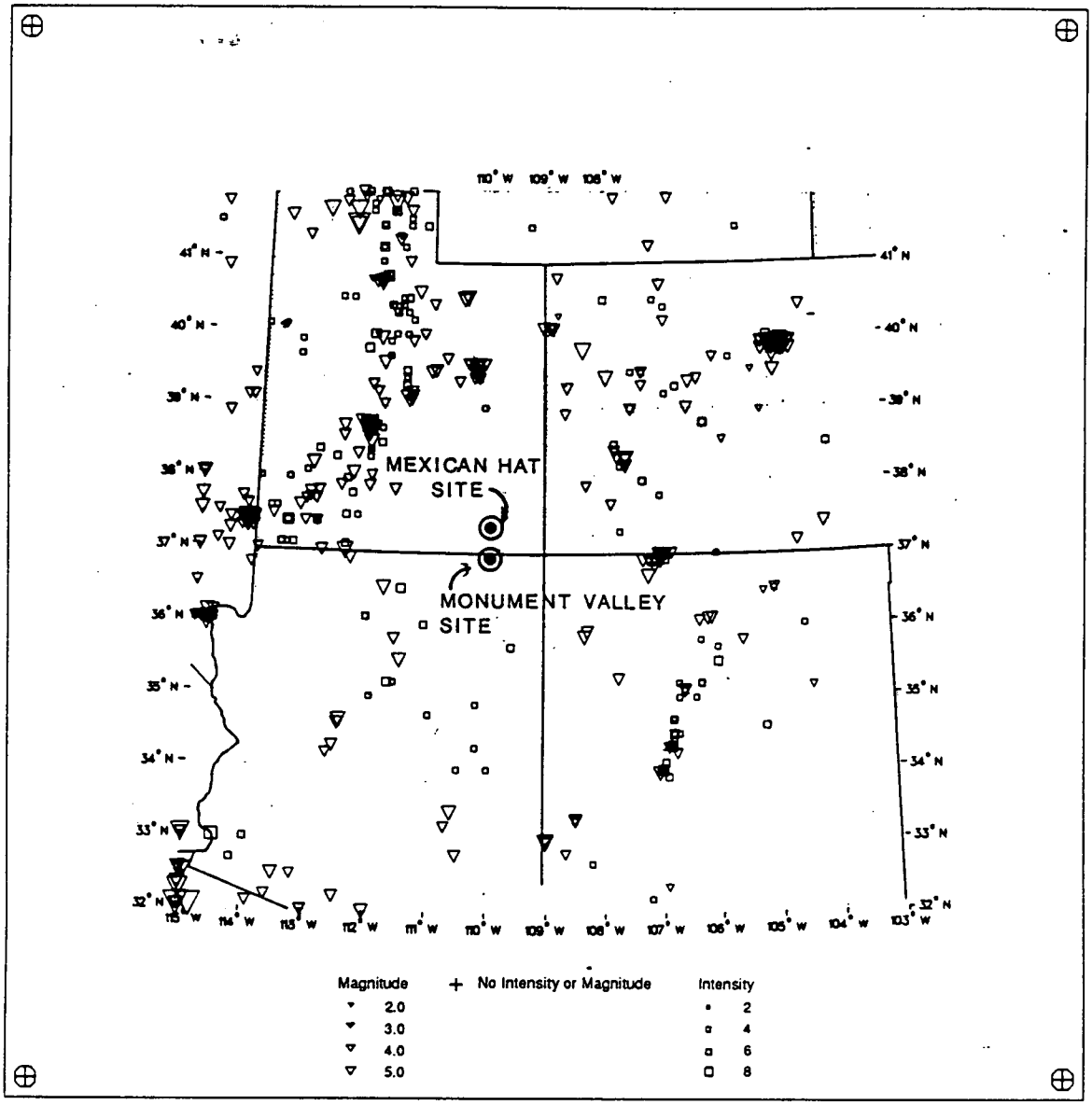
Mexican Hat site

The 200-km radius seismotectonic study area around the Mexican Hat site includes portions of the Colorado Plateau; Basin and Range; Rio Grande Rift; and Intermountain Seismic Zone seismotectonic provinces (Figure 3.10). The Colorado Plateau contains the Mexican Hat site and is the least tectonically active of the provinces. The largest historical earthquake in the Colorado Plateau occurred north of Flagstaff, Arizona, in 1912, and had a recorded magnitude of 5.5 to 5.75 on the Richter scale. The vast majority of Colorado Plateau interior events are microseismic. Outside of the San Francisco volcanic field, east of Flagstaff, neotectonic fault evidence is lacking or scanty. No historical earthquakes with recorded epicenters are reported within a 65-km radius of the Mexican Hat site. No capable faults have been identified within this same area.

A floating earthquake of magnitude 6.2 is considered to be the design earthquake for the Mexican Hat site. This event, as defined, could occur anywhere within the Colorado Plateau physiographic and seismotectonic province.

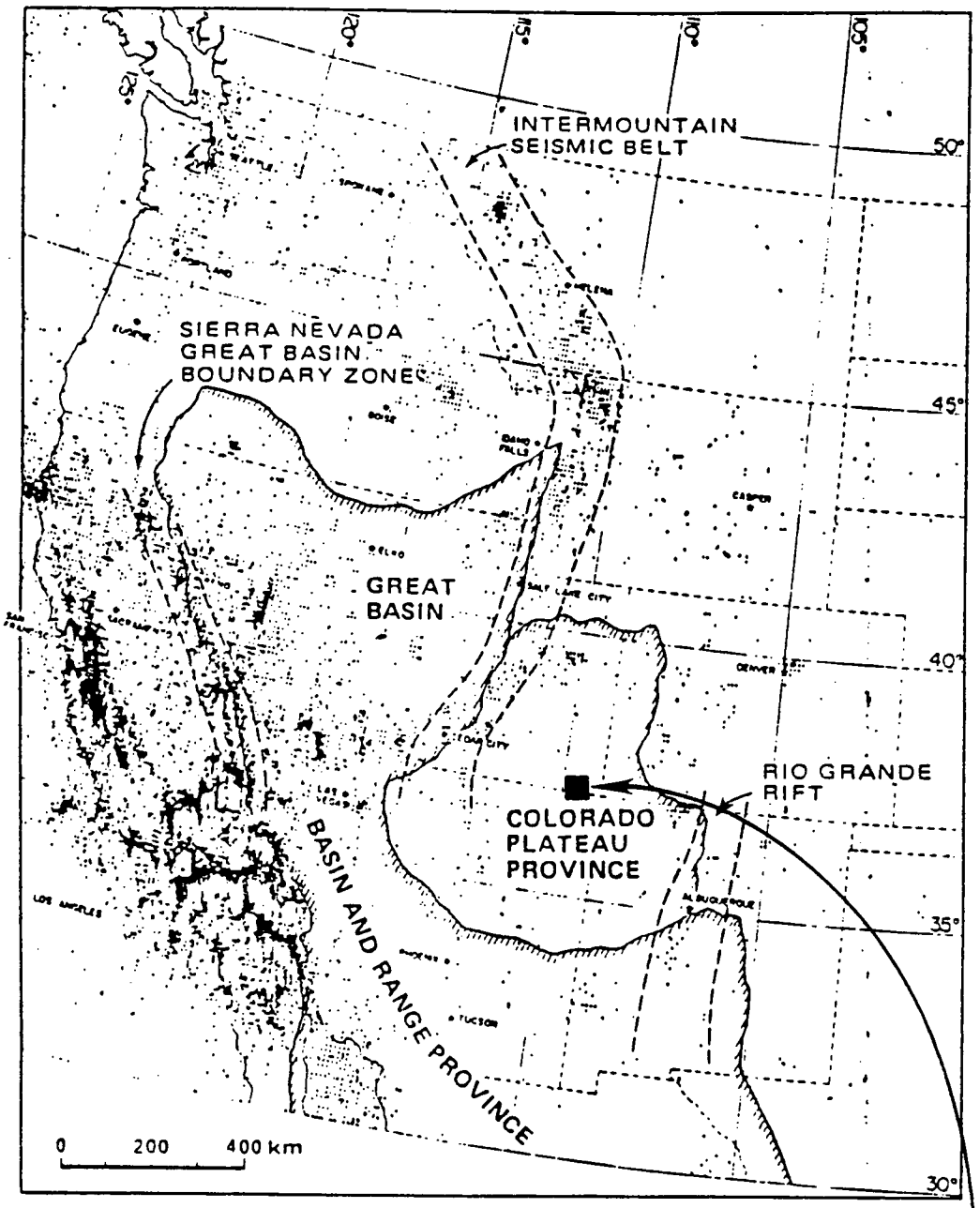
The UMTRA Project seismic evaluations assume that the floating earthquake will occur at a radial distance of 15 km from the site. It is estimated that such an event would produce an on-site, freefield, peak horizontal acceleration of 0.21 g. Existing north-to-northwest-trending faults located 200 to 300 km west of the site could host future earthquakes. These faults lie along the eastern edge of the historically active Intermountain Seismic Zone of southern Utah. The current northeast-southwest extensional regime appears to control regional seismic focus orientations of these fault systems. Activity on these faults would result in site accelerations less than that produced by the floating earthquake.

The potential for on-site fault rupture at the Mexican Hat site is statistically nonexistent based on the geologic investigations conducted for the study. There is virtually no hazard at the site from reservoir-induced seismicity or seismically induced landslides.



AFTER NGDC/NOAA, 1985.

FIGURE 3.9
MAP OF HISTORICAL AND INSTRUMENTALLY DETECTED EARTHQUAKE EPICENTERS OF THE SOUTHWESTERN UNITED STATES EPICENTRAL COMPILATION LIMITED TO EVENTS OF MAGNITUDE ≥4 AND/OR INTENSITY (MMI) ≥V.



REF: WONG ET AL., 1982

MEXICAN HAT, UTAH, AND
MONUMENT VALLEY,
ARIZONA SITE LOCATIONS

FIGURE 3.10

MAJOR SEISMIC ZONES OF THE BASIN AND RANGE - COLORADO PLATEAU PROVINCES

3.4 GEOTECHNICAL

3.4.1 Subsurface investigations

Monument Valley site

The site and nearby surrounding soils were characterized by drilling 49 boreholes and excavating 31 test pits (Appendix B, Information for Bidders, Volume III). Of the 49 boreholes, seven were completed for geotechnical soil data gathering in the natural soils, 18 holes were logged through soil and rock without gathering geotechnical soil data, six holes were logged solely through rock, and 18 holes were logged through tailings and into the underlying soils.

Six of the seven geotechnical boreholes (601 through 606) are east of the lower tailings pile. The seventh hole (607) is north of the upper tailings pile area. Continuous standard penetration tests (SPT) were conducted on each hole for the first eight feet. The holes were then drilled, without sampling, to a depth of 10 feet. SPTs were typically resumed at 10 to 14 feet, after which drilling without sampling was used to drill to the total depth of the hole. In borings 604 through 607, SPTs were also conducted over sporadic intervals at depths greater than 20 feet. No undisturbed samples were collected from these borings. All seven of the geotechnical boreholes were completed by the DOE.

All 18 holes that were logged through natural soil and rock, without gathering geotechnical data, were drilled by the DOE as part of the groundwater investigation. All except three of these holes are north of the lower pile area. The three exceptions are borings 651, 654, and 658. These holes are northeast, east, and southeast of the lower pile, respectively. These holes give complete geologic descriptions of the soils encountered, in addition to detailed descriptions of the bedrock at each location.

The six holes drilled and logged into bedrock were not logged through soil. These holes were all drilled by the DOE as part of the groundwater investigation of the area. The holes are to the west, south, and east of the lower pile. These logs start at the bedrock-soil interface, and are therefore helpful only as data pertaining to the depth of the foundation soils.

Bendix (BFEC, 1985) drilled and logged holes through the new tailings pile to characterize the tailings and to determine the depth of contamination.

All 31 of the test pits were excavated by the DOE. Of these 31 test pits, six were excavated in tailings, one in the evaporation pond area, and 24 in areas that had been, but were no longer being, considered for borrow material. Five of the six test pits excavated in tailings were excavated in a grid pattern on the lower tailings pile. Test pits MON01-062 through MON01-065 were along the upper portion of the sloping, cone-shaped pile, while MON01-066 was at the eastern edge of the pile. Test pit MON01-061 was in the center of

the heap leach pile. The test pits excavated in the interior portion of the pile ranged from nine to 12 feet deep, while the perimeter test pit (MON01-062) encountered natural soil at five feet. Test pit MON01-061, on the heap leach pile, was excavated to 15 feet without reaching natural soil.

The single test pit in the evaporation pond area is MON01-067. This test pit was excavated to seven feet and encountered natural soil at approximately three feet.

Mexican Hat site

To characterize subsurface materials in and near the Mexican Hat site, 192 borings and five test pits were completed. Of the total, 157 borings and five test pits were completed on the tailings pile. The borings were done at various times by the DOE; Ford, Bacon & Davis Utah Inc. (FBDU); Mountain States Research and Development (MSRD); and the University of Colorado (UC). Details of these investigations are presented in the following sections.

Locations of the DOE piezocone soundings, boreholes, coreholes, and test pits are shown in Figures 3.11 and 3.12. A summary of the boring, piezocone sounding, and test pit numbers and depths is presented, as well as the respective logs, in Appendix D, Site Characterization. Locations of 1979 UC borings are shown in Figure 3.13. Locations of the MSRD/Colorado State University (CSU) borings and the MSRD piezometer locations are shown in Figure 3.14. A summary of the boring numbers and depths for both the MSRD and MSRD/CSU boreholes, as well as copies of the boring logs and well completion records, are in Appendix D, Addendum D4.

Earlier subsurface investigations at the Mexican Hat site

Prior to March 1976, FBDU, in conjunction with Oak Ridge National Laboratory (ORNL), advanced 19 borings on or near the tailings pile at Mexican Hat (FBDU, 1977). These borings were done primarily to characterize the radiological properties of the tailings. Geotechnical logs of these borings, if they exist, are not available.

In March 1979, UC, under a grant from the DOE/EPA, bored three shallow unlogged holes by hand at Mexican Hat in a preliminary investigation of the geotechnical properties of a number of uranium mill tailings sites in the United States (Heuze and Dessenberger, 1979).

In late 1981, MSRD initiated a drilling program that was completed in early 1982 (MSRD, 1982). This drilling program included about 125 borings. The soils in these borings were visually classified and logged as well as continuously sampled using both split barrel and Shelby tube-type samplers. Two of the borings were completed as monitoring wells. The main purpose of this program was to obtain assay samples to determine the economic feasibility of processing the tailings. Little or no geotechnical data, beyond the

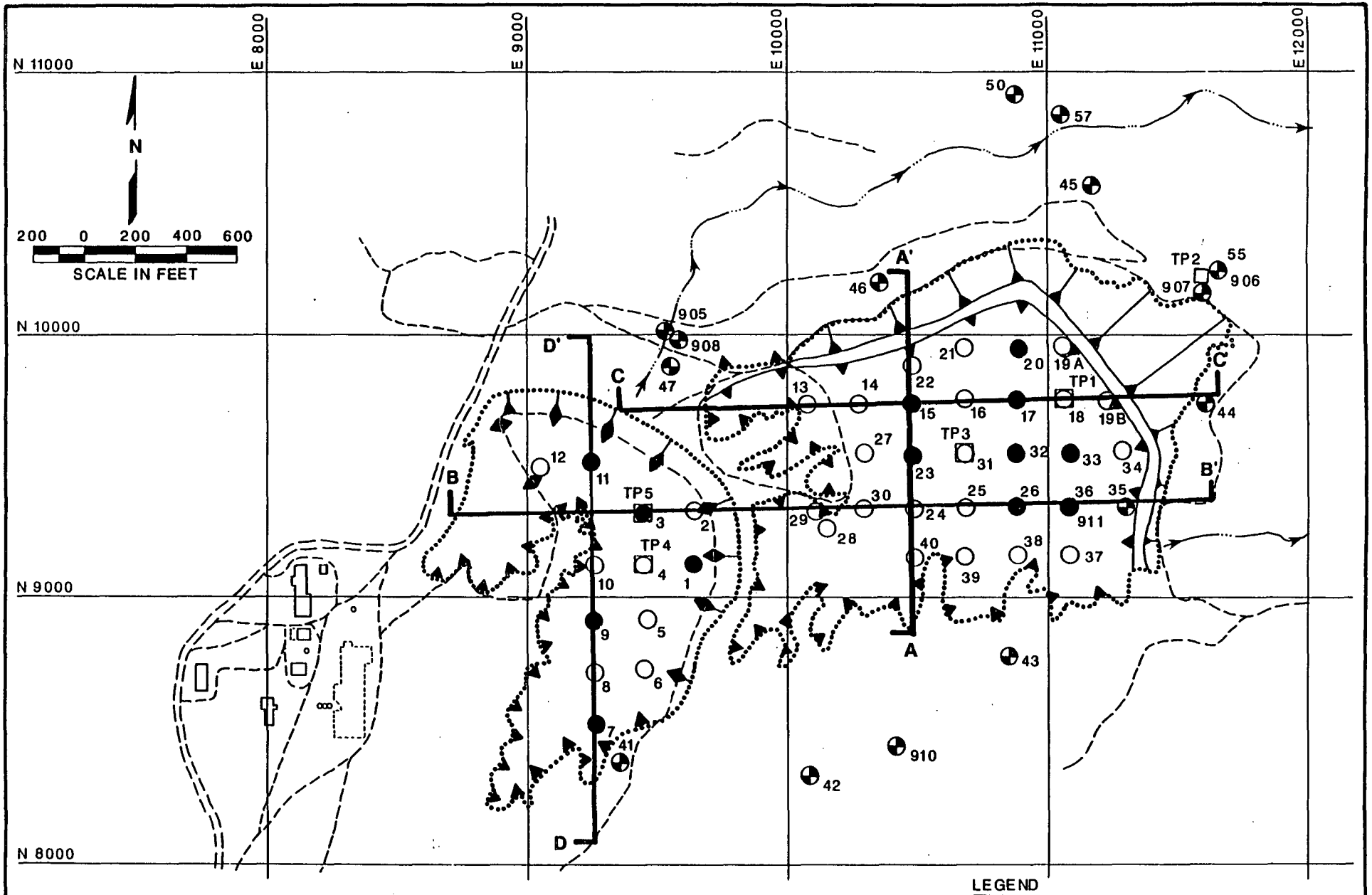


FIGURE 3.11

PIEZOCONE SOUNDING, BOREHOLE, TEST PIT AND CROSS SECTION LOCATIONS AT THE MEXICAN HAT SITE

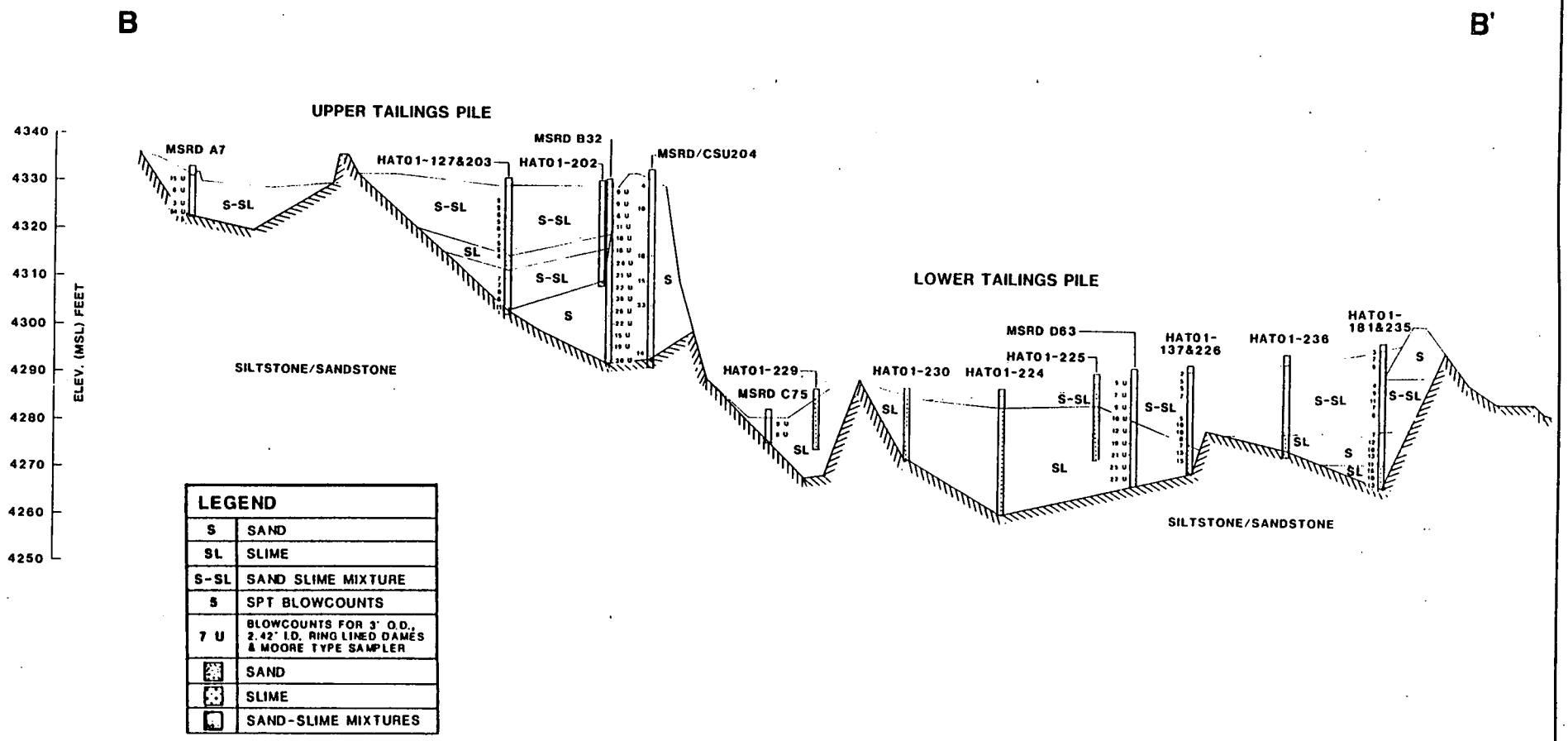


FIGURE 3.12
EAST-WEST CROSS SECTION B-B' THROUGH THE UPPER AND LOWER TAILINGS PILE AT THE MEXICAN HAT SITE

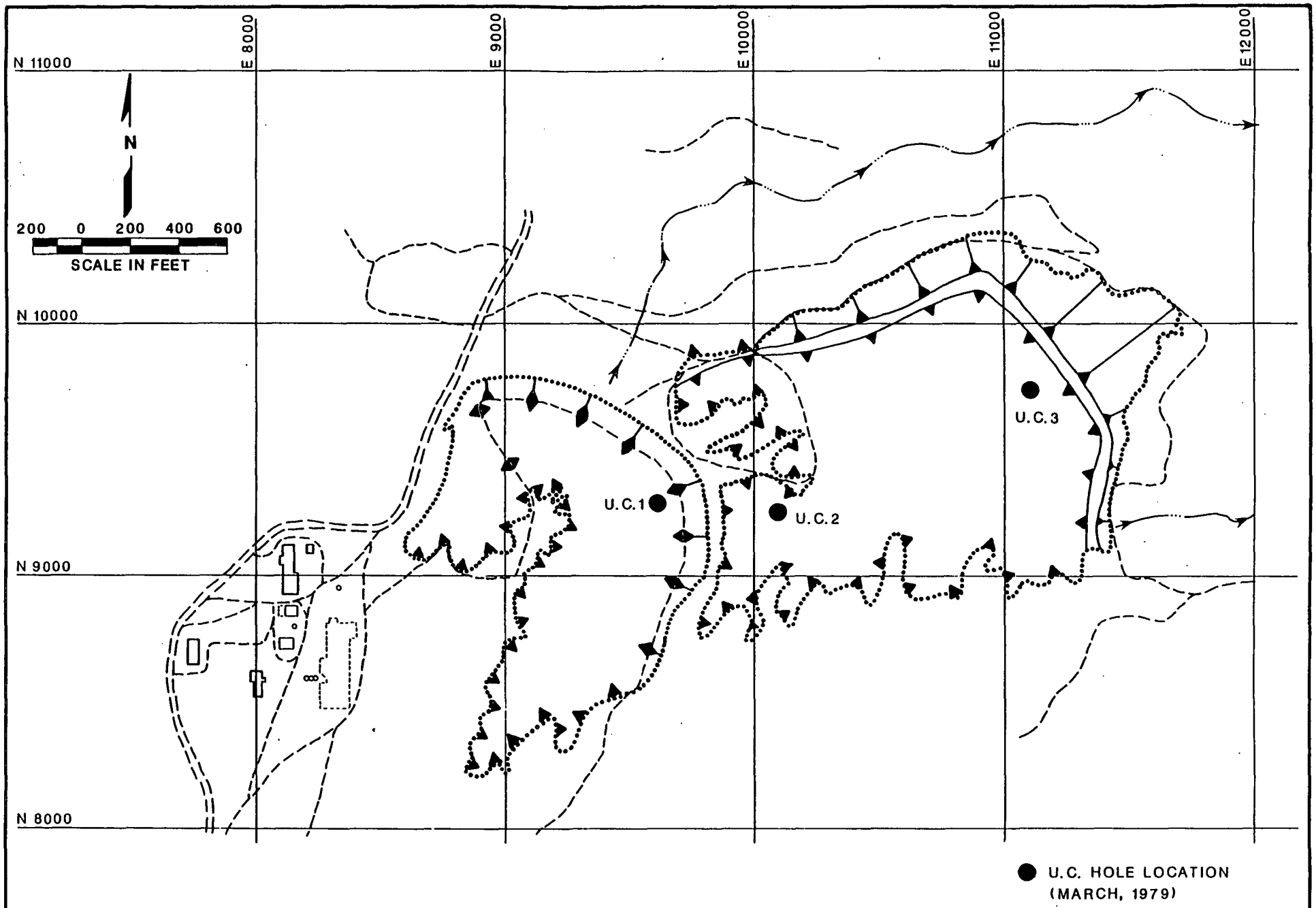


FIGURE 3.13
UC BORING LOCATIONS AT THE MEXICAN HAT SITE

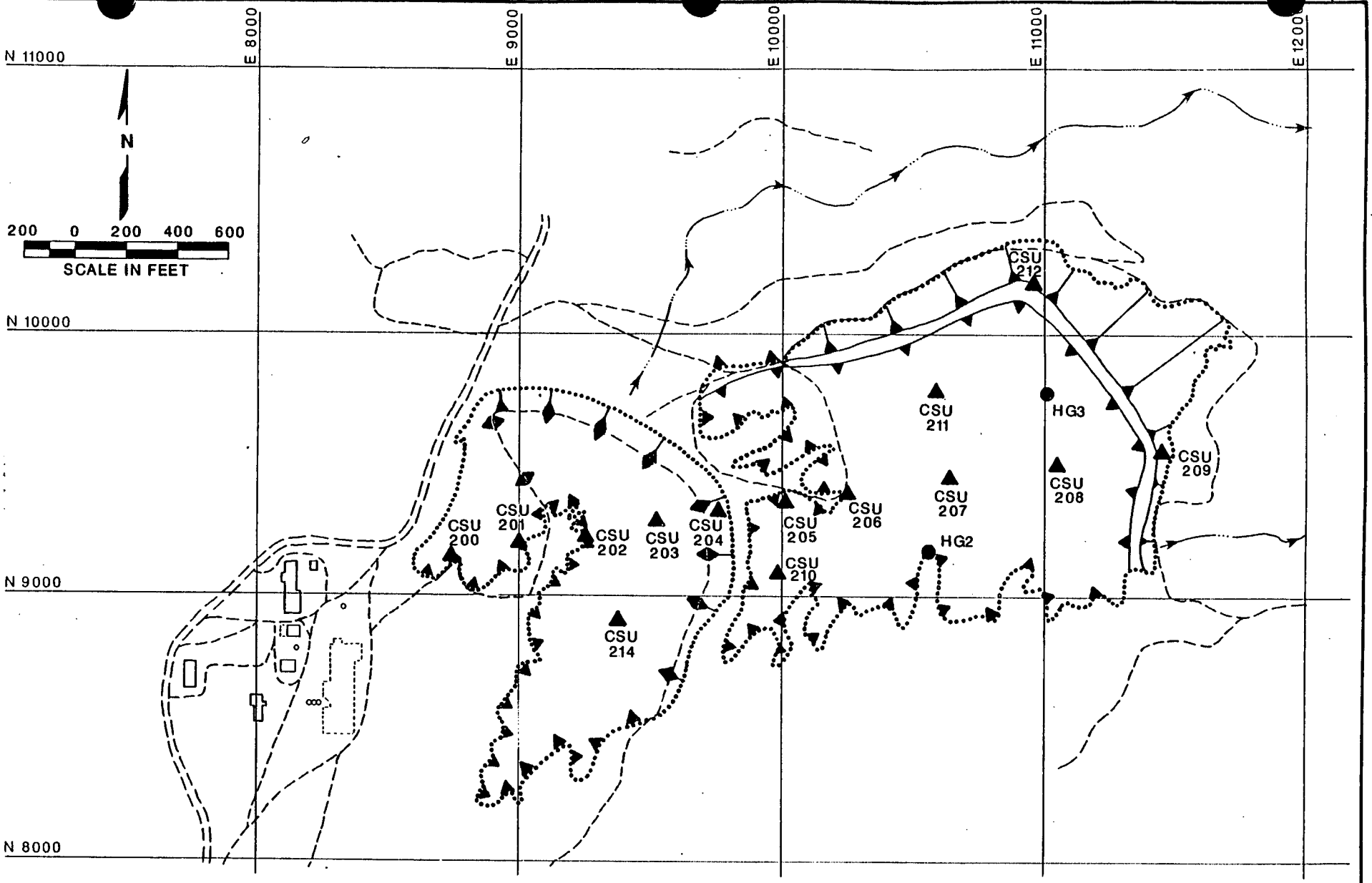


FIGURE 3.14
CSU BOREHOLE AND PIEZOMETER LOCATIONS AT THE MEXICAN HAT SITE

logs themselves, were obtained. A minor aspect of this program was to obtain samples for geotechnical testing by CSU; however, these samples were never used in a testing program.

Other subsurface geotechnical investigations at the Mexican Hat site

Forty piezocone soundings were completed on a 200-foot-square grid over the tailings pile area in order to aid in the placement of borings in the tailings, to determine which intervals should be sampled during drilling operations, and to characterize the tailings (Figure 3.11) (Appendix D, Addendum D6).

Soil samples were obtained for testing by means of both geotechnical borings and test pits. Fourteen shallow borings and two deep borings were completed in the tailings pile in late 1984 and early 1985. The shallow holes were advanced using a six-inch hollow-stem auger. The two deep boreholes were augered to bedrock and cored below the soil/bedrock interface. All boreholes were continuously logged in order to note the changes in the visual soil or rock classification with depth within the tailings and foundation. To aid in this visual classification and provide samples for laboratory testing, disturbed and undisturbed soil samples were obtained through the use of SPT, the split-barrel or Dames and Moore (D&M) sampler, and the Shelby-tube sampler (Appendix D, Addendum D4).

In addition to the on-pile borings, 16 shallow borings and 11 deep borings were done in the vicinity of the tailings pile in order to characterize the soils and rock in the foundation. The shallow borings were advanced with a four-inch hollow-stem auger. The borings were logged and auger cuttings were sampled. The deep borings were augered to bedrock without sampling, then continued through the bedrock using rotary coring with continuous core sampling and logging. Most of these deeper borings were completed as groundwater monitoring wells (Appendix D, Addendum D4).

Four test pits were dug on the tailings pile and one near it (in windblown tailings) in order to obtain bulk samples for laboratory testing. The test pits were dug to depths ranging from 0.5 to 7.5 feet using a backhoe, and were sampled and continuously logged to note soil changes with depth (Appendix D, Addendum D4).

3.4.2 Foundation materials

Monument Valley site

The soils underlying the Monument Valley site generally consist of fine-grained, unconsolidated dune sand with isolated zones of fine-grained silty clay and clayey sand alluvium. These materials have been derived from the existing sedimentary sandstone, siltstone, and, to a lesser degree, shale bedrock formations that outcrop in the immediate area of the site and within Cane Valley.

Sandstone bedrock composed of the Shinarump Member of the Chinle Formation outcrops along the west side of Cane Valley and directly underlies the former mill site and portions of the upper, older tailings pile. The heap leach pad, which is in a small wash at the base of a 20-foot-high Shinarump Sandstone cliff near the upper tailings pile, is composed of approximately 14 feet of coarse tailings materials. Under these tailings, the small wash is filled with dune sand deposits more than 80 feet deep. The lower tailings pile lies entirely atop the loose dune sand, which becomes progressively thicker eastward from the site. Approximately 500 feet southeast of the lower tailings pile, boring 603 was drilled 55 feet through loose dune sand without encountering bedrock.

The Cane Valley alluvium is primarily thin to thick layers and lenses of sand and sandy silt, with considerably lesser amounts of clay and gravel, deposited throughout the axis of Cane Valley and along drainages perpendicular to the valley axis. No material properties are required for these deposits, as they do not underlie any of the areas of importance to this study.

Mexican Hat site

The foundation materials underlying the tailings at the Mexican Hat site consist of siltstones and sandstones overlain by zero to five feet of soil derived primarily from the bedrock material.

The soils vary from silty fine sands to slightly sandy gravels. Most of the borings indicate a soil thickness in the range of zero to one foot under and near the tailings pile. In the washes, the soil is generally a gravelly alluvium between three and five feet thick. For the purpose of this investigation, the alluvium is assumed to have properties similar to the weaker tailings that directly overlie the alluvial soils.

The bedrock under the site consists of siltstones and sandstones of the Halgaito Shale Formation of the Cutler group (Permian Age). At the Mexican Hat site, this formation is composed chiefly of red-brown fine sandy siltstones that occasionally grade to silty fine sandstones. Occasional layers of limestone are greater than 15 feet thick; however, they are typically less than one foot thick. The intact rock is generally soft to hard; however, there are numerous zones that have close, nearly horizontal fractures. These fractures are often unweathered and unfilled or healed. There are a few zones where the wall rock is weathered to produce low-plasticity clay zones up to three feet thick. These clayey zones appear to be discontinuous and are found at depths greater than 75 feet below the tailings-rock interface. They should not affect the long-term stability of the finalized tailings pile.

A more detailed description of the foundation materials and their geotechnical properties can be found in Appendix D, Site Characterization.

3.4.3 Tailings

Monument Valley site

Materials forming tailings can generally be put into one of three categories: sand, sand-slime mixture, and slime. The limits of gradation for these materials are defined as zero to 30 percent passing the No. 200 sieve to be classified as a sand; 30 to 70 percent passing to be classified as a sand-slime mixture; and 70 to 100 percent passing to be classified as a slime. The processing practices at the Monument Valley site yielded tailings characterized as homogeneous fine- to medium-grained sands with little or no slimes fraction. The top three feet of the evaporation pond area contain the only slimes at the site, with a medium to coarse brown sand fill underlying these slimes to at least seven feet, which was the depth of the investigation. No sand-slime mixtures are present on the site. Since the tailings piles are composed entirely of sand tailings, no detailed cross sections of the piles are presented.

Mexican Hat site

Boring logs and field observation indicate that starter dikes or dams were built over and/or extended from naturally formed rock dikes using coarse tailings. Mill run tailings were hydraulically deposited behind the dikes via spigots that were probably moved periodically. Thus, the resulting distribution of tailings in the pile varies greatly with horizontal location and depth. The generalized cross sections in Figures 3.12 and 3.15 through 3.17 were constructed using borehole and piezocone data. Locations of these sections are found on Figure 3.11. These indicate that, as the tailings embankment filled, the retaining embankments were made up of fairly uniform sand tailings. With increasing horizontal distance from the embankment, the tailings generally tend to grade to slime. However, as is indicated in the individual boring and piezocone logs (see Section D.5 of Appendix D, Tailings Characteristics), this generalization does not hold true in detail. The assumed variation in spigot location and the temporal variations in the particle size and parent material makeup of the tailings over the life of the milling operation resulted in an extremely complicated stratified deposit that may vary from a silty sand to a silt to a clay over a relatively small change in depth or lateral location. This means that a standard-size sample that may classify as sand, sand-slime, or slime in bulk may actually be a complex layered soil in situ. This is especially true of the sand-slimes.

Material types

Generally, the sands in the Mexican Hat tailings were found to be loose to medium-dense, slightly moist to very moist, nonplastic silty sands (SM). The sand-slimes can be described as very loose to loose, moist to very moist, nonplastic silty sands (SM) or soft to medium consistency, moist to wet, nonplastic to low-plasticity sandy silts (ML). The slimes are generally best described as moist to

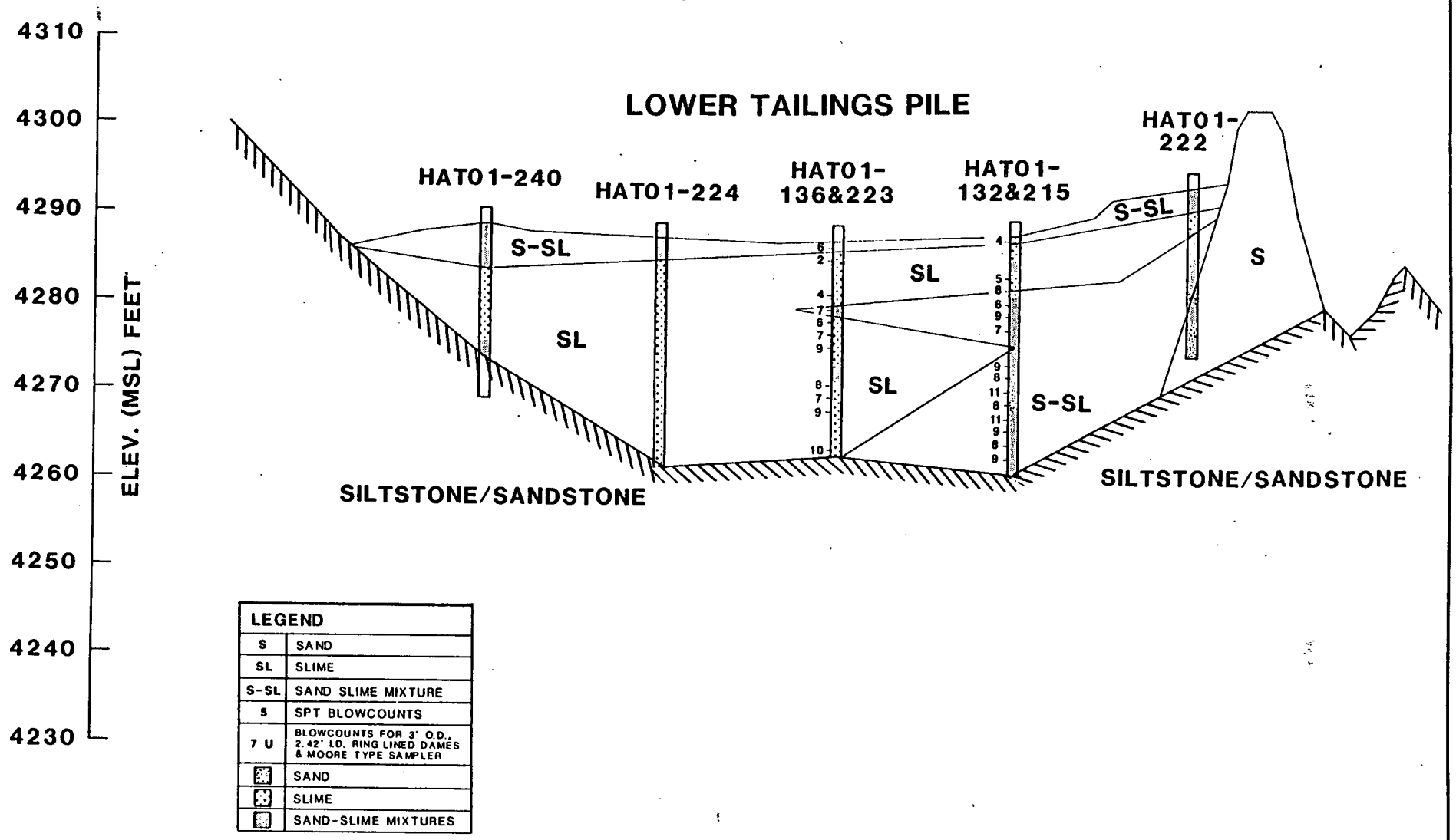


FIGURE 3.15
NORTH-SOUTH CROSS SECTION A-A' THROUGH THE LOWER TAILINGS PILE AT THE MEXICAN HAT SITE

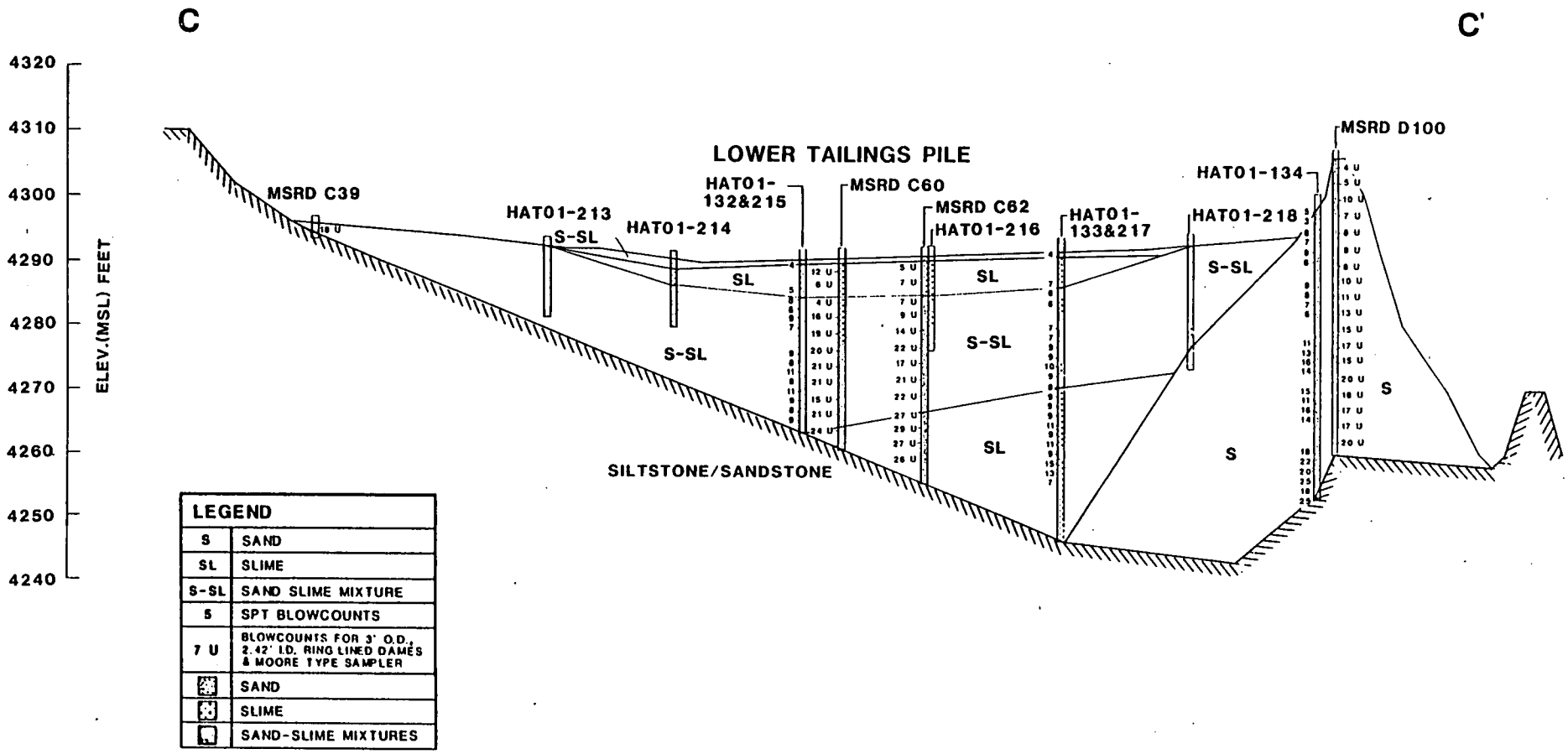


FIGURE 3.16
EAST-WEST CROSS SECTION C-C' THROUGH THE LOWER TAILINGS PILE AT THE MEXICAN HAT SITE

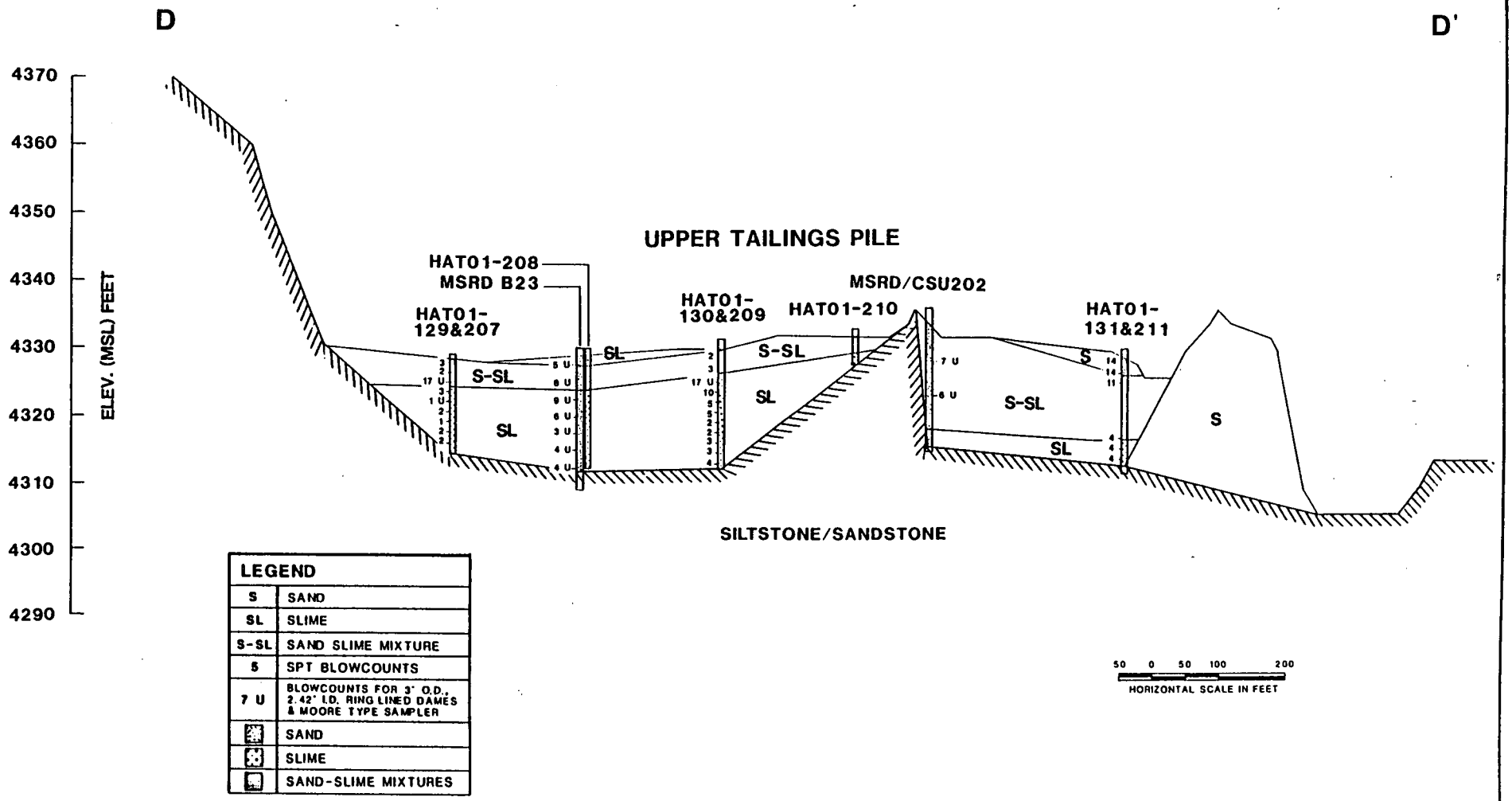


FIGURE 3.17

NORTH-SOUTH CROSS SECTION D-D' THROUGH THE UPPER TAILINGS PILE AT THE MEXICAN HAT SITE

saturated, very soft to medium consistency, low to medium plasticity clays (CL). They tend to be overconsolidated in the lower pile and softer, tending toward normally consolidated in the upper pile. Section D.5 of Appendix D, Site Characterization, provides detailed engineering properties of the tailings.

3.4.4 Borrow sites

The source for the radon cover material will be the RB-4 and RB-7 borrow sites (Figure 3.18); the borrow sites are along the bottom of an arroyo on Navajo Nation land approximately five miles south of the Mexican Hat site. There are only limited quantities of the borrow material, which is a silty sand.

Two borrow sites have been identified as potential sources for rock cover material between Bluff and Mexican Hat, Utah. Large rock for the erosion protection may be taken from the Sugarloaf quarry and the smaller rock and bedding may be taken from the Bluff quarry (Figure 3.19). The subcontractor may elect to obtain bedding and riprap materials from other borrow sources, provided the size and quality requirements are met.

3.5 GROUNDWATER

Monument Valley site

A summary of the hydrogeologic characterization at the Monument Valley site is presented in this section. A detailed hydrogeologic and groundwater quality characterization is presented in Appendix D, Site Characterization.

The major hydrostratigraphic units underlying the Monument Valley tailings site, in descending order, are alluvium and dune sand, the Shinarump Member of the Chinle Formation, the Moenkopi Formation, and the DeChelly Sandstone. The alluvium and dune sand are fine-grained, unconsolidated deposits more than 80 feet thick in the center of Cane Valley. The thickness of these deposits decreases toward the valley edges, where it is absent. The Shinarump Member outcrops west of the tailings site, dips to the east, and underlies the dune sand and alluvium below the lower tailings pile. The Shinarump Member consists of lenticular cross-bedded units of sandstone, conglomerate, and mudstone, and ranges from 25 to 90 feet thick in the site vicinity. The Moenkopi Formation underlies the Shinarump Member and consists of shaley siltstone and sandstone. The Moenkopi Formation is 50 to 60 feet thick in most of the site area; however, only about 20 feet of the Moenkopi Formation was encountered beneath the upper tailings pile. The DeChelly Sandstone is a cross-bedded, fine-grained sandstone and is approximately 550 feet thick below the site (Witkind and Thaden, 1963).

Groundwater within the alluvial aquifer is unconfined. Depths to groundwater range from a few feet near Cane Valley Wash to slightly more than 10 feet below the lower tailings pile. This unconfined groundwater is recharged by occasional flows in Cane Valley Wash and to a minor extent by

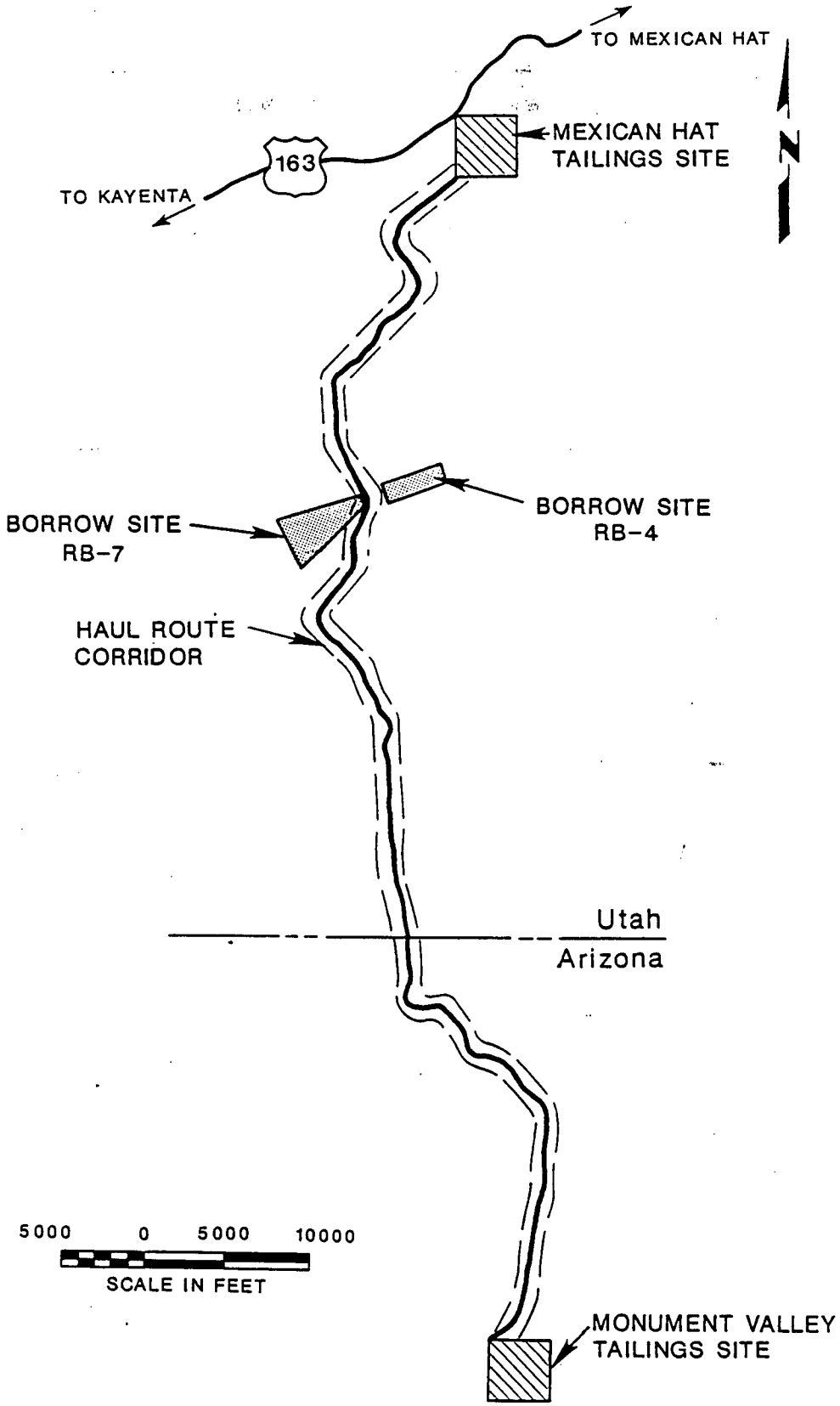


FIGURE 3.18
LOCATIONS OF RADON BARRIER BORROW SITES
MEXICAN HAT/MONUMENT VALLEY REMEDIAL ACTION

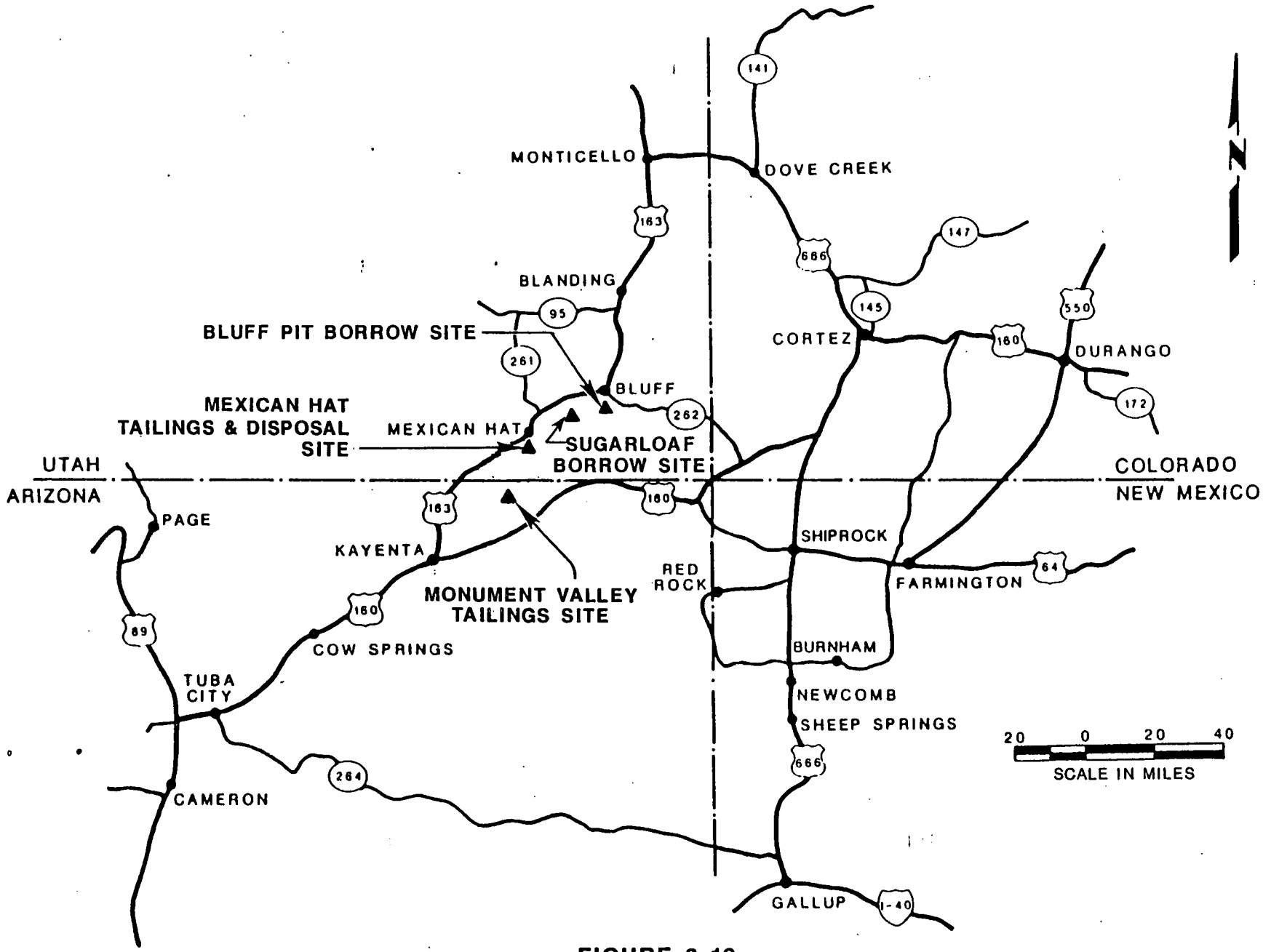


FIGURE 3.19
LOCATIONS OF THE ROCK BORROW SITES
MEXICAN HAT/MONUMENT VALLEY REMEDIAL ACTION

infiltration of precipitation. Alluvial groundwater in the site vicinity flows to the north under an average hydraulic gradient of 0.011, and discharges as underflow or to seeps in northern Cane Valley. Using the range of hydraulic conductivities of 0.3 to 19 feet/day (ft/day) (1.1×10^{-4} to 6.7×10^{-3} centimeters per second, or cm/s) and an assumed effective porosity of 0.25, the linear groundwater velocity is five to 300 ft/year.

Groundwater within the Shinarump Member is confined, probably by the mudstones found within this unit. This confined groundwater flows northward from recharge areas in the south, under an average hydraulic gradient of 0.01, and probably discharges to the alluvium in northern Cane Valley. Using the range of hydraulic conductivities of 0.4 to eight ft/day (1.4×10^{-4} to 2.8×10^{-3} cm/s) and an assumed effective porosity of 0.10, the linear groundwater velocity is 15 to 290 ft/year.

Groundwater within the DeChelly Sandstone is confined by the overlying Moenkopi Formation. This confined groundwater flows northward from recharge areas in the south, under an average hydraulic gradient of 0.01, and discharges to areas north of Cane Valley. Using the range of hydraulic conductivities of 0.02 to three ft/day (7.1×10^{-6} to 1.1×10^{-3} cm/s) and an assumed effective porosity of 0.10, the linear groundwater velocity is 0.8 to 120 ft/year.

An upward, vertical hydraulic gradient exists between the Shinarump Member and the overlying alluvium and dune sand, and between the DeChelly Sandstone and the overlying units. Wells completed within the DeChelly Sandstone flow at the surface in the area of the Monument Valley tailings site.

Background water quality in the alluvium is generally good, with no median or mean observed concentrations exceeding the proposed EPA maximum concentration limits (MCL). However, maximum observed background concentrations of molybdenum have exceeded the MCLs. Background groundwater in the Shinarump aquifer underlying the Monument Valley site has produced concentrations or activities of net gross alpha and molybdenum that exceeded MCLs prior to 1990. Only radium-226 and -228 activities exceeded the MCL in one background monitor well in 1990. Background groundwater in the DeChelly Sandstone aquifer has produced concentrations of molybdenum that exceeded MCLs prior to 1990. However, no MCLs were exceeded in the background monitor wells sampled in 1990 or in 1991.

The tailings at the Monument Valley site are much more sandy and contain fewer slimes than those at Mexican Hat. During the early years of operation, this site was used to physically concentrate the slime fraction, which contained the majority of the uranium. This fine-grained fraction was then shipped to other mills for refining. In later years, low-grade ores and the stockpiled sand fraction were heap leached. This resulted in contaminated materials that produce an acidic, oxidizing leachate. Hazardous constituents in the tailings pore fluids with mean concentrations or activities that exceed the proposed EPA MCLs are molybdenum, nitrate, and radium-226. Concentrations of these hazardous constituents in tailings pore fluids at the Monument Valley processing site are slightly less than those determined as representative of tailings pore fluid at Mexican Hat. No Appendix IX organic hazardous constituents related to uranium milling processes were observed above detection levels at the Monument Valley site.

Maximum observed concentrations of cadmium, chromium, molybdenum, nitrate, and selenium, and activities of net gross alpha, and radium-226 and -228 have exceeded the proposed EPA MCLs or background levels in the alluvium. The presence of these constituents, except cadmium and selenium, is related to uranium tailings processing activities. Cadmium and selenium did not exceed laboratory method detection limits in tailings pore water. There is no statistically significant evidence of groundwater contamination above the MCLs from chromium, molybdenum, net gross alpha, radium-226 and -228 in downgradient groundwater. However, there is statistical evidence that nitrate exceeds the MCL in groundwater from monitor wells 606 and 655.

Nitrate in the alluvium forms a plume that extends approximately 3000 feet downgradient (north) of the site. Within the plume, nitrate concentrations range from a high of over 1000 mg/l in the central portion to below the MCL on the fringe. Even though the plume has moved a distance downgradient, there has been no substantial plume migration laterally to the east.

In downgradient groundwater from the Shinarump Conglomerate, maximum observed concentrations or activities of molybdenum, net gross alpha, and radium-226 and -228 equaled or exceeded MCLs. However, there is no statistically significant evidence for groundwater contamination above the MCLs for these constituents in Shinarump groundwater.

In the DeChelly Sandstone downgradient groundwater, maximum observed concentrations or activities of chromium, molybdenum, net gross alpha, and uranium equaled or exceeded MCLs. However, there is no statistically significant evidence of groundwater contamination above the MCLs from chromium, net gross alpha, and uranium in downgradient DeChelly Sandstone groundwater. Median concentrations of molybdenum did exceed the MCL in the past in monitor wells 664 and 668 and in former production well 625. However, more recent sampling rounds showed molybdenum less than detection in monitor well 668 and well 625.

An upward hydraulic gradient between the DeChelly Sandstone and the overlying formations has served to prevent significant downward movement of contaminated groundwater from the alluvium. However, during the period of milling operations when groundwater was produced from the DeChelly, the upward hydraulic gradient could have been reversed locally in the areas of maximum withdrawal. This temporary downward gradient from the alluvium to the DeChelly could have caused contaminated groundwater to flow to the DeChelly, which would account for the elevated molybdenum concentrations in some wells in the past.

Groundwater from the alluvium in the vicinity of the Monument Valley tailings site is used as a source of drinking water by residents upgradient and far downgradient of the tailings site. Groundwater from the DeChelly Sandstone is withdrawn for domestic use from one well (625) northeast of the tailings piles. A domestic well survey was conducted in 1992. This survey did not locate residences or domestic wells in the path of the alluvial nitrate plume.

Mexican Hat site

A summary of hydrogeological characterization at the Mexican Hat site is presented in this section. A detailed hydrogeologic characterization is included in Section D.7 of Appendix D, Site Characterization. All hydrogeological calculations are included in Appendix F, Groundwater Hydrology Calculations.

The Mexican Hat disposal site is underlain by the Halgaito Shale Formation of the Cutler Group. This formation is composed of a varied sequence of interbedded, very fine-grained silty sandstone and siltstone beds (O'Sullivan, 1965) and ranges from 50 to 180 feet thick in the site vicinity. The Halgaito Shale Formation is underlain by the Honaker Trail Formation of the Hermosa Group, which consists of more than 300 feet of interbedded siltstones, limestones, shales, and sandstones (FBDU, 1981a; Wengerd, 1973).

Perched water and unconfined groundwater related to uranium milling operations occur at depths ranging from 35 to 60 feet beneath the Mexican Hat tailings in the Halgaito Shale Formation. Water-bearing fracture density within the Halgaito Shale Formation decreases with depth, so that the lower section of the formation becomes an aquitard that locally confines naturally recharged groundwater in the underlying Honaker Trail Formation. Recharge to the perched groundwater within the Halgaito Shale Formation occurs from tailings seepage and minor amounts of infiltration from precipitation and flows in the arroyos within the vicinity of the tailings. Perched water and groundwater in the area of saturation within the Halgaito Shale Formation may spread laterally along lower hydraulic conductivity layers that dip regionally to the east and southeast. The average hydraulic conductivity of the Halgaito Shale Formation is 0.20 ft/day (7×10^{-4} cm/s).

Naturally occurring groundwater within the Honaker Trail Formation flows under an average hydraulic gradient of 0.02 to the north. The Honaker Trail Formation is recharged by groundwater underflow and may contribute some discharge to springs and seeps in Gypsum Creek or discharges as groundwater underflow from the site. The average hydraulic conductivity of the Honaker Trail Formation is 0.07 ft/day (2.5×10^{-5} cm/s). Assuming an effective porosity of 0.10 to 0.20, the average linear groundwater velocity is 0.01 ft/day (3×10^{-3} meter per day, or m/day).

The perched water in an area of saturation within the Halgaito Shale Formation is present primarily as the result of milling activities. Consequently, there is little or no native groundwater and, thus, background water quality cannot be defined for the Halgaito Shale Formation. Water derived from tailings seepage, sampled in monitor wells completed within the Halgaito Shale Formation, has a relatively high total dissolved solids (TDS) content, with TDS concentrations ranging from 1670 mg/l to 6670 mg/l. Maximum concentrations of chromium, molybdenum, uranium, and nitrate, and net gross alpha activities, exceed the proposed EPA MCLs. After the tailings have been reconfigured into a disposal cell and covered with a low permeability radon/infiltration barrier, the tailings seepage to the Halgaito Shale Formation will become negligible.

Maximum observed concentrations or activities of four hazardous constituents equaled or exceeded proposed EPA MCLs in the Honaker Trail Formation groundwater. These constituents include chromium, net gross alpha, radium-226 and -228, and uranium. The lower end of the 98 percent confidence interval of the mean for concentrations of these constituents by monitor well was compared with the MCL. According to "Statistical Analyses of Groundwater Monitoring Data at RCRA Facilities - Interim Final Guidance" (EPA, 1989), if the lower end of the confidence interval of the mean exceeds the MCLs, there is statistical evidence of an exceedance of the MCLs. The lower end of the 98 percent confidence interval of the mean concentrations of these constituents do not exceed MCLs in the Honaker Trail Formation.

No contamination of the Honaker Trail Formation has occurred from the Mexican Hat site, because an upward hydraulic gradient between the Honaker Trail Formation and the Halgaito Shale Formation prevents downward migration of tailings seepage into the Honaker Trail Formation. Furthermore, the Halgaito Shale Formation hydraulic conductivity decreases with depth due to a decrease in fracture density with depth.

Codisposal of the Monument Valley and Mexican Hat tailings at the Mexican Hat site will produce an embankment containing 3.8 million cy of material. This material is a combination of sands and slimes typical of an acid leach process. The Monument Valley tailings contain less fine-grained material and are much sandier than the Mexican Hat tailings. The pH of the tailings is relatively low (3.0 to 4.5) and the redox potential is oxidizing. The Monument Valley and Mexican Hat tailings contain hazardous constituents, including Appendix IX inorganic constituents derived from the uranium milling processes. Concentrations or activities of hazardous constituents in the codisposed tailings that exceed the proposed EPA MCLs are arsenic, cadmium, chromium, molybdenum, nitrate, uranium, radium-226 and -228, selenium, silver, and net gross alpha. No Appendix IX organic hazardous constituents related to uranium processing activities were above detection limits in the tailings at the Mexican Hat site. A screening of Appendix IX inorganic constituents identified antimony, cobalt, copper, fluoride, nickel, vanadium, and zinc as hazardous constituents or elements contained in hazardous constituent compounds above detection limits.

Water discharges from seeps in the North Arroyo exhibit maximum observed concentrations or activities of molybdenum, net gross alpha, nitrate, and uranium above MCLs. Discharges from these seeps are from water related to milling operations. Water discharges from Gypsum Creek seep GS-3 (254) may also have some contribution from milling operations-related water based on major cation/anion chemistry, elevated nitrate concentrations, and elevated uranium concentrations. Discharges from seeps in Gypsum Creek are primarily from the upward movement of native groundwater from either the Halgaito Shale Formation or the Honaker Trail Formation. However, in addition to seep GS-3, four Gypsum Creek seeps exhibit concentrations of uranium elevated generally an order of magnitude above background. These seeps appear to have a component of discharge derived from milling operations-related water. These seeps have very low flow rates of 0.5 gallons per minute (gpm) or less, where measured, and discharge into arroyos which are dry most of the time. A risk assessment has been conducted to address the potential risk of these seeps to humans, wildlife, and domestic animals (Appendix E, Section E.3.3). This

assessment concluded that no adverse non-carcinogenic health effects are expected for the above groups.

Groundwater in the Halgaito Shale Formation and the Honaker Trail Formation in the vicinity of the Mexican Hat site is not used as a source of drinking water or for other domestic beneficial purposes. Groundwater has not been developed in the Halgaito Shale Formation because of the limited areal extent of saturation in the site vicinity and the low hydraulic conductivity of the formation, which results in low yields to wells. Groundwater within the Honaker Trail formation has not been developed because of poor water quality (hydrocarbons and hydrogen sulfide gas). Alternative supplies of good water quality are readily available from the San Juan River, which supplies all the water used in the area.

3.6 SURFACE WATER

Monument Valley site

Surface-water features in the vicinity of the Monument Valley tailings site include Cane Valley Wash and several small ephemeral drainages. The tailings site is approximately 10 feet higher in elevation and 1300 feet west of Cane Valley Wash (Figure 3.20). The San Juan River, 15 air miles north of the site, is the only perennial stream in the area.

Cane Valley Wash has a drainage area of 90 square miles at the tailings site. The east and south arroyos drain a 650-acre watershed on Yazzie Mesa south of the tailings site. The arroyos join 300 feet east of the lower tailings pile to course northward into the wash. Another arroyo (the west arroyo) drains a 1120-acre watershed and courses northeastward to the upper tailings pile and heap leach pad area. The middle arroyo drains a 60-acre watershed and flows into the south arroyo (Figure 3.20).

Runoff from the 1180-acre west and middle arroyo watersheds passes through the site. After passing through the upper tailings pile area, drainage from the west arroyo spreads runoff to a flat area north of the lower tailings pile. Drainage from the middle arroyo flows into the south arroyo, and eventually empties into Cane Valley Wash. It is doubtful that surface water flows over the upper pile area during most runoff events. Rather, runoff probably infiltrates into the soil because of the permeability of the eolian deposits. The middle arroyo flows northeast toward the lower tailings pile boundary and then turns to the east at a sandstone bedrock outcrop approximately 750 feet south of the pile boundary. The channel is incised eight feet below the alluvial surface and 10 feet below the sloping edge of the bedrock outcrop. During normal runoff events, water is probably contained in the channel.

Runoff from the site area generally flows northeast towards Cane Valley Wash. However, there are some low-lying areas and depressions in the west arroyo plus a few areas east and west of the lower tailings pile (particularly in the old evaporation pond area) where ponding may occur during precipitation events.

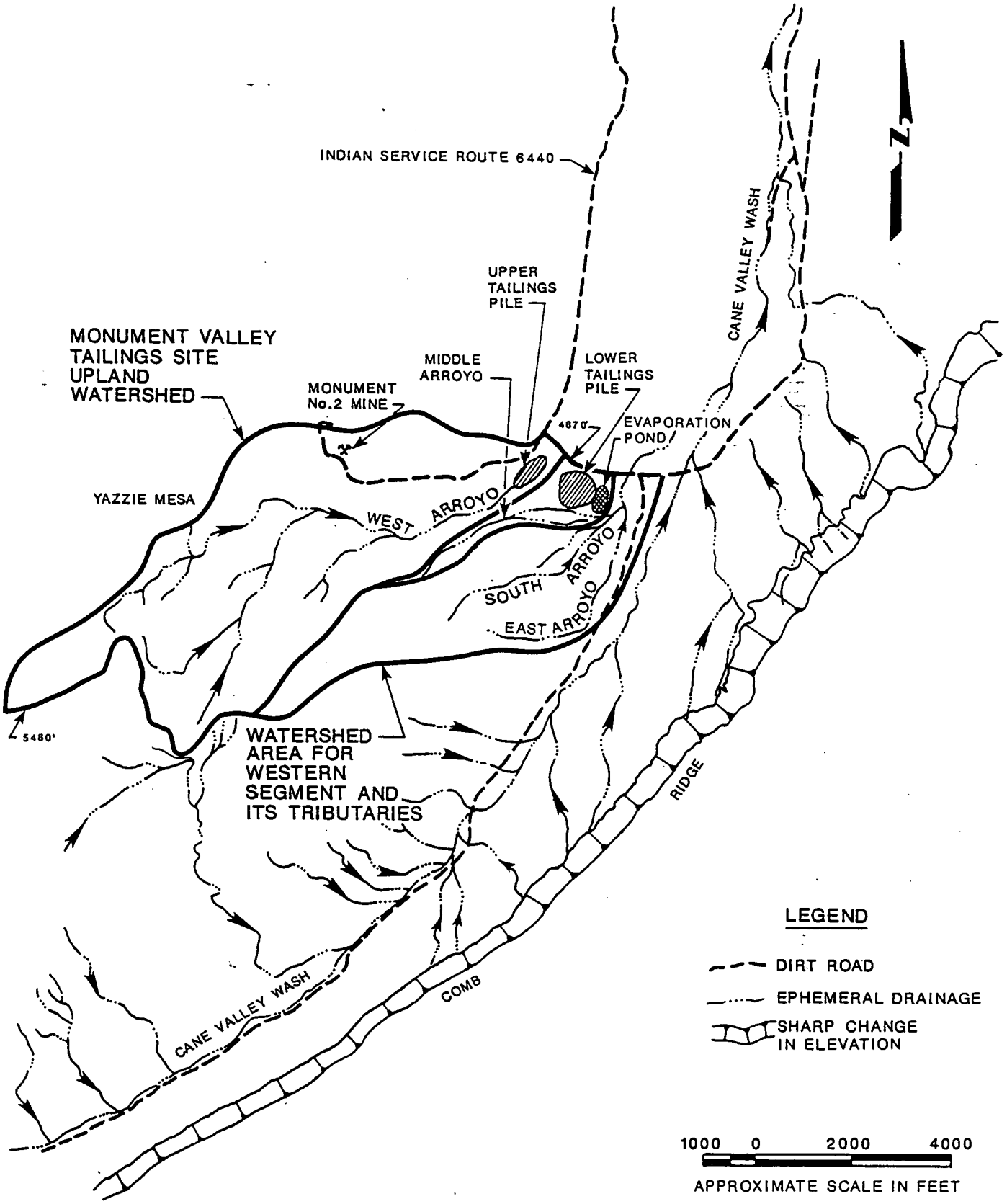


FIGURE 3.20
REGIONAL SURFACE WATER CHARACTERISTICS AT THE MONUMENT VALLEY SITE

There are no water quality data for any of the surface water features associated with the Monument Valley tailings site. The surface water features at the site are arroyos and only contain water during runoff events.

There are no known uses for any of the surface waters in the ephemeral arroyos and Cane Valley Wash, since flow in these drainages occurs only after excessive precipitation.

The existing tailings site could be affected by a flood in the west, east, or south arroyo. Water from a Probable Maximum Precipitation (PMP) event could overtop the channel banks in the east arroyo and reach the boundary of the lower tailings pile. A PMP is defined as the maximum precipitation that could occur from the most severe combination of meteorological conditions that are reasonably possible in a region. Areas indicative of periodic standing water and possible flooding exist between the east arroyo and the eastern edge of the lower tailings pile.

Mexican Hat site

The San Juan River, the major surface-water feature in the Mexican Hat area, is approximately one air mile north of and 240 feet below the Mexican Hat tailings site (Figure 3.21). This perennial river flows generally west-northwest along a deeply incised, meandering course. Over a 69-year period of record at Mexican Hat, the river had a mean flow of approximately 2500 cubic feet per second (cfs), for an average annual discharge of approximately 1,800,000 acre-feet. The recorded peak flow in the river at Mexican Hat is 52,800 cfs (USGS, 1985).

The U.S. Geological Survey (USGS) operates a continuous water-quality sampling station on the San Juan River downstream of the tailings site. Data from this station (USGS, 1985) and from sampling performed by Geochemistry and Environmental Chemistry Research (GECR, 1982) show that the river water meets National Primary Drinking Water Standards and exceeds Secondary Drinking Water Standards only for iron and pH. Additional sampling of the river water by the EPA (1973) and the DOE has shown that radiological contaminant levels in the water are below the standards and that the tailings piles have had no effect on the quality of the water. Water samples are withdrawn from the river at a treatment facility on the south bank of the river near the crossing of U.S. Highway 163 (Figure 3.21).

Several well-entrenched arroyos drain a watershed of approximately 500 acres south of the tailings site into the San Juan River. The largest and closest of these arroyos is Gypsum Creek (Figure 3.21), which is approximately 0.5 air mile northeast of, and approximately 100 feet below, the tailings site. There are no flow records for any of the arroyos because flows occur only after excessive precipitation.

At the tailings site, a small area around the Halchita sewage lagoons drains into an ephemeral arroyo north of the lagoons (Figure 3.21). The rest of the tailings site and a 370-acre watershed around Halchita drain into an ephemeral arroyo north of the tailings pile (North Arroyo). These two well-entrenched arroyos course north and northeast, respectively, to the San Juan River. Several smaller arroyos tributary to the northeast-

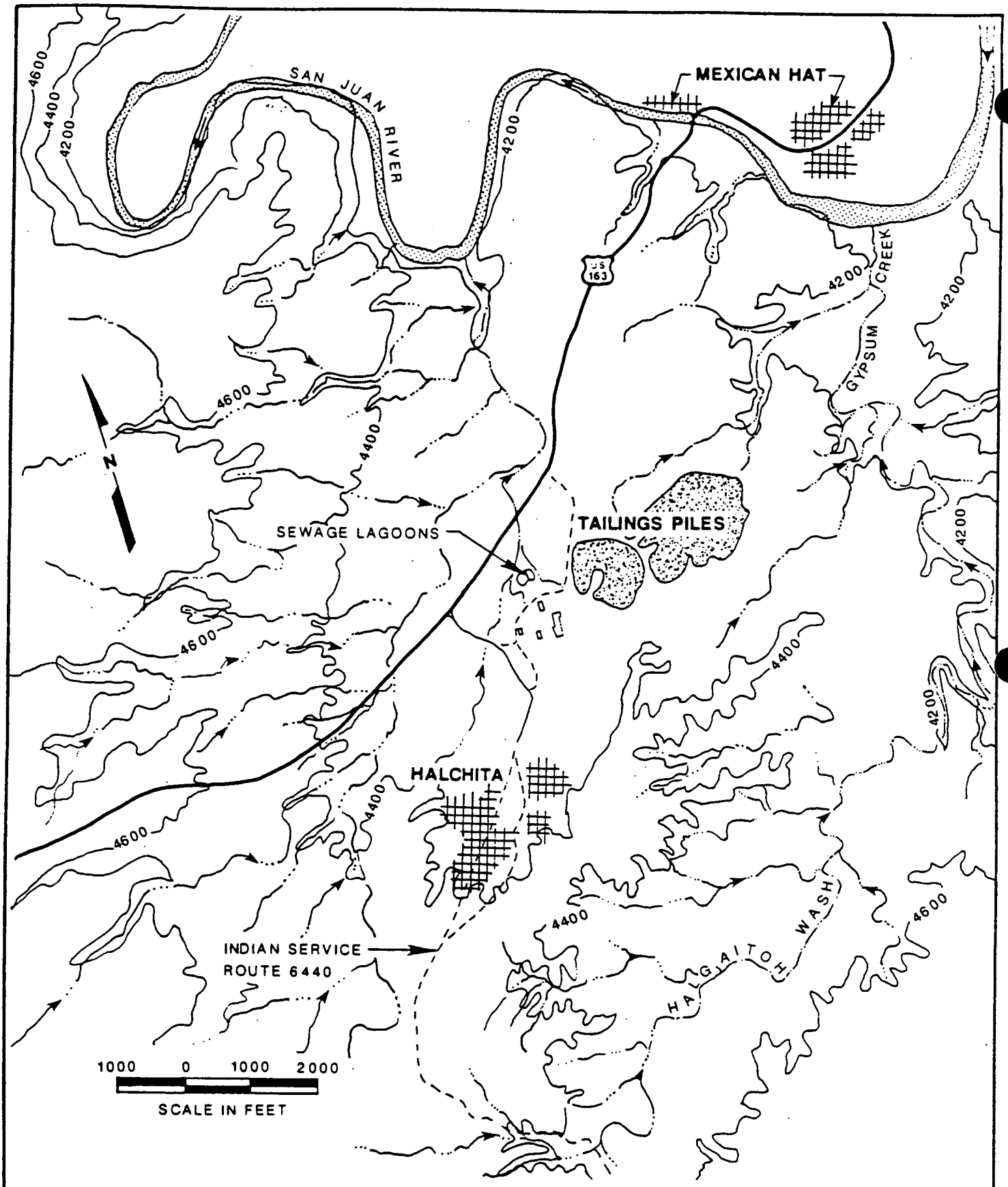


FIGURE 3.21
SURFACE WATER FEATURES, MEXICAN HAT SITE

coursing arroyo intersect the lower tailings pile on the north and east sides. There are no flow records for any of the ephemeral arroyos at the tailings site.

Seven seeps have been identified within Gypsum Creek east of the tailings site, and three seeps occur in the North Arroyo north of the tailings pile. These surface discharges of groundwater are low (less than approximately one-half gpm each, where measured) and discharge into the arroyos which are dry most of the time. These seeps are discussed in more detail in Section D.7 of Appendix D, Site Characterization.

There are no water-quality data for the ephemeral drainages at and around the tailings site, and there are no known uses of the ephemeral flows in the drainages.

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4.0 SITE DESIGN

4.1 INTRODUCTION

This section describes the design for codisposal of the Mexican Hat and Monument Valley tailings at the former uranium processing site near Mexican Hat. The data are intended to provide sufficient detail to evaluate the feasibility and effectiveness of the proposed design. The proposed design is predicted to meet the requirements of 40 CFR 192. The proposed design details are presented in Appendix B, Specifications and Drawings.

4.2 SUMMARY OF PROPOSED REMEDIAL ACTION

The Mexican Hat site consisted of two tailings piles; stockpiled rubble from the Phase I demolition of several of the original mill buildings, structures, and concrete pad of the mill buildings; and windblown areas. The Monument Valley site consists of two tailings piles; heap leach pads; an evaporation pond; two ore storage and mill yard areas; rubble piles; and windblown areas. Prior to Phase II suspension, the lower pile at Mexican Hat was shaped, and approximately 1,210,000 cy of Mexican Hat tailings from the upper pile and off-pile contaminated materials were placed on top of the lower pile.

Approximately 1,093,300 cy of contaminated material from the Monument Valley site will be transported to the Mexican Hat site and will be placed as the upper ten feet of the Mexican Hat tailings embankment. The top of the resulting stabilized pile will slope to the northwest. The final embankment will cover an area of approximately 60 acres (Figure 4.1). Construction completed to date is described in Appendix A, Phases I and II Subcontract Completion Report.

The cover placed on the stabilized pile will consist of a radon and infiltration barrier and erosion protection layer. The radon barrier will consist of selected uncontaminated material obtained from designated borrow areas. The entire radon barrier will be amended with bentonite. The erosion protection materials will consist of a layer of bedding material topped by a layer of rock riprap. The radon barrier borrow materials will be obtained from the RB-4 and RB-7 borrow sites (see Figure 3.18) and the erosion protection borrow materials are expected to be obtained from the Bluff and Sugarloaf sites (see Figure 3.19). During remedial action, all disturbed areas will be graded to promote drainage and appropriate measures taken to resist erosion.

4.3 DESIGN FEATURES

The principal feature of the remedial action is the stabilization of the Monument Valley and Mexican Hat contaminated materials at the Mexican Hat disposal site.

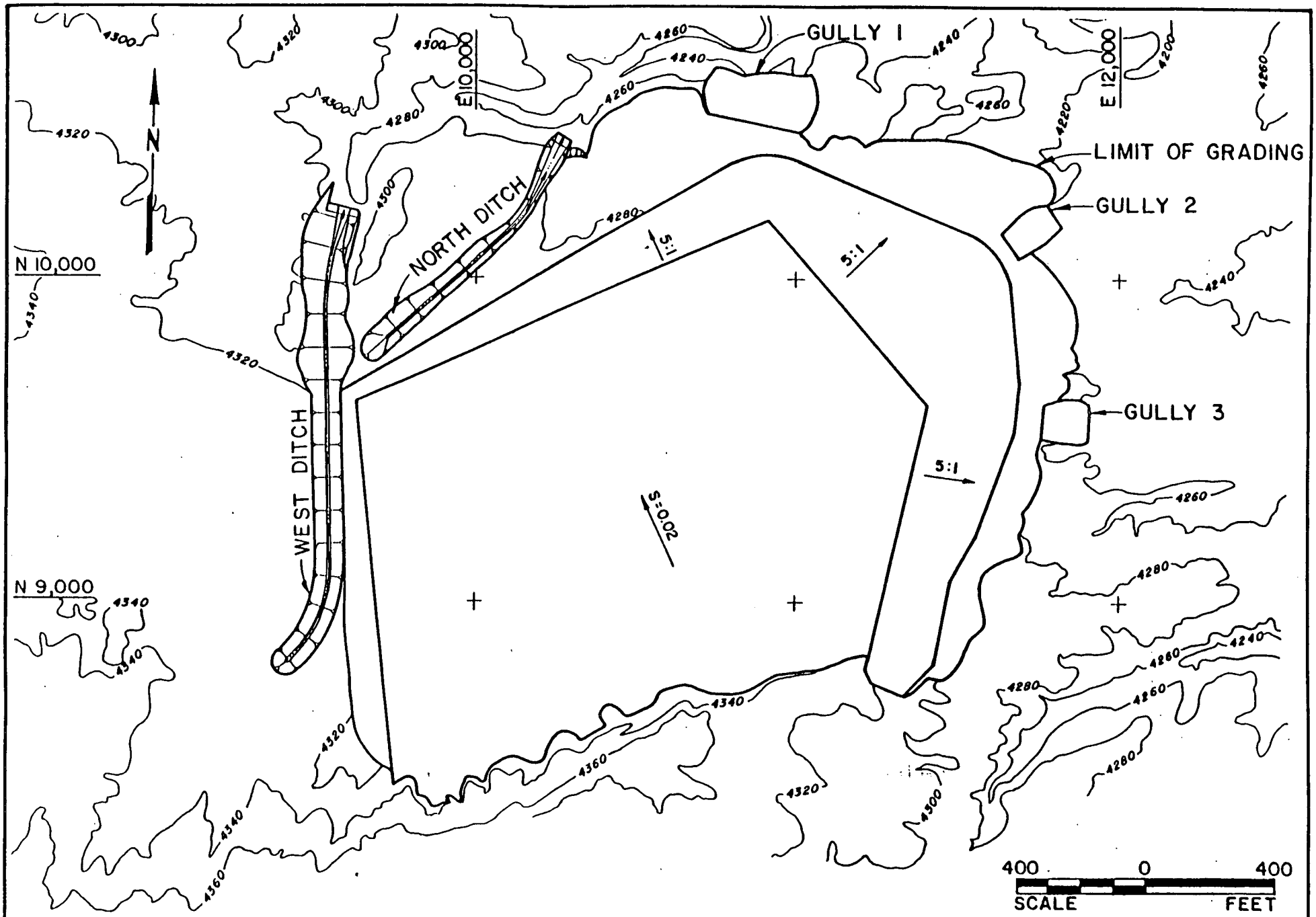

FIGURE 4.1
FINAL EMBANKMENT, MEXICAN HAT SITE

The following activities, including the construction of temporary facilities, have been completed during Phase I and Phase II construction at Mexican Hat and Monument Valley:

- Construction of temporary wastewater retention basins and dikes to prevent release of contaminants, a decontamination pad to wash equipment, and site security fencing.

- Demolition and stockpiling of on-site surface and subsurface structures and utilities at Mexican Hat.

- Reshaping of the lower tailings pile at Mexican Hat.

- Excavation, transportation, and placement of the remaining contaminated materials at the Mexican Hat site on the lower tailings pile. These materials include the upper tailings pile, portions of the lower pile, off-pile contaminated materials, and demolished material stockpiled at the former mill site.

- Site preparation at the Monument Valley site, including construction of temporary wastewater retention basin and dikes, and decontamination facilities.

- Upgrade of the haul road between the Monument Valley and Mexican Hat sites (Indian Service Road 6440) and construction of a bypass at Halchita.

- Construction of permanent ditches, aprons, and a diversion ditch to collect and carry surface runoff away from the stabilized embankment at Mexican Hat.

Major construction activities to be performed at both Mexican Hat and Monument Valley for completion of remedial action construction would be as follows:

- Excavation and transportation of tailings and contaminated materials from the Monument Valley site to be placed on the tailings embankment at the Mexican Hat site.

- Cleanup of remaining windblown and waterborne contaminated materials at Mexican Hat.

- Installation of the final cover over the tailings at Mexican Hat to inhibit water infiltration, radon emanation, and erosion.

4.4 PERMANENT DESIGN FEATURES

4.4.1 Layout

The tailings embankment has been designed to contain an additional 2,300,000 cy of contaminated material on top of the lower tailings pile and will cover approximately 60 acres, resulting in a pile containing a total of 3.8 million cy of contaminated

material. The lower tailings pile at Mexican Hat has been stabilized in place. Tailings from the upper pile and contaminated materials from windblown areas were then placed over the lower tailings pile. Contaminated material from Monument Valley will be placed as the top layer of the stabilized pile. Lastly, the radon and infiltration barrier, erosion protection, and permanent drainage structures will be constructed (Figure 4.2).

4.4.2 Decontamination and restoration

Contaminated materials from the wastewater retention basins, dikes, and decontamination facilities at both sites will be placed in the tailings embankment. Access to the completed tailings embankment will be restricted while the remainder of the Mexican Hat site and all of the Monument Valley site are graded to promote drainage, stabilized from erosion, then released for any use consistent with land use controls. Backfill at the Monument Valley site will be minimal.

4.4.3 Embankment construction

The configuration of the embankment at the Mexican Hat site will minimize the handling of tailings and contaminated materials and use the natural topography of the Mexican Hat processing site to reduce the potential impacts from erosion. The design also incorporates existing sand dikes at the Mexican Hat site to minimize earthwork (see Figure 4.2).

Relocated tailings and contaminated materials will be placed and compacted on the tailings embankment. Contaminated organic materials will be evenly distributed throughout the embankment so that no more than five percent organic material by volume is present in any area of the pile. Demolition debris will be placed in the lower portion of the embankment and surrounded with compacted tailings. Site preparation details and embankment compaction criteria are presented in the Project Site Design Criteria (DOE, 1984b).

The embankment top will have a two percent grade to promote drainage. The sideslopes will be limited to a 20 percent grade to create a stable slope.

4.4.4 Cover construction

The radon emanation rate will be controlled through a design that meets EPA standards by placing and compacting less-contaminated materials in the upper portion of the pile, then placing a radon barrier consisting of 24 inches of compacted, uncontaminated soil over the embankment. The radon barrier will be composed of a silty sand from a nearby borrow source amended with 10 percent bentonite. The radon barrier will be protected on all sides by a rock riprap layer designed to prevent erosion due to wind or rain runoff from the PMP.

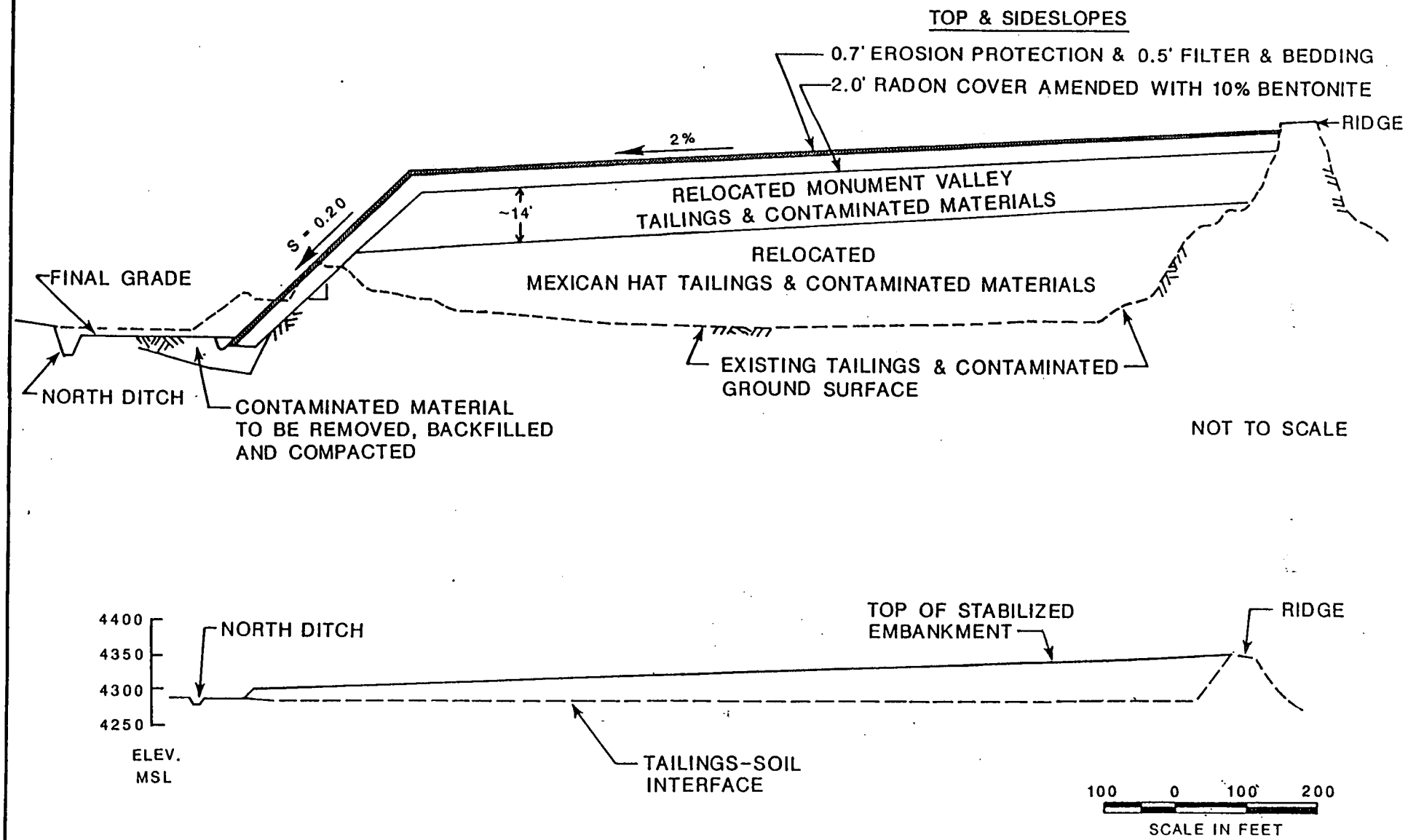

FIGURE 4.2
TYPICAL CROSS SECTION OF THE DISPOSAL CELL
MEXICAN HAT SITE

The erosion protection layer consists of an eight-inch-thick layer of 1.7-inch (or larger) mean diameter rock on the top of the embankment, and a one-foot-thick layer of 4.4-inch (or larger) mean diameter rock on the sideslopes and the aprons of the embankment. A graded bedding layer will be placed beneath the rock layer to protect the fine-grained soils of the radon barrier from erosion by interstitial flow, protect the radon barrier during placement of the riprap layer, and function as a drain that sheds water laterally off the pile.

4.4.5 Site drainage

The Mexican Hat site will be graded and permanent drainage features constructed to protect the embankment from erosion. Drainage ditches will direct runoff around the embankment and into the arroyos. Runoff from the western watershed and west sideslopes of the embankment will be intercepted by the west ditch. Runoff from the east sideslope of the embankment will flow eastward and northeastward as sheet flow and will be released across the rock-covered aprons. Runoff from the top of the embankment will flow to the north and northwest as sheet flow, and down the north side of the embankment across the rock-covered apron into the north ditch. The ditches will be sized and protected with riprap sufficient to carry the runoff from a one-hour PMP, except for the north ditch and diversion ditch. Both of these ditches are expected to be excavated within the upper resistant layer of sandstone, which would not require additional erosion protection. The north ditch will have engineered riprap in an excavated keyway at its outfall into the North Arroyo to prevent headcutting.

In addition, a 1.25-foot-thick layer of 6.9-inch (or larger) mean diameter rock will be placed in the diversion ditch and gully 1; a 1.5-foot-thick layer of 4.4-inch (or larger) mean diameter rock will be placed in gully 2; a 1.5-foot-thick layer of 6.9-inch (or larger) mean diameter rock will be placed in gully 3; and a 13-inch-thick layer of 6.9-inch (or larger) mean diameter rock will be placed in the west ditch (Appendix B, Subcontract Drawings).

4.4.6 Groundwater protection

The disposal cell design will comply with the site-specific groundwater protection standards in 40 CFR 192.02(a)(3) as determined from an assessment of the hydrogeologic characteristics of the site, design analysis of the disposal unit, and performance assessment of the disposal site (NRC, 1988). The disposal cell is designed to meet the proposed EPA MCLs or background water quality, whichever is higher, in the Honaker Trail Formation (the uppermost aquifer). A detailed analysis of the groundwater protection strategy at the Mexican Hat site is provided in Appendix E, Water Resources Protection Strategy. Seepage of tailings fluids into the Honaker Trail Formation is precluded by the upward gradient between

the Honaker Trail Formation and the Halgaito Shale Formation and by a decrease in hydraulic conductivity with depth in the Halgaito Shale Formation in the area of the tailings pile. This upward hydraulic gradient is artesian in the vicinity of the tailings disposal cell. Because of the advantageous hydrogeologic setting, the surface remedial action will comply with the proposed EPA groundwater protection standards.

Groundwater contamination from milling-related tailings seepage forms an area of saturation in the Halgaito Shale Formation beneath and downgradient of the Mexican Hat site. This groundwater has migrated laterally east and southeast of the pile and is the major component of seep discharge for seeps in the North Arroyo and for seep GS-3 (254) in Gypsum Creek. This contaminated groundwater also contributes to flow of four other seeps in Gypsum Creek. However, based on the water quality type of major cations and anions, the major component of flow is from upward movement of natural groundwater. The North Arroyo seeps are located within the site boundary. A risk assessment has been performed (JEG, 1990) that addresses the health and environmental risk from the Gypsum Creek seeps located beyond the designated site boundary (Appendix E, Section E.3.3). This study concluded that there is negligible risk to human health and the environment associated with the Gypsum Creek seeps, given the relative inaccessibility of Gypsum Creek.

4.4.7 Flood protection

The stabilized site will be protected from the Probable Maximum Flood (PMF) generated from the PMP on the upland watershed and on the embankment. Permanent drainage ditches will be constructed to carry the PMF runoff.

4.5 CONSTRUCTION FEATURES

4.5.1 Layout

Construction will occur at the Mexican Hat and Monument Valley processing sites, the borrow sites, and along the haul roads. During Phase I construction at the Mexican Hat site, an access control area was built east of U.S. Highway 163 and northeast of the former Mexican Hat processing site, and an equipment decontamination pad was constructed adjacent to the vehicle access gate. During Phase II construction, a second decontamination pad was constructed in the southwest corner of the Mexican Hat site. Access control, decontamination, and drainage facilities were constructed at the Monument Valley site. Contaminated wastewater at both sites will be directed to retention basins constructed on the sites. Fences will isolate the staging areas at both sites.

4.5.2 Site access

The sites are fenced to control traffic entering and leaving the sites and prevent unauthorized traffic from entering the controlled areas.

4.5.3 Staging area facilities

During construction, temporary facilities will be provided for construction workers and supervisory, engineering, administrative, security, and radiation monitoring personnel at both the Monument Valley and Mexican Hat sites. The facilities will consist of office space, emergency showers, change facilities, and portable toilets.

4.5.4 Utilities

At the Mexican Hat site, existing power lines, a six-inch water line, and a sanitary sewer line leading to the health clinic will be maintained during remedial action. All other site utilities will be removed or abandoned during construction. No utilities are present at the Monument Valley site.

4.5.5 Drainage, erosion control, and wastewater retention basins

During remedial action, all drainage from contaminated areas will be diverted to wastewater retention basins or catchment areas. Temporary drainage ditches and dikes are designed to carry the peak flow from the one-hour 10-year storm event. Runoff outside the affected areas will be diverted away from contaminated areas.

Existing catchment areas will be enlarged to control peak flows into the heap leach pad area at the Monument Valley site. In addition, dikes will be used to divert runoff to the retention basin at this site. This will eliminate the need for ditches being constructed in the rock terrain and becoming a permanent feature after construction.

The retention basins are designed to retain the runoff from a 24-hour 10-year storm as well as the wash water from decontamination operations. The retention basins at each site have sufficient capacity to hold all sediment inflow over the life of the project without sediment removal. The emergency overflow of the basins is designed to safely discharge the one-hour 25-year storm peak inflow.

4.5.6 Equipment decontamination pad

Decontamination pads with a concrete sump will be provided to wash contaminated equipment and trucks at both processing sites, thereby preventing contaminated materials from being removed from the controlled area.

4.5.7 Dust control

Dust generated by excavation, earth movement, vehicle use, temporary material stockpiling, and similar activities will be controlled and minimized by the use of water and water-based surfactants sprayed from hoses or trucks. Dust suppression water for use on contaminated areas will be supplied by the wastewater retention basins, supplemented as necessary with uncontaminated water. Contaminated water will be used only in the contaminated areas. Spraying schedules will be determined hourly. The frequency of spraying will increase when combinations of low soil moisture and windy conditions are encountered.

4.5.8 Borrow areas

Borrow areas for radon barrier and erosion protection materials have been identified. Radon barrier material will be obtained from the RB-4 and RB-7 borrow sites, which are approximately five road miles south of the Mexican Hat processing site. The haul route will be Indian Service Road 6440 and a bypass already constructed to the east of Halchita connecting the service road to the Mexican Hat processing site.

Rock for erosion protection and bedding material is expected to be quarried at the Bluff and Sugarloaf quarries. The subcontractor may elect to obtain bedding and riprap materials from other borrow sources, provided the size and quality requirements are met. Material for restoring the Mexican Hat processing site will be excavated from uncontaminated areas at the site. Restoration material for the Monument Valley site will be excavated from a borrow area adjacent to the site.

4.5.9 Compaction

All contaminated materials, except the top three feet of the tailings, will be compacted to 90 percent of Standard Proctor density. The top three feet of tailings will be compacted to 95 percent of Standard Proctor density. The radon barrier will be placed wet of optimum moisture content and compacted to 100 percent of Standard Proctor density. No materials (tailings or cover) will be placed during freezing conditions. Uncontaminated material used as fill for site restoration will be compacted to 90 percent of Standard Proctor density.

4.5.10 Construction sequence

Work completed during Mexican Hat Phase I construction included demolition of the remaining mill buildings (except the sheet metal shop and the health clinic) and the construction of the wastewater retention basin, dikes, temporary construction ditches,

the decontamination pad, security system, and staging and access control areas.

Initial Phase II construction primarily consisted of stabilization of the pile in place and relocation of the Mexican Hat upper pile and windblown materials to the disposal cell (lower pile).

The Phase II subcontract includes the completion of all remedial action at the Mexican Hat site and the Monument Valley site. The work at the Mexican Hat site will include the following: (Ref. Completion of Phase I and II Subcontracts, Revision I)

- o Disposal of stockpiled debris.
- o Disposal of all off-pile contaminated materials.
- o Construction of radon barrier and infiltration cover.
- o Construction of all permanent drainage features.
- o Removal of all temporary facilities.
- o Site restoration.

On May 31, 1989, the Monument Valley portion of the work was added to the Phase II subcontract. The Monument Valley work will include the following:

- o Construction of temporary facilities.
- o Disposal of rubble.
- o Excavation, hauling, and disposal of tailings and other contaminated materials in the Mexican Hat disposal cell.
- o Removal of temporary facilities.
- o Site restoration.

4.5.11 Construction performance summary

The total embankment settlement expected to occur at the Mexican Hat disposal cell ranges from 0 to 2.7 feet (Calculation 9-420-01). The total settlement is greatest in the central portion of the embankment in the vicinity of piezocone soundings HAT01-231 and HAT01-232. The differential settlement is greatest at the southeast corner of the embankment. The differential settlement of the embankment is not expected to cause any flow concentration or adversely affect the stability of erosion protection material on the embankment.

The cover cracking potential is assumed to be the greatest when the differential settlement is the greatest. The maximum horizontal tensile strain, $\varepsilon_t max$, of the radon barrier material at this section is 0.04 percent (Calculation 9-420-02). The estimated failure tensile strain of the radon barrier is at least 0.05 percent.

The factors of safety for slope stability are shown in Calculation 19-349-03-01. The required factors of safety for each condition are as follows:

Condition	Required factors of safety	Actual factors of safety
Short-term static	1.3	1.9
Short-term seismic	1.0	1.2
Long-term static	1.5	3.0
Long-term seismic	1.0	1.1

4.6 SCHEDULE

Mexican Hat Phase I work was completed in October 1987, and Phase II construction stopped in May 1990. Completion of the remedial action will require approximately 28 months.

4.7 REPROCESSING ASSESSMENT

The feasibility of reprocessing the Mexican Hat tailings to recover residual uranium, vanadium, and molybdenum was evaluated (MSRD, 1982). This analysis indicated that the 1981 market price of these materials would need to triple before reprocessing would become economically feasible.

The feasibility of reprocessing the Monument Valley tailings was not quantitatively evaluated. However, initial studies of the tailings revealed that the prospects of economically reprocessing the tailings were poor due to the low residual uranium, vanadium, and molybdenum contents of the tailings (FBDU, 1981b).

4.8 SITE ACQUISITION REQUIREMENTS

The Mexican Hat site is located within the Navajo Reservation. The DOE will enter into a land withdrawal agreement with the Navajo Nation for the area that will contain the stabilized tailings. Pursuant to that agreement, the DOE or another designated Federal agency will monitor and maintain the land containing the stabilized tailings.

The Monument Valley site is also located within the Navajo Nation. The entire site will be returned to the Navajo Nation after remedial action for any use consistent with land use controls.

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5.0 WATER RESOURCES PROTECTION STRATEGY

The following is a summary of the water resources protection strategy for the Mexican Hat disposal site. A hydrogeologic characterization of the Mexican Hat site is presented in Appendix D, Section D.7; a more detailed analysis of this strategy is presented in Appendix E, Water Resources Protection Strategy.

The performance of the disposal cell is expected to comply with the site-specific groundwater protection standards as determined from an assessment of the hydrogeologic characteristics of the site, design analysis of the disposal unit, and performance assessment of the disposal site (NRC, 1988). The disposal cell will meet the proposed EPA MCLs or background water quality, whichever is higher, in the Honaker Trail Formation (the uppermost aquifer). Seepage of tailings fluids into the Honaker Trail Formation is precluded by the upward gradient between the Honaker Trail Formation and the Halgaito Shale Formation and a decrease in hydraulic conductivity with depth in the Halgaito Shale Formation in the area of the tailings piles. This upward hydraulic gradient is artesian in the vicinity of the tailings disposal cell. Because of the advantageous hydrogeologic setting, the remedial action is expected to comply with the proposed EPA groundwater protection standards.

The transient drainage of water added to suppress dust and compact relocated tailings, and tailings drainage that occurs prior to equilibration with the infiltration rate through the cover, should not cause the proposed EPA groundwater protection standards to be exceeded, as the seepage rate will be less than that which occurred from the tailings during processing activities. Because no contamination has been observed in the Honaker Trail Formation as the result of previous activities, concentrations of hazardous constituents in the Honaker Trail Formation should not be affected by the transient drainage of construction water and residual tailings fluids.

Qualitatively, several components of the cover design will provide additional conservatism for compliance with the proposed EPA groundwater standards. In the remedial action, the lower pile at Mexican Hat has been left in place and the upper pile was relocated and consolidated onto the lower pile. During the next phase of surface remedial action, the contaminated materials from Monument Valley will be relocated and consolidated onto the lower pile. The proposed cover design for the Mexican Hat disposal cell consists of a three-component cover system. In ascending order, the cover consists of a radon/infiltration barrier composed of highly compacted bentonite-amended soil; a bedding (filter) layer of sand; and an erosion protection layer of rock riprap. Recent studies on infiltration through radon barriers with similar cover components in areas with similar climates suggest that infiltration rates will be negligible, as infiltration is a function of the unsaturated hydraulic conductivity of the radon barrier (DOE, 1989b). The Mexican Hat disposal cell overlies the Halgaito Shale Formation, which unconformably overlies the Honaker Trail Formation in the site vicinity. The cell design favors the hydrogeologic isolation for moisture exiting the disposal cell. The design aligns the natural setting by incorporating a low cover flux and controlling the use of construction water. Unsaturated hydraulic conductivities are substantially lower than saturated hydraulic conductivities. Operational unsaturated conditions in the Mexican Hat radon/infiltration barrier result in an estimated seepage flux through the stabilized pile three to eight orders of

magnitude less than is occurring under presently unstabilized conditions. This represents a negligible long-term seepage flux through the disposal cell, implying that the proposed concentration limits (either background concentrations or MCLs, whichever is higher) would be met at the point of compliance (POC), even if the seepage could migrate into the Honaker Trail Formation.

The remedial action will meet the requirements of the standards because the proposed disposal cell design minimizes the need for active maintenance and minimizes or eliminates releases of hazardous constituents to groundwater. The need to minimize active maintenance is achieved by using natural, durable materials and shaping the pile to accommodate natural forces. The pile morphology has been designed to provide slope, settlement, and deformation integrity.

Pursuant to 10 CFR 40 and 40 CFR 192, the DOE is required to submit an LTSP that describes groundwater performance monitoring and demonstrates that the performance of the disposal cell is in accordance with the design requirements at the Mexican Hat Site. The LTSP will be supplied in a separate document. This plan will include a program for Gypsum Creek and North Arroyo seep monitoring. This seep monitoring program will provide a data base that will allow observation and prediction of seep water quality trends. This seep water quality data base will also provide information necessary to reach a decision as to the need for and extent of mitigative measures under Subpart B of UMTRCA as described below.

Closure performance monitoring of groundwater will not be needed at the Mexican Hat site. Water quality impacts in the Honaker Trail Formation have not been observed, even though processing activities began over 30 years ago. Because of the advantageous hydrogeologic setting, the water quality is not expected to be affected in the future.

If the proposed EPA groundwater standards are found or projected to be exceeded, a corrective action plan will be proposed to bring the disposal site into compliance. Proposing a specific detailed action plan to clean up or control the movement of groundwater at this time is not possible. However, should a failure of the disposal cell occur, or should the site be found not to be in compliance following tailings stabilization, within 18 months corrective action plans shall be formulated and implemented.

Based on the present level of site characterization, no groundwater cleanup is anticipated at the Mexican Hat processing site. The uppermost aquifer, the Honaker Trail Formation, has not been and is not expected to be influenced by tailings seepage. The zone of saturation in the Halgaito Shale Member that resulted from uranium processing will eventually diminish as recharge through the tailings is limited by the consolidation of the tailings into a disposal cell with a cover that restricts infiltration. Although this Halgaito Shale Formation saturation contributes to Gypsum Creek seep discharges, a human health and ecological risk assessment (JEG, 1990) found that negligible risk was associated with the seeps given their remote location from human activity and livestock. The seeps in the North Arroyo and in Gypsum Creek will continue to be monitored until the need for mitigative measures is assessed under the separate NEPA process.

Groundwater in the vicinity of the Mexican Hat tailings site has never been used as a water resource due to the naturally poor quality and limited yield. Based on the historic record of groundwater use and the present and future

availability of alternative water supplies, groundwater at the site is not projected to constitute a viable water resource in the area. After remedial actions are completed at the Mexican Hat disposal site, groundwater within the Halgaito Shale Formation will disperse for an unknown, but finite, time. Eventually, recharge to the Halgaito Shale Formation will be governed by infiltration of precipitation, which will result in a return to unsaturated conditions, as was likely the case prior to uranium milling operations. Existing saturation within the Halgaito Shale Formation will diminish with time.

The need for and extent of groundwater cleanup at the Monument Valley processing site will be determined based on the extent of the existing contamination, the potential for current or future use of the aquifer for drinking water supplies, and the technical practicability of restoring the aquifer from an engineering perspective. The relocation of the Monument Valley processing site tailings to the Mexican Hat disposal site will remove the source term for the groundwater contamination at Monument Valley. This will not affect the ability to perform groundwater cleanup at the Monument Valley site. Studies are currently under way to develop plans, guidance materials, and procedures for groundwater cleanup activities. The decision as to the need for and extent of groundwater cleanup, required to be addressed under 40 CFR 192 Subparts B and C, will be made as part of a separate process under the NEPA. These investigations will be carried out during the Subpart B groundwater restoration phase.

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6.0 ENVIRONMENTAL, HEALTH, AND SAFETY

6.1 POLICY

The UMTRA Project health and safety policy is that the DOE and its contractors will take all reasonable precautions in the performance of the remedial action work to protect the environment, ensure the health and safety of employees and the public, and provide protection of the government. The DOE and its contractors will comply with all applicable Federal and state/tribal health and safety regulations and requirements including, but not limited to, those established pursuant to the Occupational Safety and Health Act (OSHA).

The site Remedial Action Contractor (RAC) will have the principal responsibility for implementing a health and safety program. The program should include an on-site professional health and safety staff responsible for implementing, monitoring, sampling, training, and reporting procedures. The surrounding community and the on-site workers must be protected from accidents and radiation exposure. The RAC health and safety program will meet all of the requirements of the UMTRA Project Environmental, Health, and Safety Plan (DOE, 1989c) or its revisions, as well as DOE Orders 5400.5 and 5480.11.

6.2 SITE CONDITIONS AFFECTING HEALTH AND SAFETY PLANNING

The remedial actions at the Mexican Hat and Monument Valley sites will require special attention to potential hazards because of the wide range of activities conducted at the sites during their operation, the various toxic and hazardous materials that may remain at the sites, and the physical hazards that exist at the sites. This section describes those specific conditions that are known or suspected to exist at the sites, and that will require special attention in the health and safety program to be implemented by the RAC.

A sulfuric acid plant was constructed and operated at the Mexican Hat site. As a result, soil in the area of the plant is highly acidic. Caution should be exercised to prevent manual handling of the material. Steep slopes and cliffs are present in the vicinity of the sites. Poisonous snakes have been observed in the local area of the sites.

While no known Th-230 separation was performed at the Mexican Hat site, measurements of Th-230 in air particulates collected in the mill yard, as well as adjacent to the tailings pile, have resulted in average values about 15 percent of the maximum permissible concentration (MPC). Thorium concentrations as high as 56 percent of the MPC were measured at the Monument Valley site. These samples were collected during a period of no construction activity. Th-230 levels in air particulates during construction may approach and even exceed the administrative limits despite ongoing efforts to minimize dust generation. This would necessitate the use of respirators.

The nearest hospital with 24-hour emergency service is the Monument Valley Adventist Hospital. The nearest Highway Patrol office is in Monticello, Utah. Phone numbers for contacting emergency response organizations are provided below:

Ambulance	(801) 587-2232
Monument Valley Adventist Hospital	(801) 727-3242
Fire Department	(801) 587-2237
Highway Patrol	(801) 587-2116
Navajo Police, Kayenta	(602) 697-3578

7.0 RESPONSIBILITIES OF PROJECT PARTICIPANTS

7.1 INTRODUCTION

The following defines the various responsibilities of the DOE UMTRA Project Office, the NRC, the Navajo Nation, the Bureau of Indian Affairs (BIA), and the Bureau of Land Management (BLM) during design, remedial action, and through the initiation of custodial surveillance and maintenance. The DOE will be assisted by its Technical Assistance Contractor (TAC) and its RAC, Morrison-Knudsen, Inc. However, all assigned responsibilities will remain the ultimate responsibility of the DOE. In general, the TAC will assist the DOE in the preparation of conceptual designs and a remedial action plan, and will provide quality assurance, audits, and recommendations for final certification. The RAC will prepare detailed design and manage field construction activities. The Navajo Nation's responsibilities will be administered and coordinated by the Navajo Division of Resources.

Major areas of responsibility for future actions by the DOE, the Navajo Nation, the NRC, the BIA, and the BLM are summarized as follows:

<u>DOE (including TAC and RAC)</u>:

Manage and coordinate project.
Obtain permits and approvals.
Prepare detailed design and specifications.
Prepare quality assurance plan.
Prepare and implement public participation and information plan.
Provide funds.
Conduct remedial action.
Audit remedial action.
Prepare and submit license application.
Prepare LTSP.
Certify remedial action.
Obtain license.
Conduct surveillance and maintenance.

<u>Navajo Nation</u>:

Review and concur in the RAP.
Assist the DOE in acquiring or extinguishing the interests of landowners or others with property interests at the designated processing and disposal sites.
Assist in obtaining local Chapter and Tribal Council approvals.
Issue Navajo Tribal permits or approvals.
Assist in public participation and information.
Assist in the land acquisition process.

<u>NRC</u>:

Review and concur in the RAP.
Review and concur in the LTSP.

Review and concur in the final certification report.
Issue a license for long-term surveillance and maintenance of the disposal site.

BIA:

Review and concur in the RAP.
Issue sand and gravel permits for excavation of borrow materials.
Assist the DOE in acquiring or extinguishing the interests of those with property interests at the designated processing site.
Concur in the land acquisition process.

BLM:

Issue free use permit for the extraction of gravel and rock.

7.2 DETAILED RESPONSIBILITIES

Detailed responsibilities of the project participants in the areas of permitting, licensing, land acquisition, detailed design, construction, health and safety, public information, radiological support, quality assurance, and custodial surveillance and maintenance are defined in the following sections.

7.2.1 Regulatory compliance

Requirements for regulatory compliance, previously identified by Federal and state agencies (Agencies), will be incorporated into the final design specifications, as needed, by the DOE. Revisions to the design and specifications resulting from internal DOE reviews will be incorporated prior to the Agencies' review for permits.

The RAC will submit permit applications and supporting details to the Agencies for permit issuance.

During the remedial action, the DOE will audit construction activities for compliance with provisions of the permits and approvals (permitting Agencies may independently audit relevant activities consistent with normal practice). Summary audit reports will be prepared by the DOE and submitted to the appropriate Agencies as required. Depending upon Agency comments, revisions to construction compliance activities will be made.

Upon completion of the permitted action, the DOE will conduct a final review and will prepare a close-out report for submittal to the Agencies as required. Permits will then be terminated.

7.2.2 Licensing

As part of the licensing task and prior to completion of the remedial action, the DOE will prepare a draft license application including the site LTSP. The draft application will be submitted to the NRC for review and comment. Revisions resulting from this review will be incorporated into the final application, which will be submitted to the NRC by the DOE following the completion of remedial action and documentation in a certification report.

Any final revisions required will be added and the licenses will be issued by the NRC to the DOE (or responsible designated Federal agency).

7.2.3 Land acquisition

The Navajo Nation and the BIA will assist the DOE in acquiring or extinguishing the interests of assignees, permittees, lessees, sublessees, or other individuals with property interests in the processing and disposal site. Upon completion of the remedial action, the DOE will execute the long-term custody agreement for the long-term surveillance and maintenance of the site by the Federal government.

7.2.4 Detailed design

The RAC prepared preliminary engineering drawings for review by the DOE. Based upon this review, the RAC will prepare final design drawings, specifications, and bid packages. Once final and approved by the DOE, the bid packages will be issued to prospective bidders pursuant to Federal regulations, and a construction subcontractor(s) will be selected.

Final design and specifications are provided in Appendix B, Specifications, Design Drawings, Calculations, and Information for Bidders.

7.2.5 Construction

The DOE will prepare guideline documents to comply with health and safety, security, quality assurance, public information, and other regulatory requirements.

The RAC will acquire the necessary permits and approvals from the appropriate Agencies.

Site mobilization and initiation of construction activities will occur in accordance with the DOE-approved construction schedule.

Construction activities will be audited by the DOE. These audits will be provided to the NRC and the Navajo Nation and to other regulatory Agencies upon request to the DOE. The Navajo Nation, the NRC, and other regulatory Agencies may also perform independent audits of the remedial action. Revisions to the remedial action resulting from site audits will be incorporated into the as-built design and the RAP by the DOE as necessary.

Upon completion of the remedial action, the sites will be certified by the DOE. The NRC will review and concur in the final site certification report.

7.2.6 Health and safety

Based upon the guidance of the UMTRA Project Environmental, Health, and Safety Plan (DOE, 1989c), site-specific implementation methods will be developed by the RAC. As part of the implementation methods, the RAC will institute radiation control and environmental monitoring and will develop response procedures for severe weather and medical emergencies.

Construction contractors will comply with approved procedures, file reports with the DOE that record the results of monitoring, and report accidents and illnesses. Records will be maintained by the DOE following remedial action construction.

Employee and public complaints will be investigated by the DOE.

7.2.7 Public information

The DOE will establish local site managers who will provide information to the public and local media.

Prior to and during construction, the DOE, with assistance from Navajo Nation officials and local citizens, will conduct public information meetings to inform the interested public of key aspects and current progress of the remedial action.

Concurrent with the public meetings, the DOE will provide status and progress reports for the Navajo Nation and other agencies (e.g., NRC, EPA, BIA).

7.2.8 Radiological support

The DOE will prepare and implement a Radiological Support Plan (Appendix C) and will take measures to independently ensure the quality of the analyses and compliance with the procedures.

After remedial action, the DOE will prepare a completion report, conduct a final verification survey, and provide a recommendation for

site certification. The NRC will concur in the final site certification report.

7.2.9 Quality assurance (QA)

Quality will be controlled in accordance with the DOE/UMTRA Quality Assurance Plan (DOE, 1990). QA audits and the in-process surveillance shall be conducted by DOE and the TAC to verify and ensure that the remedial action activities are performed in accordance with approved Project requirements.

7.2.10 Surveillance and maintenance

The DOE will prepare and submit to the NRC the LTSP as part of the site license application. The NRC will review and concur with the plan, and the DOE (or designated Federal agency) will ensure that the plan is implemented.

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8.0 LONG-TERM CARE PROGRAM

8.1 INTRODUCTION

To control the stabilized RRM, Section 104(f)(2) of the UMTRCA requires that the disposal sites be cared for under a general license issued by the NRC. The NRC's regulations, 10 CFR 40, define the conditions that must be met before the general license becomes effective for the disposal site at Mexican Hat, Utah.

The general license is for the disposal sites only. Its objective is to ensure that the disposal cell remains undisturbed and that the stabilized RRM will not present a hazard to the public or the environment. The general license will become effective for the Mexican Hat disposal site after the following take place:

- The NRC concurs in the DOE's certification that the remedial action has been completed in accordance with 40 CFR 192 and all applicable standards for the Navajo Nation.
- Title to or custody of the RRM and the disposal site has been transferred to the DOE.
- The NRC has formally accepted the site-specific LTSP.

At this time, surveillance and monitoring (S&M) under the Title I long-term care program will begin and programmatic responsibility for carrying out this program will be transferred to the DOE Grand Junction Projects Office (GJPO).

It is estimated that once the surface remedial action activities are completed, it will take a minimum of 28 months for the licensing process to be completed.

8.2 THE LONG-TERM SURVEILLANCE PLAN

The LTSP contains the licensing conditions for the Mexican Hat disposal site. As defined in 10 CFR 40.27b, the LTSP will contain the following information:

- A legal description of the disposal site to be licensed, including documentation on whether land and interests are owned by the United States or an Indian tribe.
- A detailed summary description of the final site conditions, specific maps and drawings of permanent site surveillance features, and a characterization of existing groundwater quality and any necessary groundwater protection activities or strategies.

- A detailed description of the long-term surveillance program, including the proposed inspection frequency, reporting to the NRC, and the extent of groundwater monitoring, if required.

- The criteria for follow-up inspections in response to observations from routine inspections or extreme natural events.

- The criteria for instituting maintenance or emergency measures (e.g., corrective action).

The Guidance for Implementing the UMTRA Project Long-term Surveillance Program (DOE, 1992) provides guidance for carrying out the long-term care program in accordance with the licensing conditions and for preparing the LTSP.

At the time the disposal site is completed, a draft LTSP will be prepared for review and comment by the NRC and the Navajo Nation. The final LTSP will be submitted to the NRC for acceptance after their concerns and those of the Navajo Nation have been addressed, and after the NRC has concurred in the DOE's certification of completion of remedial action and custody of the RRM and the disposal site has been transferred to the DOE.

For the disposal site at Mexican Hat where the RRM is to be stabilized in place (SIP), a two-step process will be applied to 1) the NRC's concurrence in the DOE's certification that surface remedial action is completed, and 2) the licensing process. The two-step process will avoid delaying the licensing of the disposal site so that surveillance and monitoring under the long-term care program can begin. When any groundwater restoration activities that may be required have been addressed, the NRC will then concur in the second phase of the DOE's certification and the second, and final, phase of the license will be in effect for this SIP site.

When the NRC concurs that all groundwater restoration activities have been addressed at the Mexican Hat disposal site, the need to modify the LTSP will be assessed and reported to the NRC.

8.3 THE LONG-TERM CARE PROGRAM

8.3.1 Baseline conditions

The LTSP will describe the final site as-built conditions. It will contain a summary of the disposal cell design and a description of baseline conditions, including groundwater characterization. In addition to the site as-built drawings, aerial photographs will be taken to visually record baseline conditions. These photographs also will be used to supplement the site inspections to identify changes in site conditions (e.g., patterns of developing erosion that may affect the function of the disposal cell design). If potential problems are identified over time, additional aerial photographs will be taken to aid in the determination of the long-term effect of the problem.

8.3.2 Groundwater monitoring

The need for groundwater monitoring is identified and described in the RAP. The LTSP will provide a summary of the groundwater protection strategy identified in the RAP. The LTSP also will include the following:

- o A summary of the hydrogeologic conditions, including background and baseline groundwater conditions.
- o The identification of hazardous constituents to be monitored, their established concentration limits, and excursion criteria.
- o The seep monitoring network, including the number and location of the seeps. Site surveyed coordinates and ground elevations will be kept in the permanent site file to be used by GJPO in long-term surveillance.
- o Seep water quality and water flow data summaries. Reference to the complete reports on groundwater quality will be provided.
- o The frequency and extent of the groundwater monitoring program.

8.3.3 Site inspections

The most effective way of ensuring that the disposal cell is functioning as designed is by conducting on-site inspections. The primary objective of the site inspection is to record any changes or modifications to the disposal cell and disposal site over time and identify potential problems at an early stage prior to the need for extensive maintenance, repairs, or corrective action.

Scheduled inspections

Site inspections will be conducted annually for the first five years after the site is licensed. At the end of this five-year period, the DOE will review all inspection reports, as well as any maintenance or corrective action reports. If a determination is made that less frequent inspections are required, the DOE will modify the LTSP and submit it to the NRC for acceptance. The Navajo Nation also will receive a copy for review.

Follow-up inspections

Follow-up inspections are a second level of inspection to investigate and further quantify specific site problems detected during a scheduled inspection. A follow-up inspection could be

required to evaluate the need for custodial maintenance, repair, or corrective action. These inspections will be conducted by technical specialists in the discipline appropriate to a reported problem. Based on the recommendations from this inspection, a program of evaluative monitoring may be recommended, or a corrective action program may be initiated.

At the conclusion of the follow-up inspection, an inspection/preliminary inspection report will be submitted to the NRC within 60 days of the initial report of the problem. The DOE also will provide copies of these reports to the Navajo Nation within the 60-day time frame.

Contingency inspections

Contingency inspections are unscheduled inspections ordered by the DOE when it receives outside information indicating that the disposal site integrity has been threatened. This inspection could be triggered by unusual events such as a report of severe vandalism, continuing intrusion by livestock, or a report of an extreme natural event such as flooding or, possibly, an earthquake.

The procedures for conducting a contingency inspection, as well as the reporting requirements, are the same as those for a follow-up inspection.

To ensure that the DOE is notified promptly of unusual or extreme events, the DOE will implement the contingency plans and reporting procedures with appropriate state, local, and Federal agencies (e.g., the National Weather Service and the Earthquake Information Center) when the LTSP is under preparation.

8.3.4 Custodial maintenance or repair

The need for custodial activities can be determined only during the site inspection. It is anticipated that custodial maintenance or repair would be limited to fence or sign repair or weed control. The final LTSP will identify any planned custodial activities that may be required, the timing and frequency with which they will be performed, and the manner in which the work will be authorized.

8.3.5 Corrective action

The need for corrective action will be defined by the nature and magnitude of the problem and its effect on the disposal cell's ability to comply with the EPA standards. If the need for corrective action is indicated, the DOE will initiate a program to identify the factors that caused the problem and to determine the best course of action for correcting the problem and ensuring that its recurrence is precluded.

Once a potential problem is identified, the DOE will notify the NRC and will submit an inspection/preliminary assessment report to the NRC for review within 60 days of the report of the problem. After NRC review, the DOE will develop a corrective action program for NRC approval. Copies of these reports will be provided to the Navajo Nation for review. Once the NRC has approved the corrective action, the plan will be implemented by the DOE.

If an excursion is identified during the groundwater monitoring program, 40 CFR 192.02(c) requires that corrective action be implemented within 18 months of verification of the excursion.

8.3.6 Reporting and record keeping

The DOE will prepare a report to the NRC that provides the results of scheduled inspections, groundwater monitoring results, and the results of any unscheduled inspections, repairs, or corrective actions that may have been required at the disposal site. This report will be prepared annually, in accordance with the requirements of 10 CFR 40. A copy of this report also will be provided to the Navajo Nation.

The DOE will maintain complete records and supporting documentation in permanent site files. The reports, records, and supporting documentation will: 1) demonstrate that the license provisions continue to be met; 2) provide the DOE and NRC information necessary to forecast future surveillance and monitoring; and 3) provide information to the public to demonstrate that site integrity is being maintained.

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UMT 10208

SURF008881

UNITED STATES DEPARTMENT OF ENERGY
Albuquerque, New Mexico

Uranium Mill Tailings Remedial Action Project (UMTRAP)

Mexican Hat, Utah
Monument Valley, Arizona

Completion
Mexican Hat and Monument Valley

Remedial Action Completed During Phase I and Phase II Subcontracts

APPENDIX A

VOLUME I

August 1991

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

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UMTRA PROJECT
MEXICAN HAT/MONUMENT VALLEY
REMEDIAL ACTION COMPLETED DURING
PHASE I AND PHASE II SUBCONTRACTS
APPENDIX A

AUGUST 1991

PREPARED BY

MORRISON KNUDSEN CORPORATION
MK Environmental Services Division
180 Howard Street
San Francisco, California 94105

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UMTRA PROJECT
MEXICAN HAT/MONUMENT VALLEY
REMEDIAL ACTION COMPLETED DURING
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UMTRA PROJECT
MEXICAN HAT/MONUMENT VALLEY
REMEDIAL ACTION COMPLETED DURING
PHASE I AND PHASE II SUBCONTRACTS
APPENDIX A

1. SUMMARY

This appendix, which consists of two volumes, contains additional information pertaining to the remedial activities that were completed at the Mexican Hat site during the Phase I and Phase II Subcontracts. Following is a brief description of the contents of this appendix.

A. Site Investigation for Demolition Design at Mexican Hat, Utah

- This report, dated October 28 and 29, 1986, was originally included in the Phase I Information for Bidders. It includes an industrial hygiene report, radiological report, location map, description of the physical structure, and a photograph of each item to be demolished.

- The demolition and stockpiling of the structures at Mexican Hat was completed during the Phase I Subcontract. Therefore, this report was not included with the Phase II and Completion Subcontracts. The demolition debris was placed in the tailings embankment during the Phase II Subcontract.

B. Subsurface Information

- This section includes a boring location plan for the Mexican Hat Site along with data and analytical results for various borings, piezocones and test pits at the site. This information was originally included in the Phase II Information for Bidders.

- The subsurface information contained in this section was for the upper tailings pile. This information was excluded from the Completion Subcontract Information for Bidders because the upper tailings pile was removed during the Phase II Subcontract. All other boring, piezocone and test pit information is included in the Information for Bidders for the Completion Subcontract.

  Information on wells that were sealed or removed during the Phase II subcontract and the corresponding well data were not included in the supporting documents for the Completion Subcontract.

C. Radiological Characterization of the Mexican Hat, Utah, Uranium Mill Tailings Remedial Action Sites, January 1985

- This report was originally included in both the Phase I and Phase II Subcontract Information for Bidders.

- The information in this section was obtained from the Bendix report, and contains mostly off-pile sampling data along with some minor on-pile sampling data.

- This section is not included in the Completion Subcontract Information for Bidders. It has been replaced with sampling and testing data for the disposal cell that was obtained during Phase II remedial action. (See "Sampling and Testing for Site Cell Radiological Characterization During Construction," in the Information for Bidders for the Completion Subcontract.)

D. Topographic Maps

Three topographic maps of the Mexican Hat site are included in this section.

- 1982 Contour Lines - Before any remedial action was performed.
- 1990 Contour Lines - After the completion of both Phase I and Phase II remedial action.
- 1982 and 1990 Contour Lines - Superimposed.

E. Calculations

The following calculations are included in Volume II of Appendix A.

1. Upper Tailings Excavation (MKES Calc. 9-226-03-00)

- This calculation, which was originally included in the supporting documents for the Phase II Subcontract, estimated the volume of contaminated material in the upper tailings pile to be excavated as 833,010 cy.

- During Phase II Remedial Action, all of the upper tailings were removed. Therefore, this calculation is not included in the supporting documents for the Completion Subcontract.

2. Contaminated Material Excavation - Windblown and Waterborne Excavation Quantities (MKES Calc. 9-226-02-01)

- This calculation, which was originally included in the supporting documents for the Phase II Subcontract, estimated the excavation quantity of windblown contaminated material to be 191,000 cy, waterborne contaminated material to be 22,900 cy, and tailings adjacent to the lower pile to be 52,600 cy at the Mexican Hat site.

- Since most of the off-pile contaminated material at Mexican Hat was excavated and placed in the pile during the Phase II remedial action, this calculation has been superseded by MKES Calc. 9-419-01-00, Contaminated Material Excavation at Hat Site, which estimates the remaining quantities of windblown/waterborne contamination. Calculation 9-419-01-00 is included in the supporting documents for the Completion Subcontract.

3. Embankment Design - Piezocone Interpretation (MKES Calc. 9-239-11-00)

- This calculation was originally included in the supporting documents for both the Phase I and Phase II Subcontracts.

- The purpose of this calculation was to check and verify the Mexican Hat piezocone data interpretation provided by the UMTRA Technical Assistance Contractor.

- This calculation is not included in the supporting documents for the Completion Subcontract because the subsurface conditions of the lower tailings have changed due to the remedial action completed during Phase II.

4. <u>Site Drainage - North Ditch (MKES Calc. 9-228-03-01)</u>

- This calculation, which was originally included in the supporting documents for the Phase II Subcontract, defined the configuration of the North Ditch (located on the north side of the tailings embankment).

- This calculation is not included in the supporting documents for the Completion Subcontract because the North Ditch was completed, except for the outlet, during the Phase II Remedial Action. The outlet has been redesigned for the Completion Subcontract. The estimated quantity of work remaining on the North Ditch and a description of the new outlet configuration can be found in MKES Calc. 9-423-03-00, Earthwork Quantity - North Ditch, included in the Completion package.

5. <u>Site Drainage - West Ditch (MKES Calc. 9-228-02-02)</u>

- This calculation, which was originally included in the supporting documents for the Phase II Subcontract, defined the configuration of the West Ditch (located on the west side of the tailings embankment) and computed the D_{50} riprap size for the erosion protection along the ditch.

- This calculation is not included in the supporting documents for the Completion Subcontract because the excavation for the West

Ditch has been nearly completed, except for the outlet area which has been revised. For a quantity estimate of the work remaining and a description of the new outlet configuration, see MKES Calc. 9-423-02-00, Cut/Fill Quantities - West Ditch, included in the Completion Subcontract package.

SITE INVESTIGATION FOR DEMOLITION DESIGN
MEXICAN HAT, UTAH

OCTOBER 28 and 29, 1986

PREPARED FOR MORRISON-KNUDSEN ENGINEERS, INC.
SAN FRANCISCO, CA

BY
MK-FERGUSON COMPANY/CNSI

Rob Cooney - MK-F
Jerry Lyons - MK-F
Mark Thomson - MK-F
Carl Begley - CNSI

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SECTION 1	PHYSICAL STRUCTURE AND PHOTOGRAPHS
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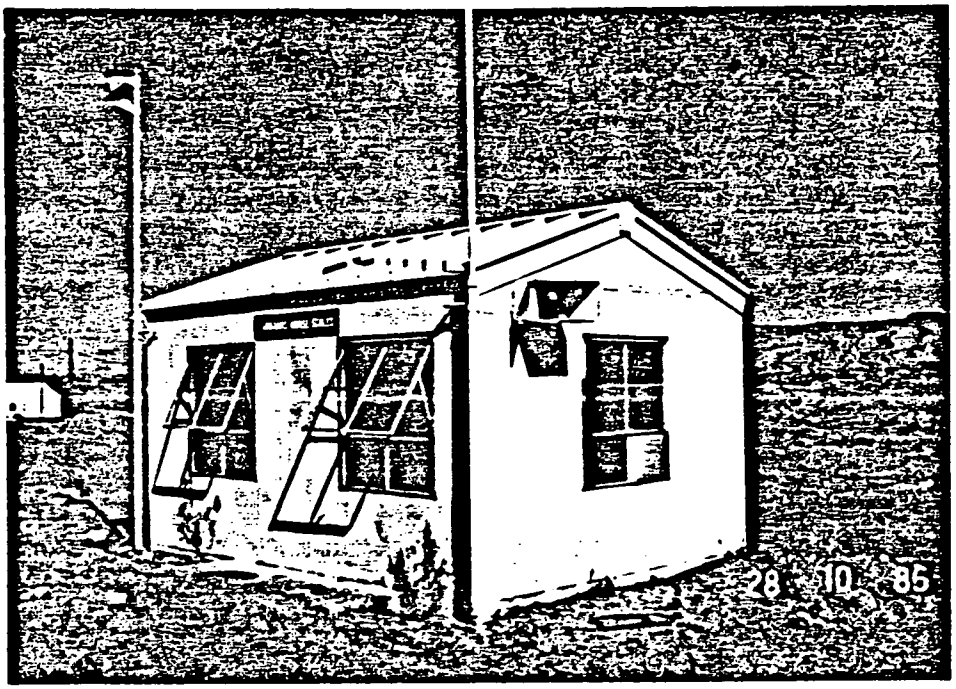
SECTION 4	LOCATION MAP

SCALE HOUSE

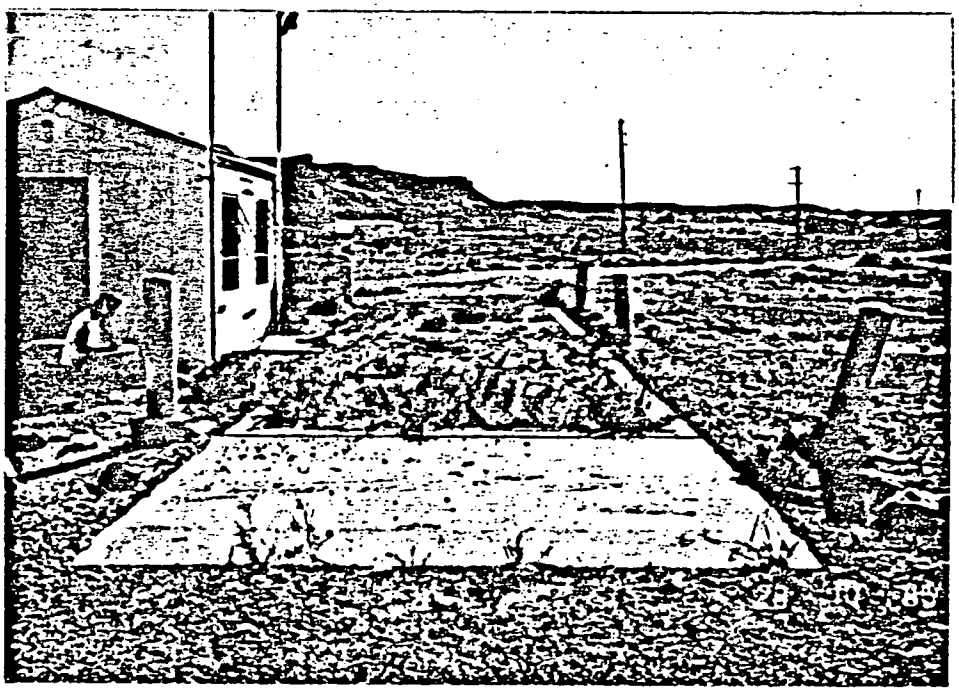
Building is 10' x 12' x 12' h at the roof peak. It is a metal ribbed building and sits on a slab approximately 8 inches thick. The windows have all been broken out. Wiring has been disconnected and most of it has been removed. There is gas service to this building but cannot determine if the line has been abandoned. There is a manhole on the west side of the building, type unknown, and a 3' x 6' x 6" slab at the entry way on the north end of the structure.

SCALE PIT

The scale pit structure is approximately 48' long x 12' wide. There are 12' x 12' x 1' thick slabs on each end of the pit. The pit itself is constructed with 8 inch walls. We assume the pit is 8 to 10 feet deep and has been filled in. There are also five each concrete guardposts surrounding the scale pit area. They are approximately 6 inches in diameter and are about 4 feet above grade.

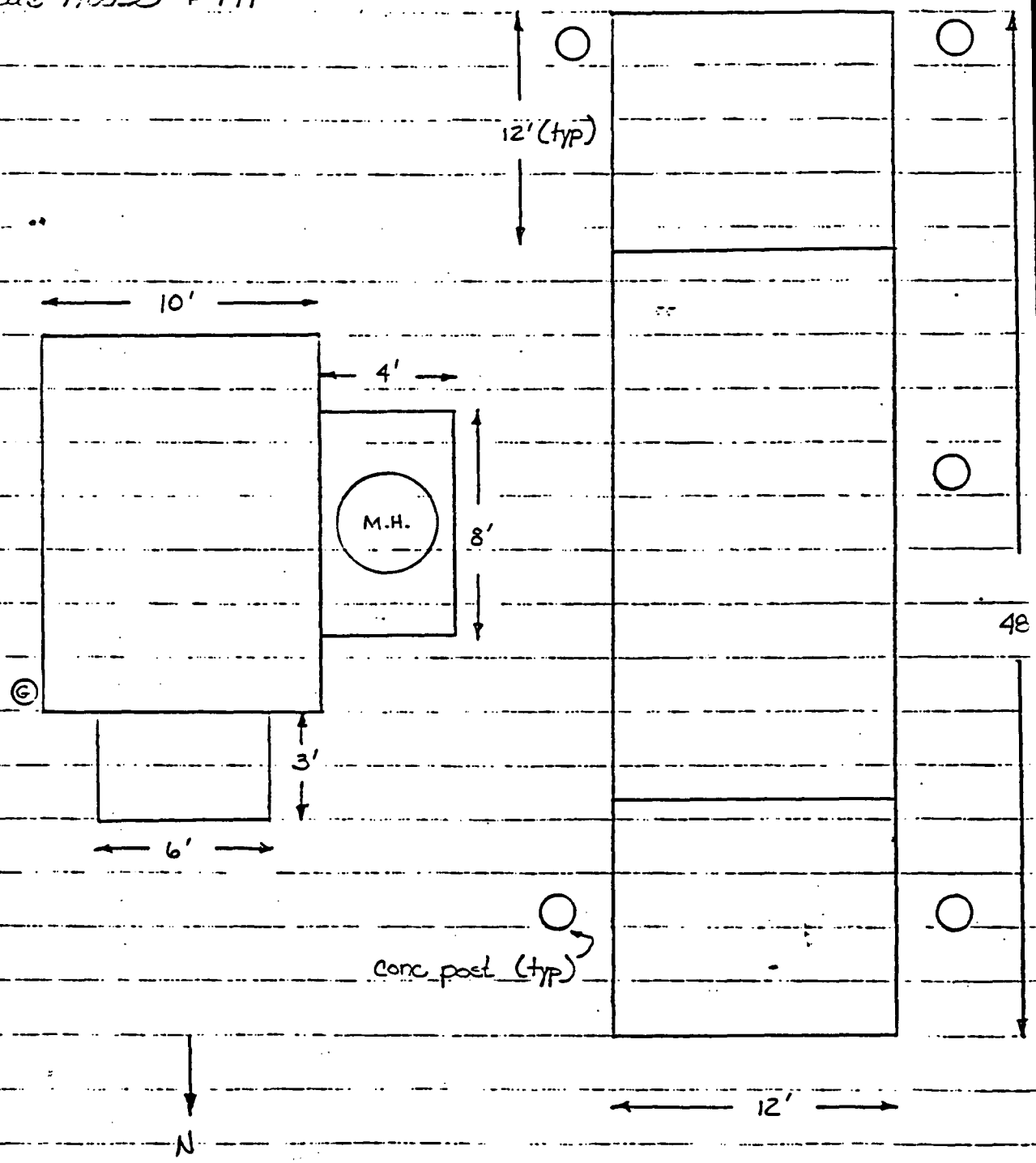


Scale House - Looking East

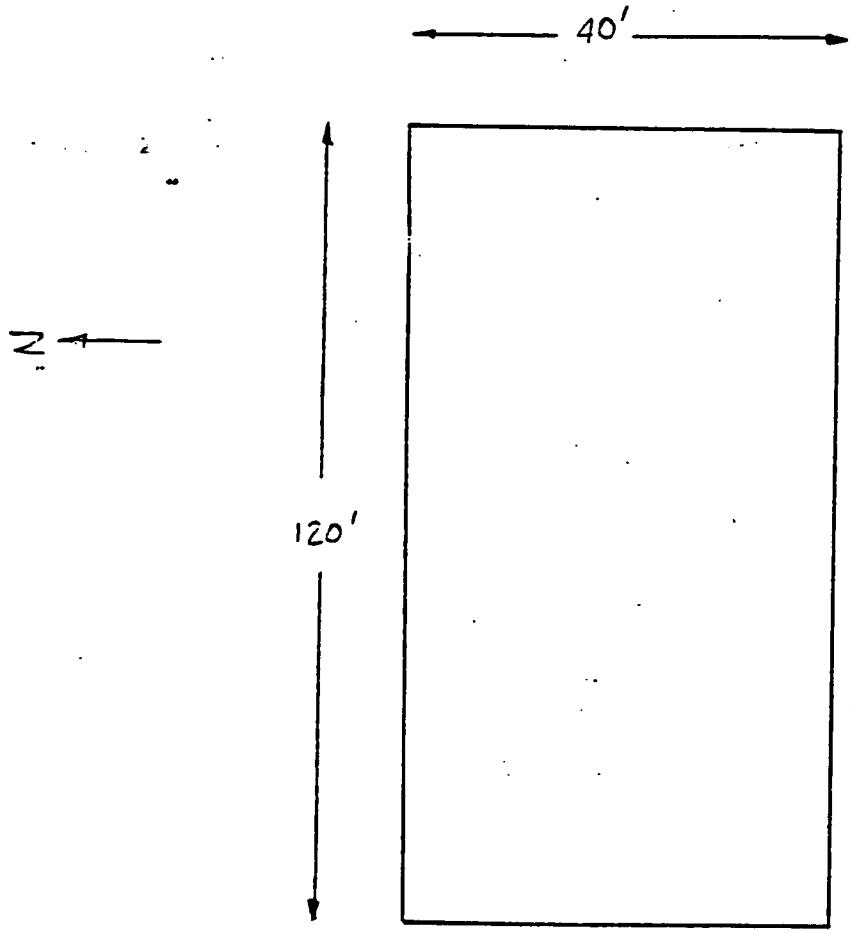


Scale Pad and Pit - Looking South

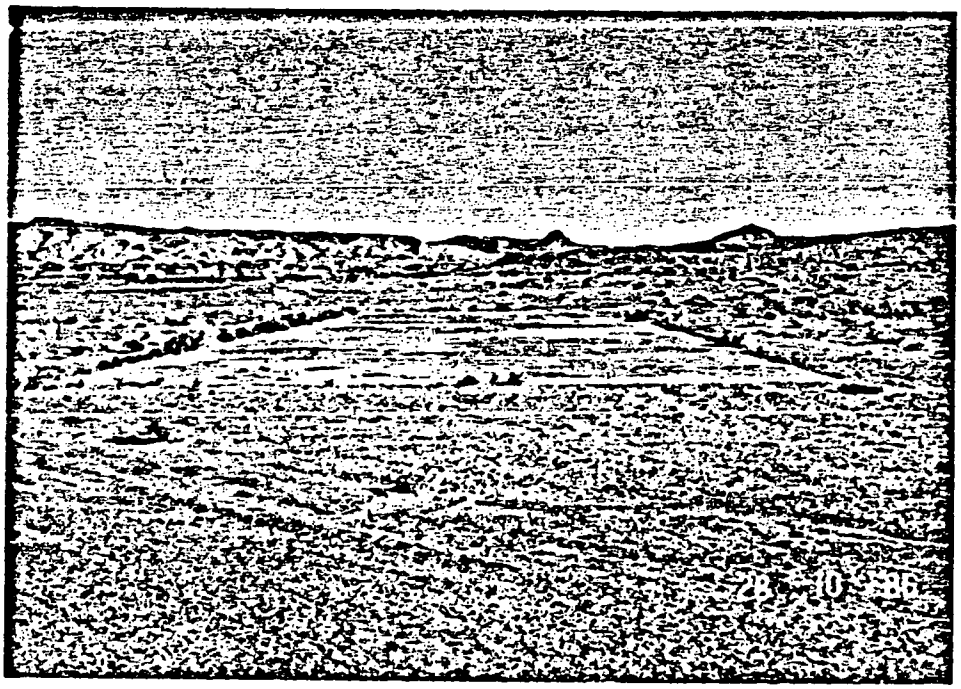
Scale House & Pit



CONCRETE FOUNDATION (East of Scale House)



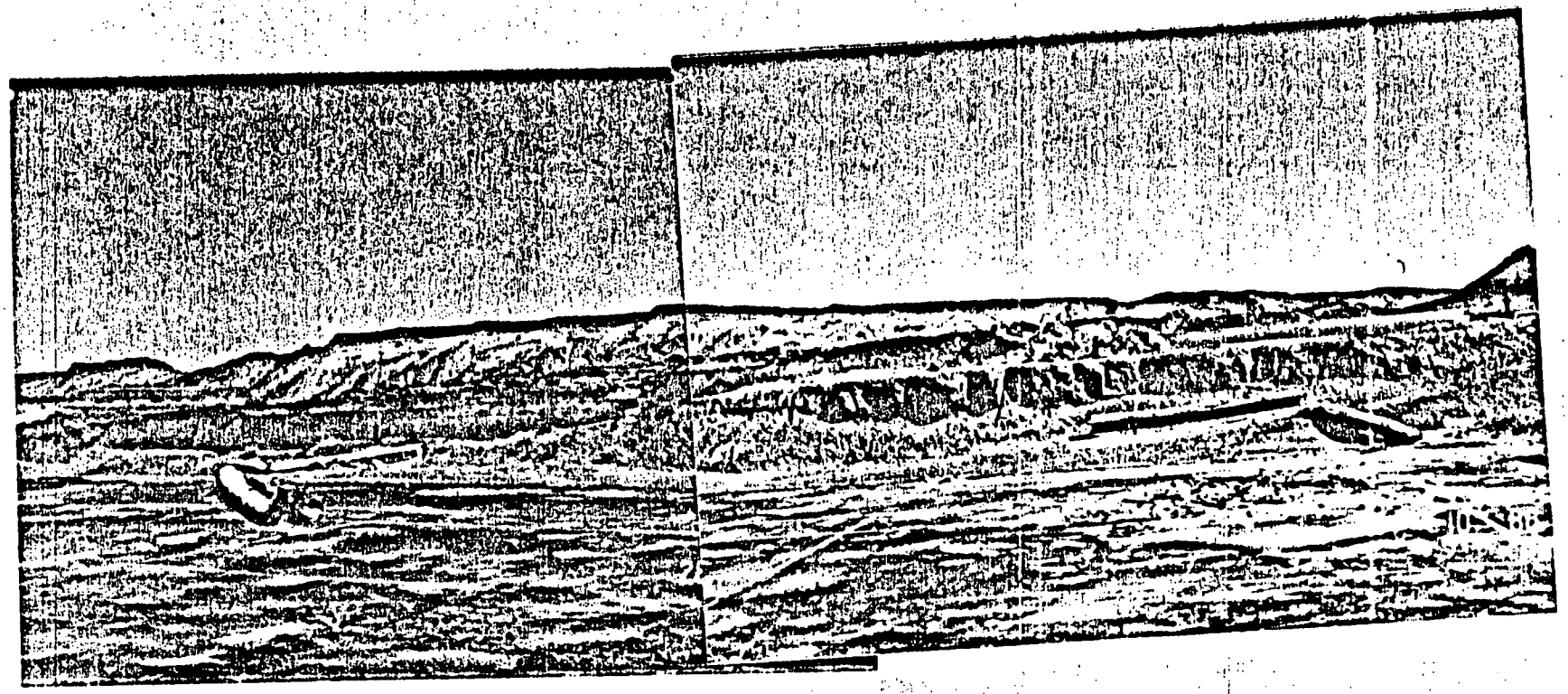
The concrete foundation is on grade. It is approximately 40' x 120' and we have assumed a thickness of 1 foot.



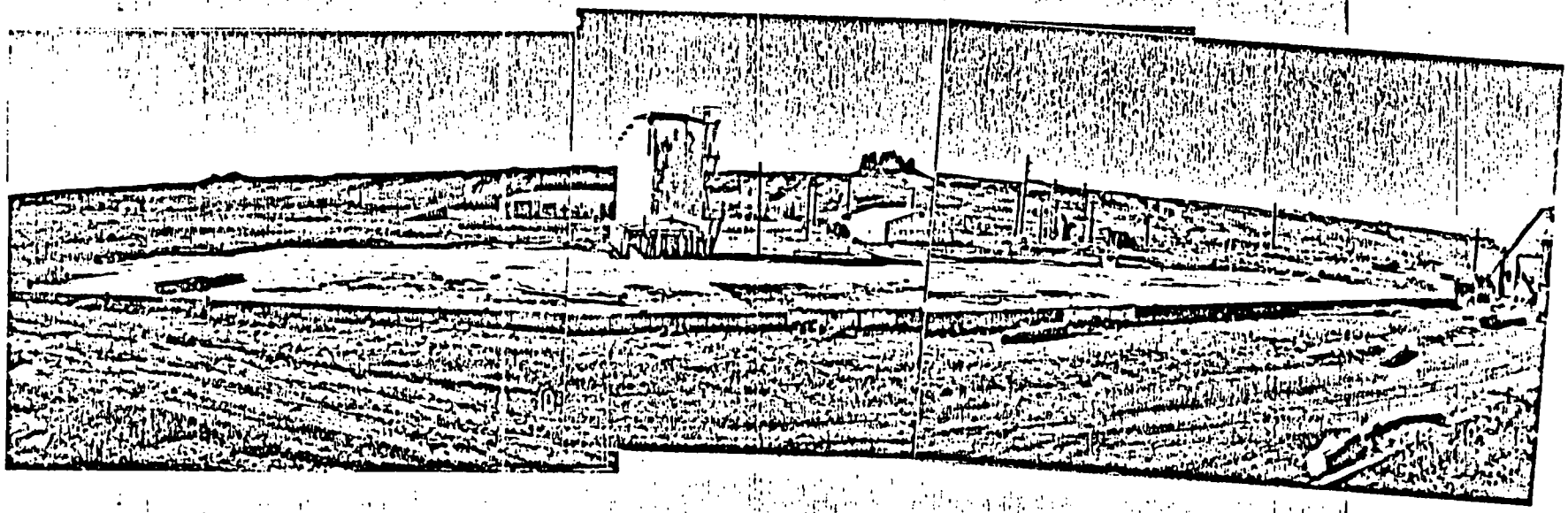
Concrete Slab - Looking East

CONCRETE FOUNDATION EAST END OF SITE

There is a concrete structure on the east side of the buildings area. It is approximately 200' x 100' and is split level. It appears that the foundation walls are of reenforced concrete and are about 5 feet high. There is a slab on the south half of the structure, which is probably 6 to 8 inches in thickness. There is no apparent slab on the northern half. No foundation walls could be located on the east side, however, a good deal of this structure is covered with earth that has been bulldozed up from the eastern side. It appears that part of the north end has been demolished, as chunks of reenforced foundations are partially buried in an earthen pile just north of the foundation.



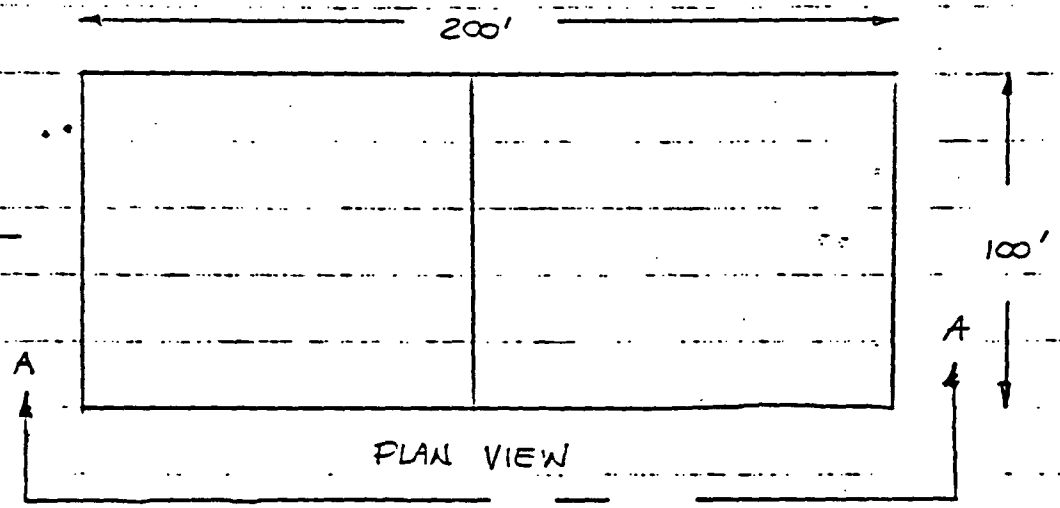
Buried Foundation and Slab -
Looking East

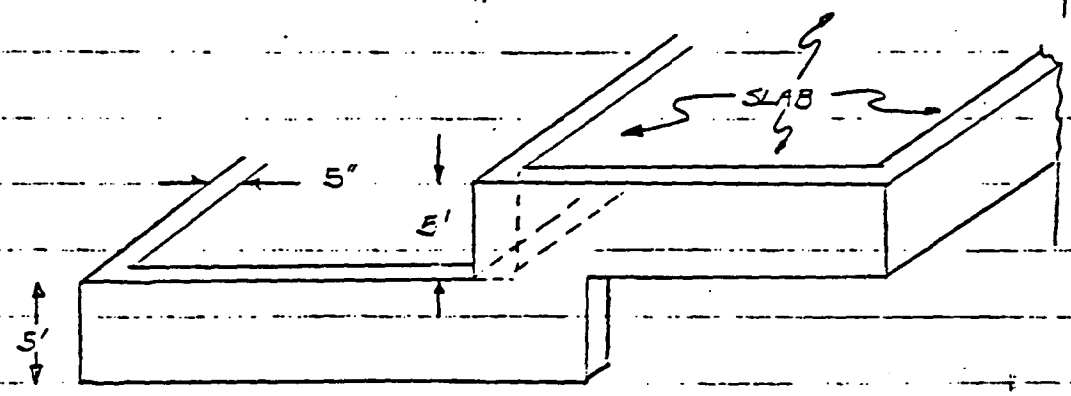


Panorama of Foundation -
East of Tanks

Buried Foundation - Looking North

Concrete Foundation East End of Site





SECT A-A

FOUNDATION JUST EAST OF THE FOUR STORAGE TANKS

The foundation is approximately 100' x 342'. The foundation walls are typically 8" x 4' high. Slab thickness varies, with the majority being 4 to 6 inches. In walking over the foundation, a small area sounds hollow, indicating a supported slab or that the fill has settled underneath. The foundation walls in some areas are lined with corrugated metal panels. On the east side, the foundation also includes Concrete Masonary Units. The steel columns have been burned off at slab level. We assume that there are concrete piers on spread footings under the slab that support the columns. The columns indicate.two bays from east to west. The first bay is 60 feet wide and the second bay is 30 feet wide. Columns run every 20 feet center to center from north to south.

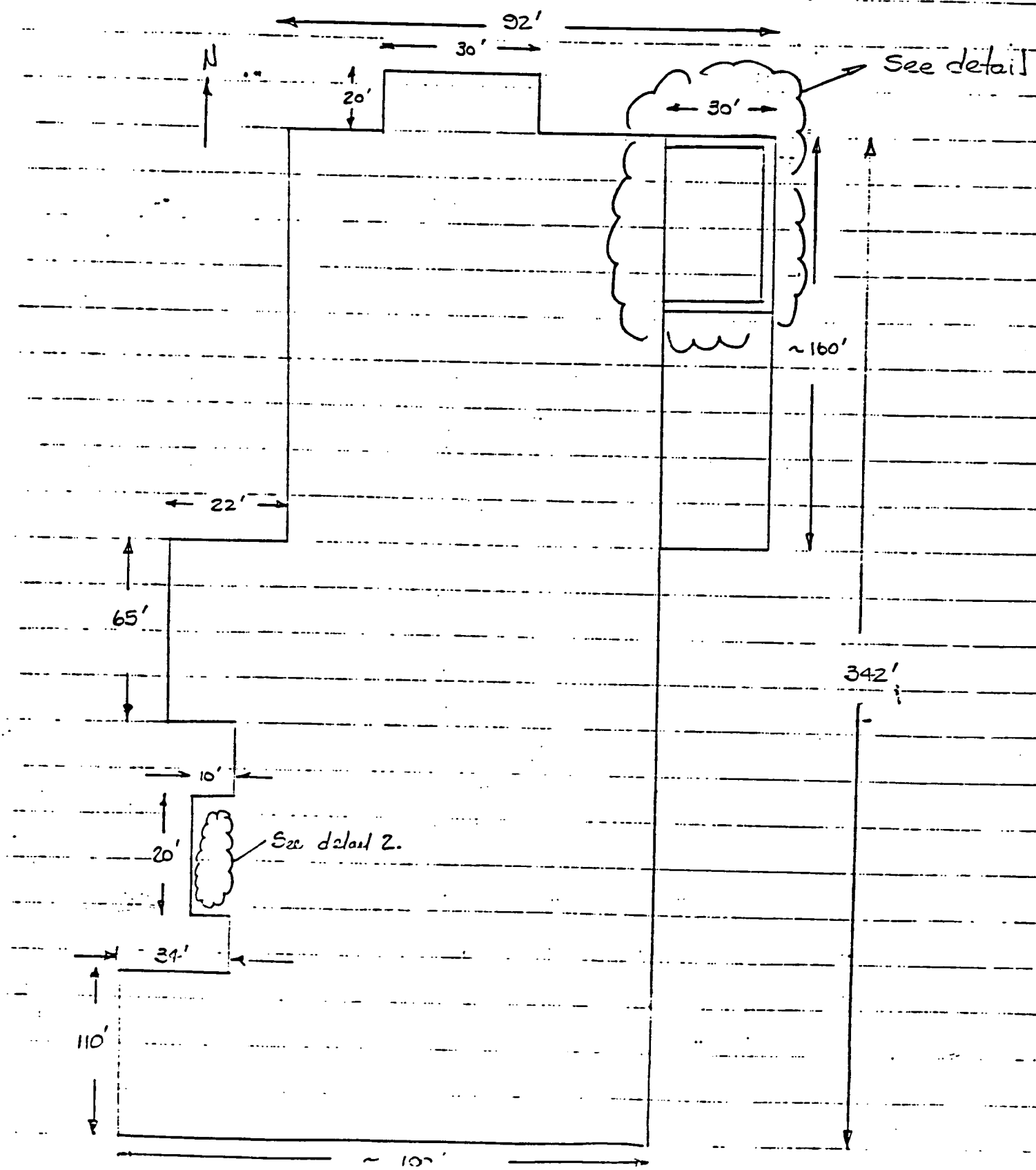
Detail No. 1

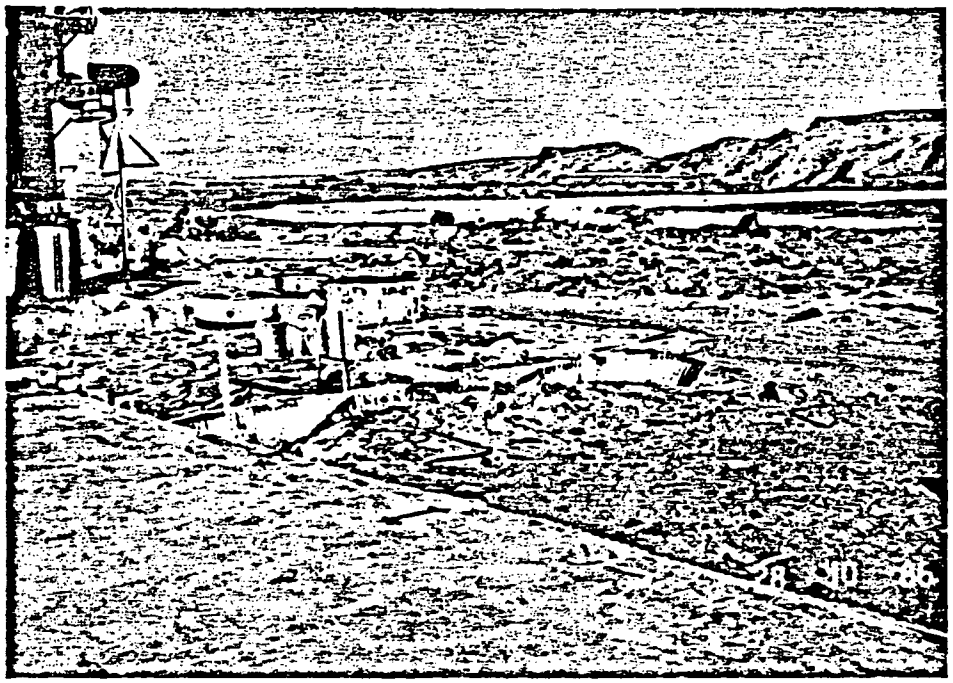
This area appears to be for tank storage. The surface area is approximately 65' x 30'. There is a concrete stairwell in the southeast corner. The foundation walls are 8" wide by 2-3' high and are on the north, east and south sides. Based on the types of foundations in this pit, we have assumed the slab thickness to be one foot. There are two each 10 foot diameter concrete tank foundations, probably 18 inches to two feet thick, miscellaneous piers, pedestals and tank saddles. Also, there is a storage tank that is 6 feet in diameter by 4 feet high. The tank is supported by miscellaneous metal legs.

Detail No. 2

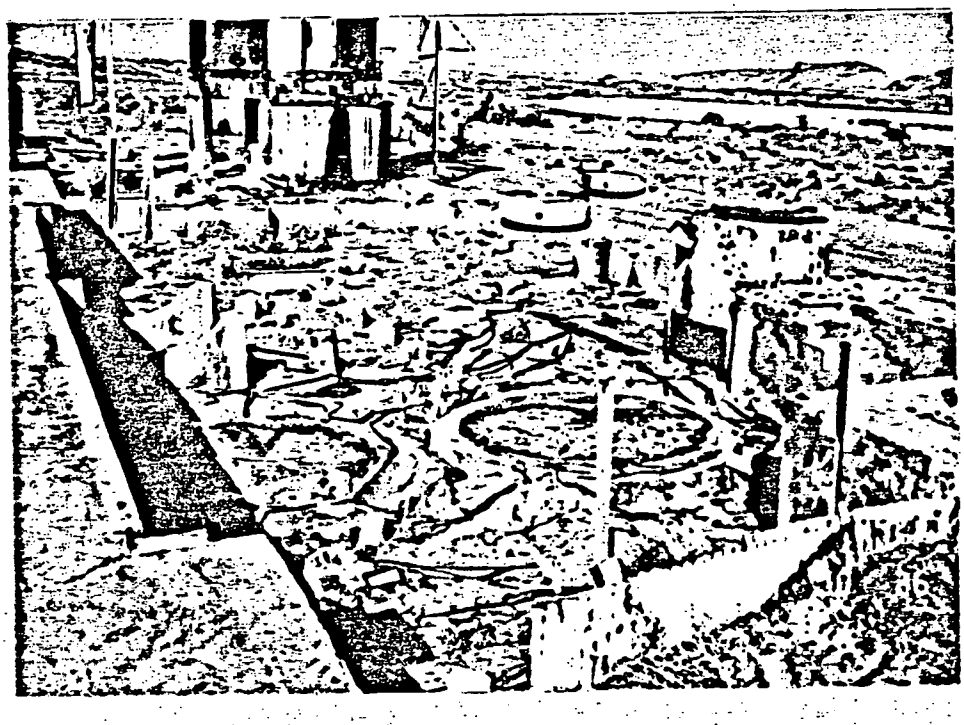
There is an equipment foundation located in the southwest quadrant of the slab. This foundation is 2 feet wide by 10 feet long with eight sleeved anchor bolts. The foundation sits 2 feet above the slab. Judging from the size of the anchor bolts, we have assumed this concrete to be 6 feet thick.

Foundation Just East of the 4 Storage Tanks

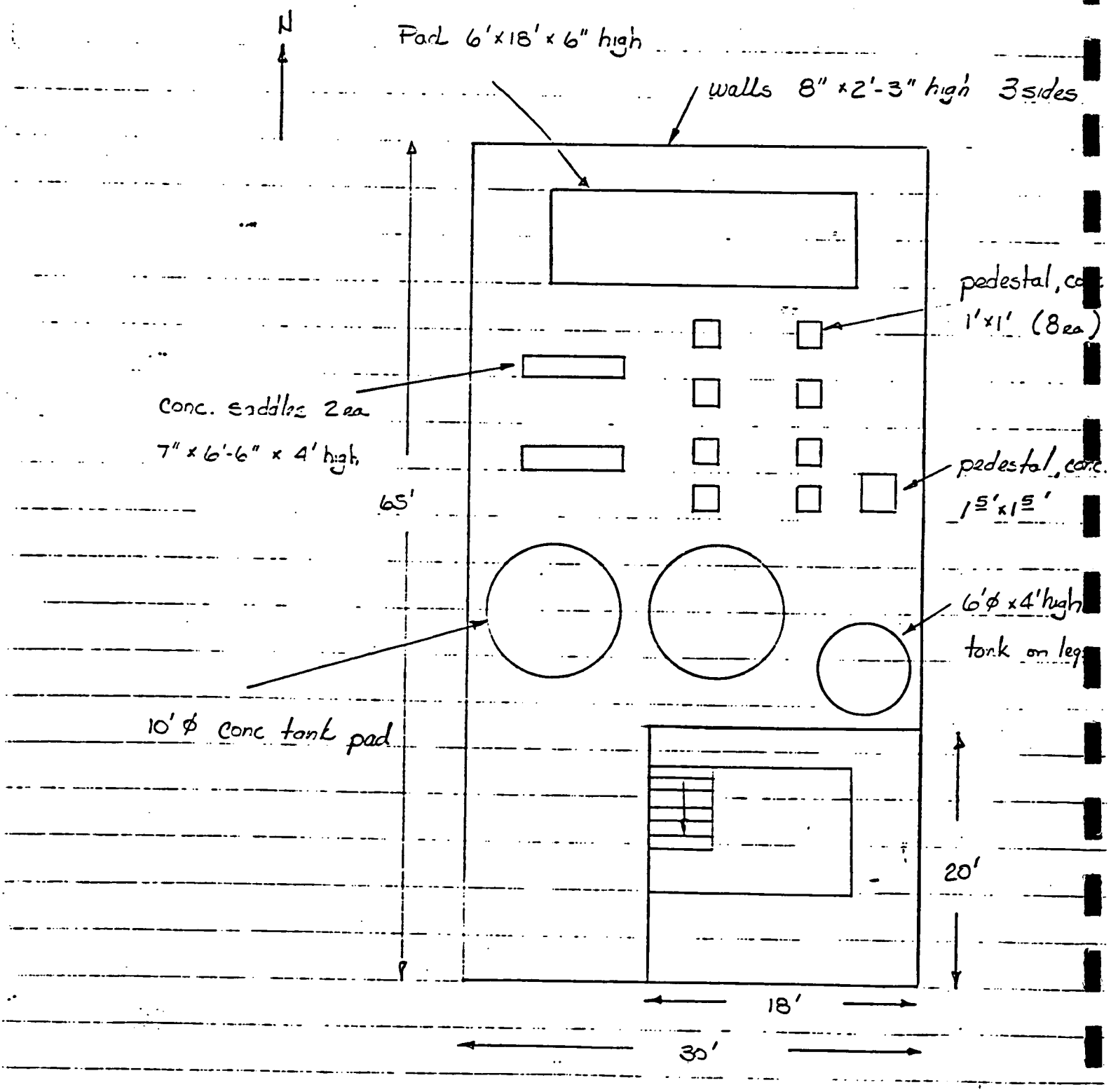




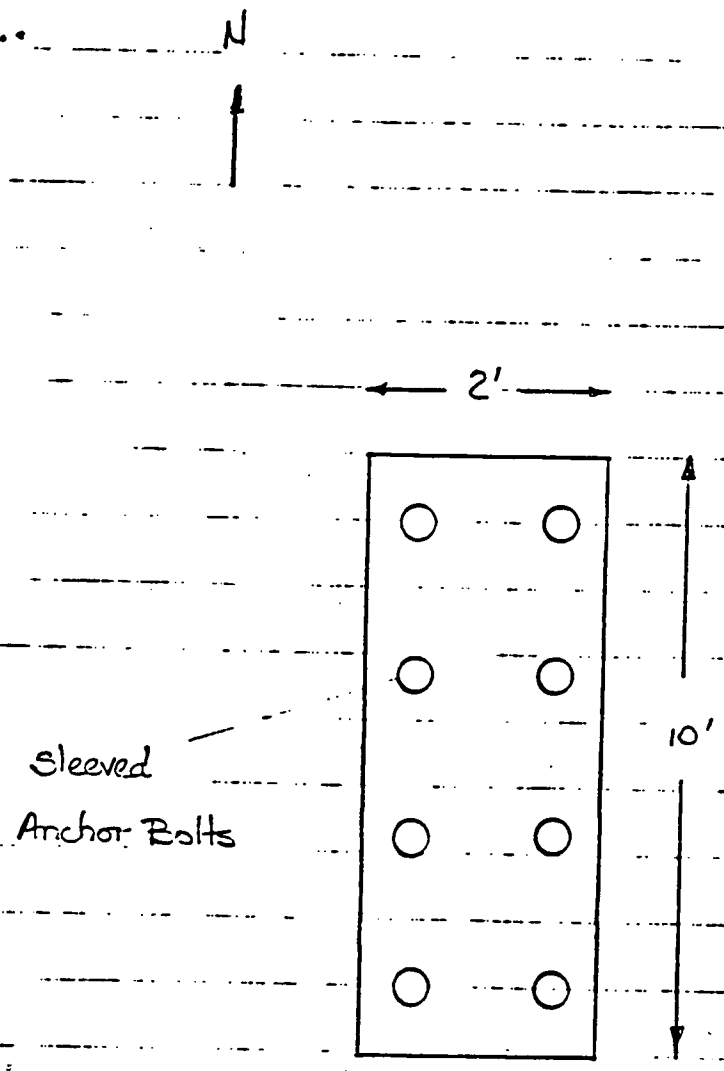
Detail - Tank Support Pit



Detail - Tank Support Pit


N
Pad 6'x18'x6" high
walls 8" x 2'-3" high 3 sides
pedestal, conc
1'x1' (8 ea)
Conc. saddles 2 ea
7" x 6'-6" x 4' high
pedestal, conc.
1.5'x1.5'
65'
6'ϕ x 4' high
tank on legs
10' ϕ Conc tank pad
20'
18'
30'

DETAIL 1.



DETAIL 2. Equip. Fdn.

CRUSHER BLDG. & STRUCTURES TO THE SOUTH

Detail No. 1 - Crusher Bldg.

The crusher building is on a concrete foundation, we assume with foundation walls and a one foot thick slab. It is approximately 100' x 42' with the roof peak being about 20 feet high. The building is comprised of light structural steel. The largest column appears to be a W 12 x 35. The siding material is corrugated metal. Roof framing is light structural members with the skin removed.. The window glass has all been broken out. The pit on the east side of the building slopes from grade just outside the building to about 10 feet deep in the center. Small light structural frames the building at the pit entrance. Electrical service has been severed and much of the wire has been removed. There are still some large overhead light fixtures in the room on the north end of the building. In the center of the building is a heavy concrete equipment foundation that stands about 10 feet above the slab on grade. There are three miscellaneous footings outside and just south of the structure.

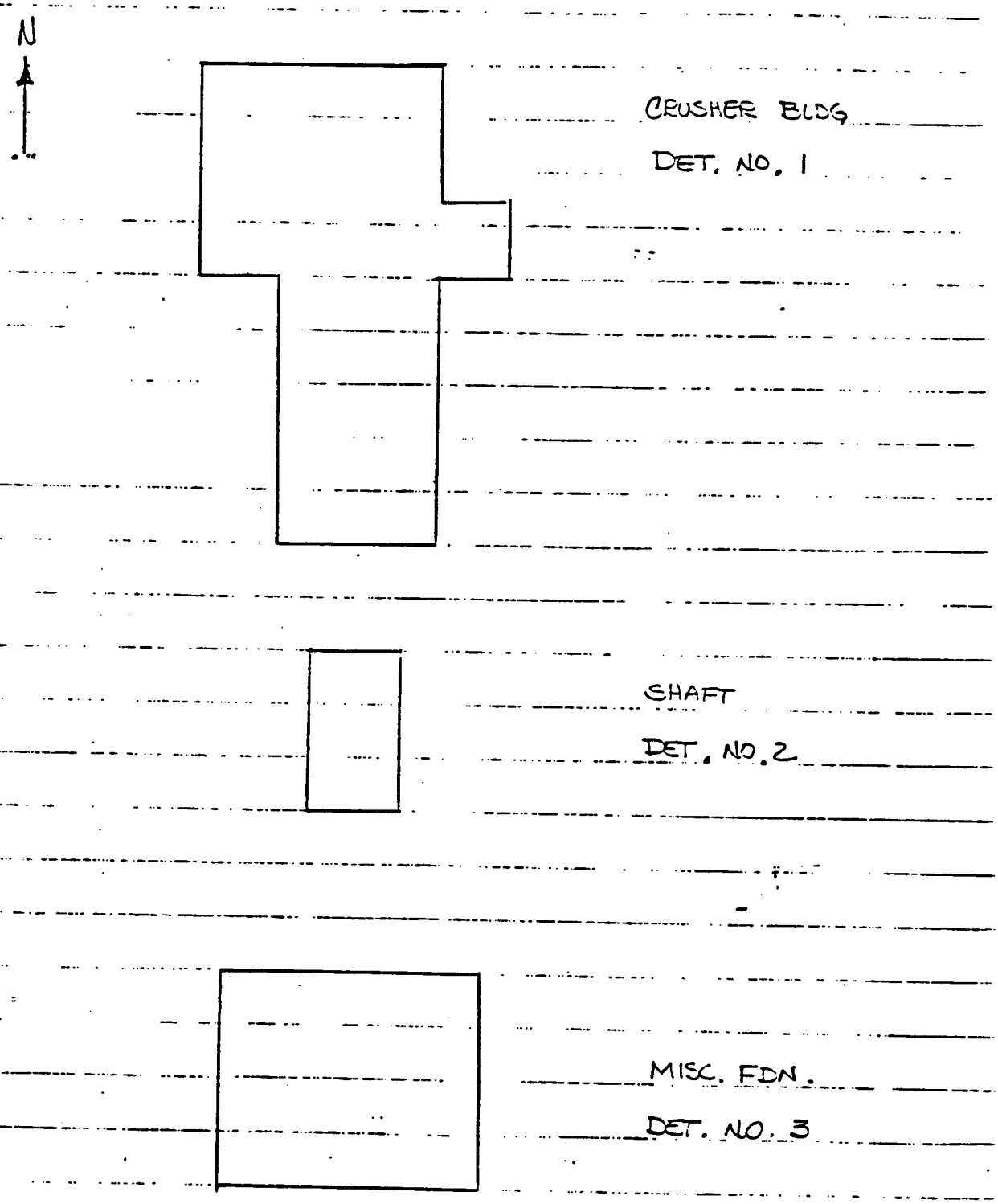
Detail No. 2 - Shaft

The shaft is located 75 to 100 feet directly south of the Crusher Building. The opening to the shaft faces north and is 9' wide by 8' high with one foot thick walls. The structure is on an incline and runs 140 feet into the ground. We estimate that the bottom of the shaft is about 20 feet below grade. The bottom of the shaft runs into a earthen wall. We do not know if the shaft ends at this point or if it has been sealed to prevent further entry.

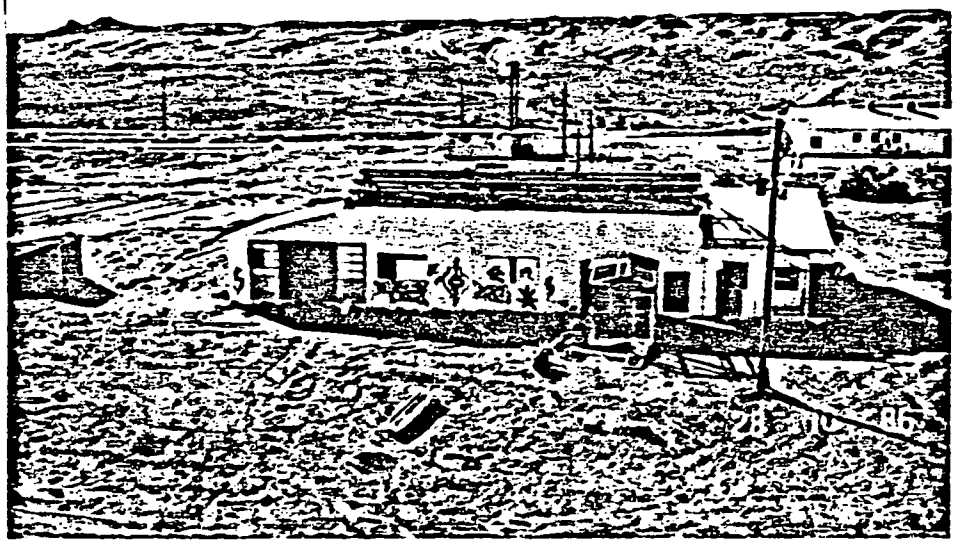
Detail No. 3 - Miscellaneous Foundation

The foundation is located approximately 75 feet directly south of the shaft. The overall dimensions are 30' by 42'. The structure appears to be constructed of 15 inch thick foundation walls that are approximately four feet high. There are two slabs which are considered to be one foot thick as shown in the detail. The rest of the structure interior has been backfilled to grade.

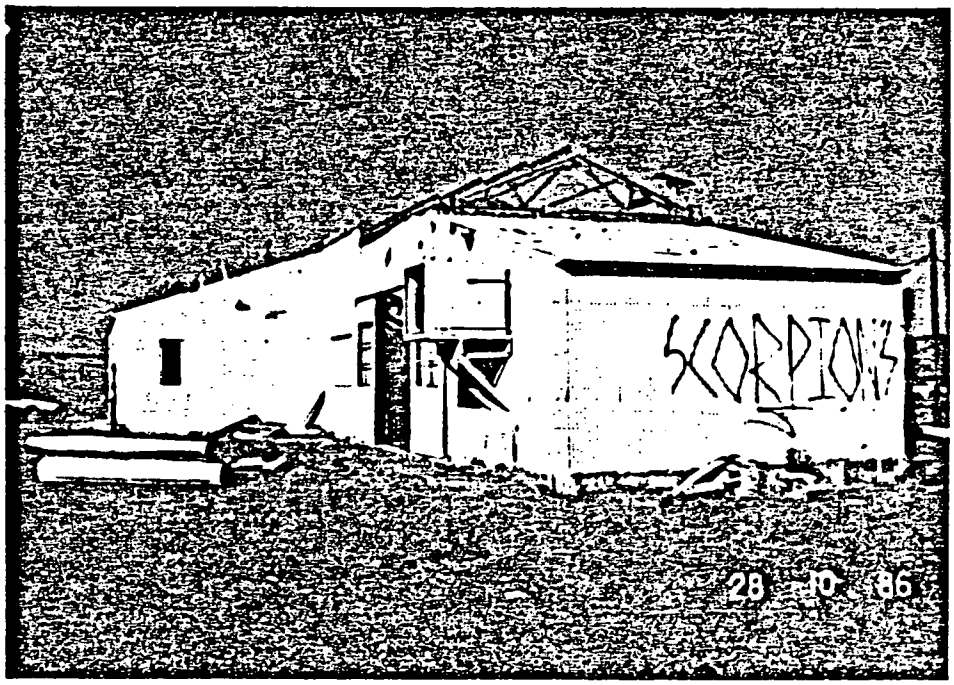
Crusher Building & Structures Directly South



PLOT PLAN VIEW

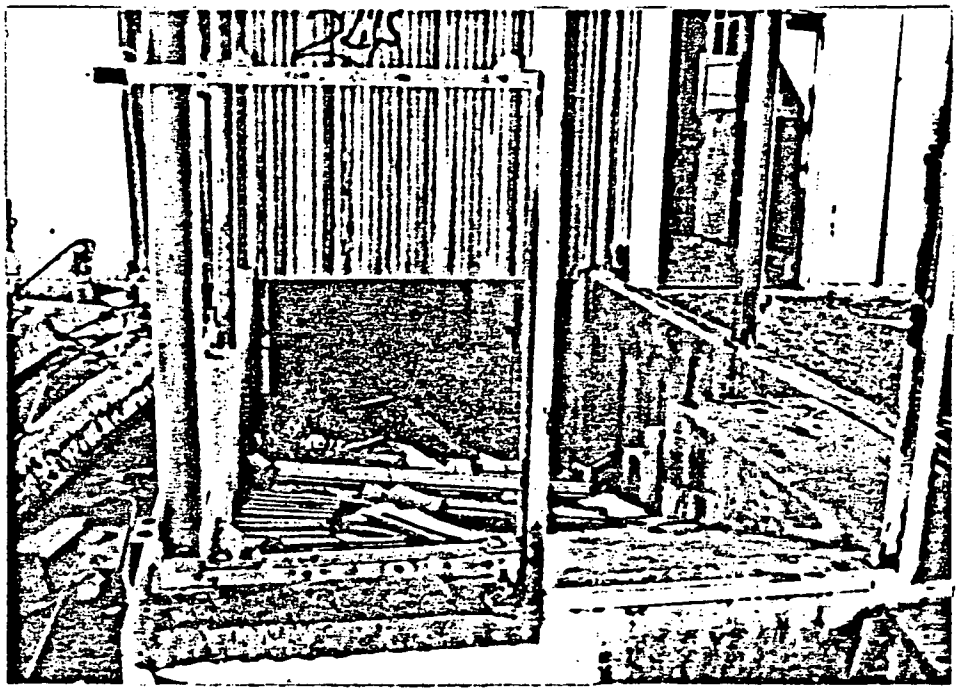


Crusher Building - Looking West



Crusher Building - Looking North

Crusher Building - North Interior

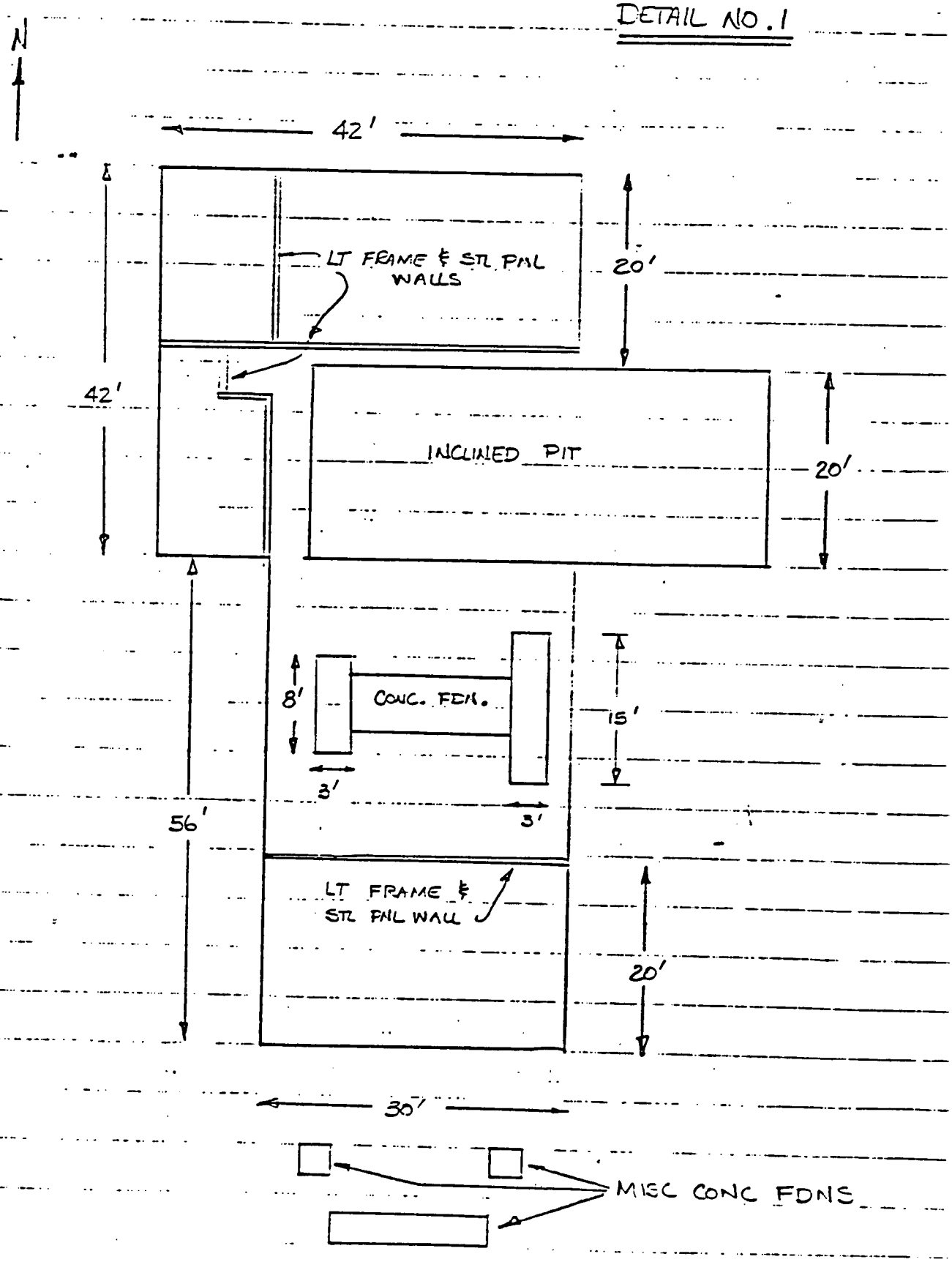


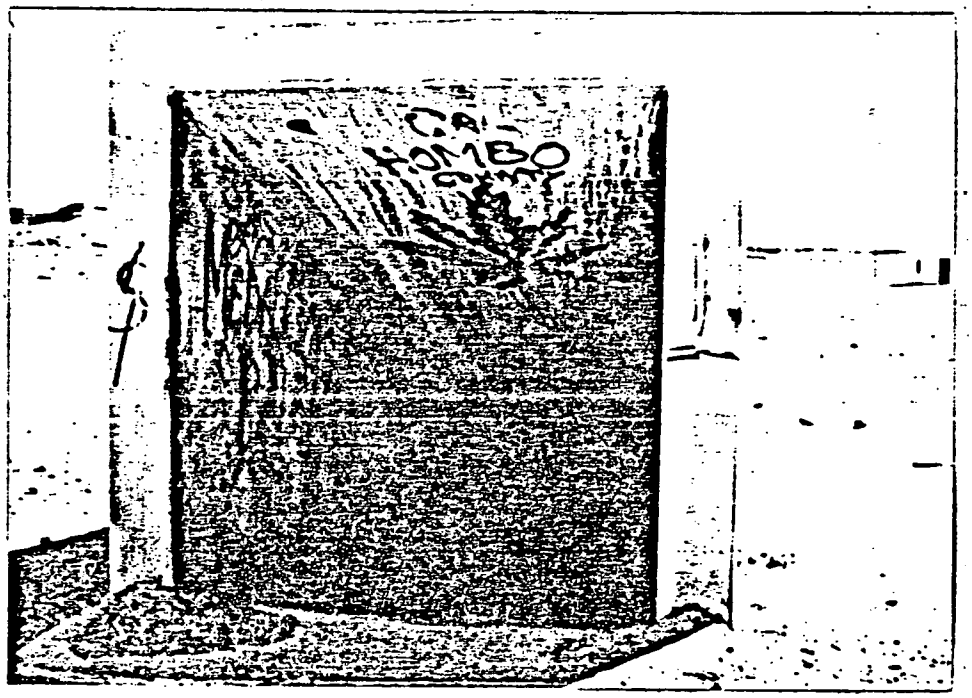
Crusher Building - Conveyor Pit

Crusher Building -
Interior Foundation

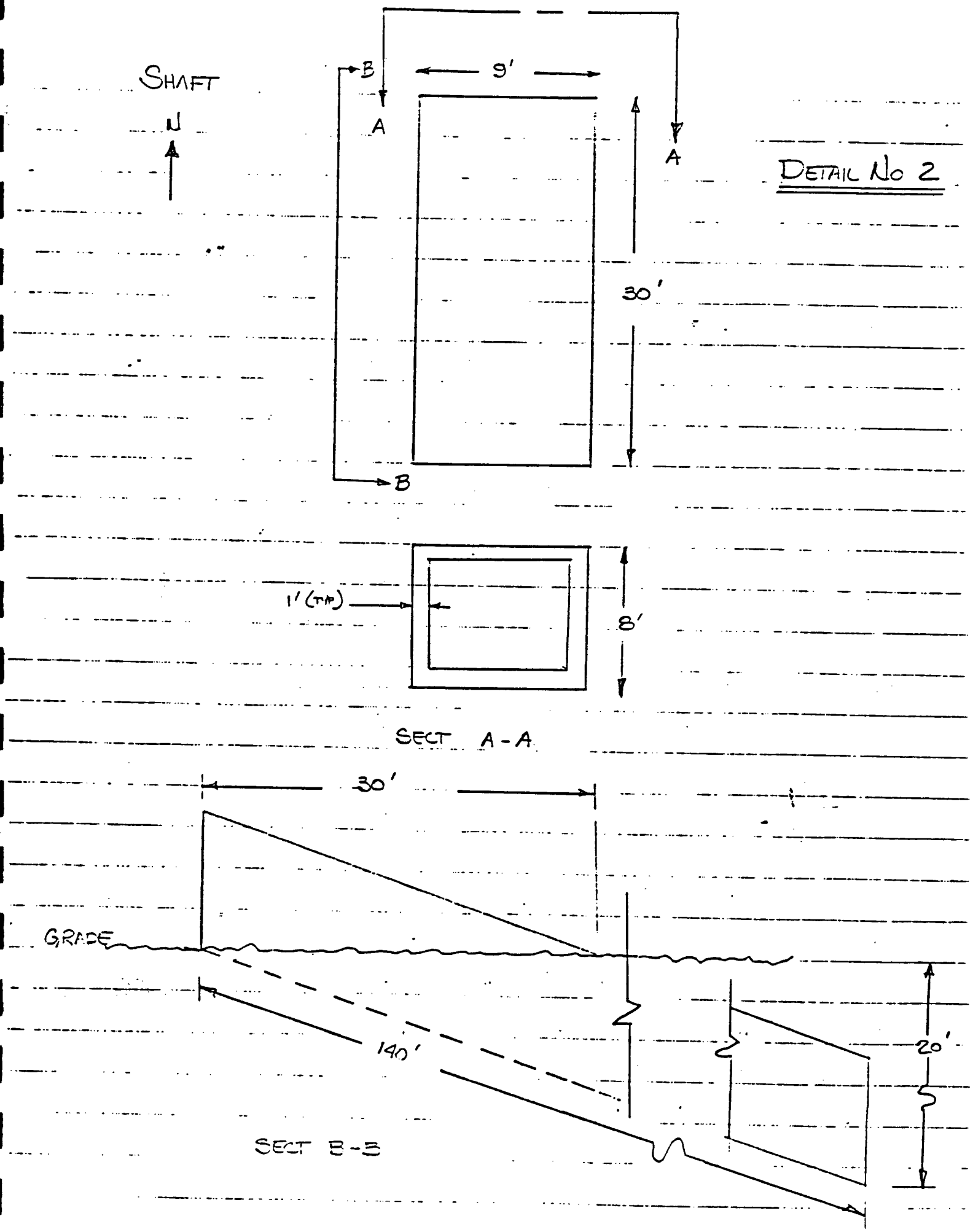
CRUSHER BLDG

DETAIL NO. 1

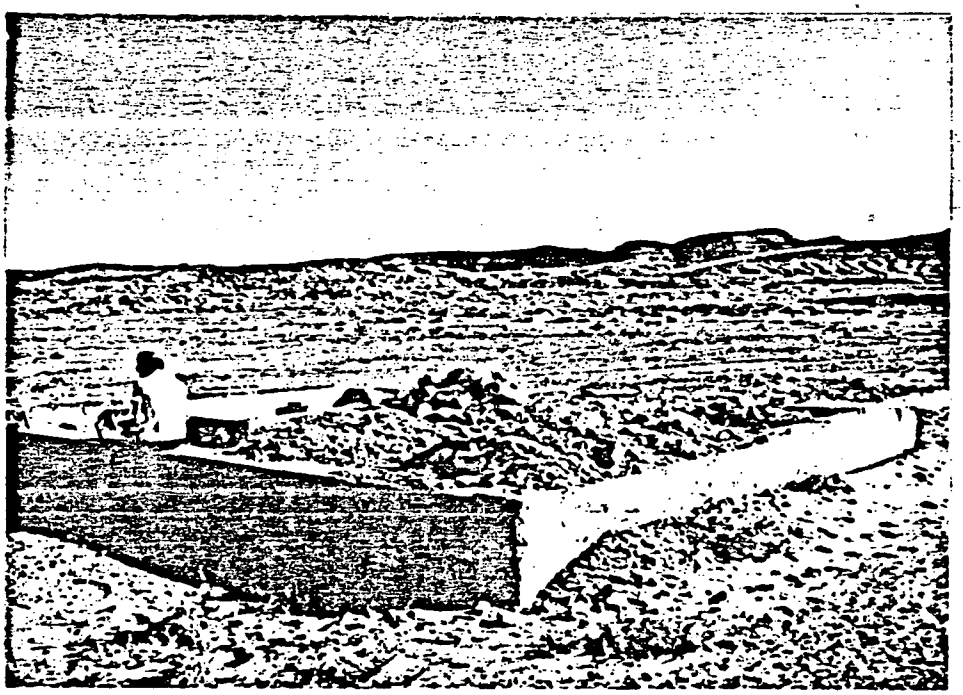




Shaft - South of Crusher Building



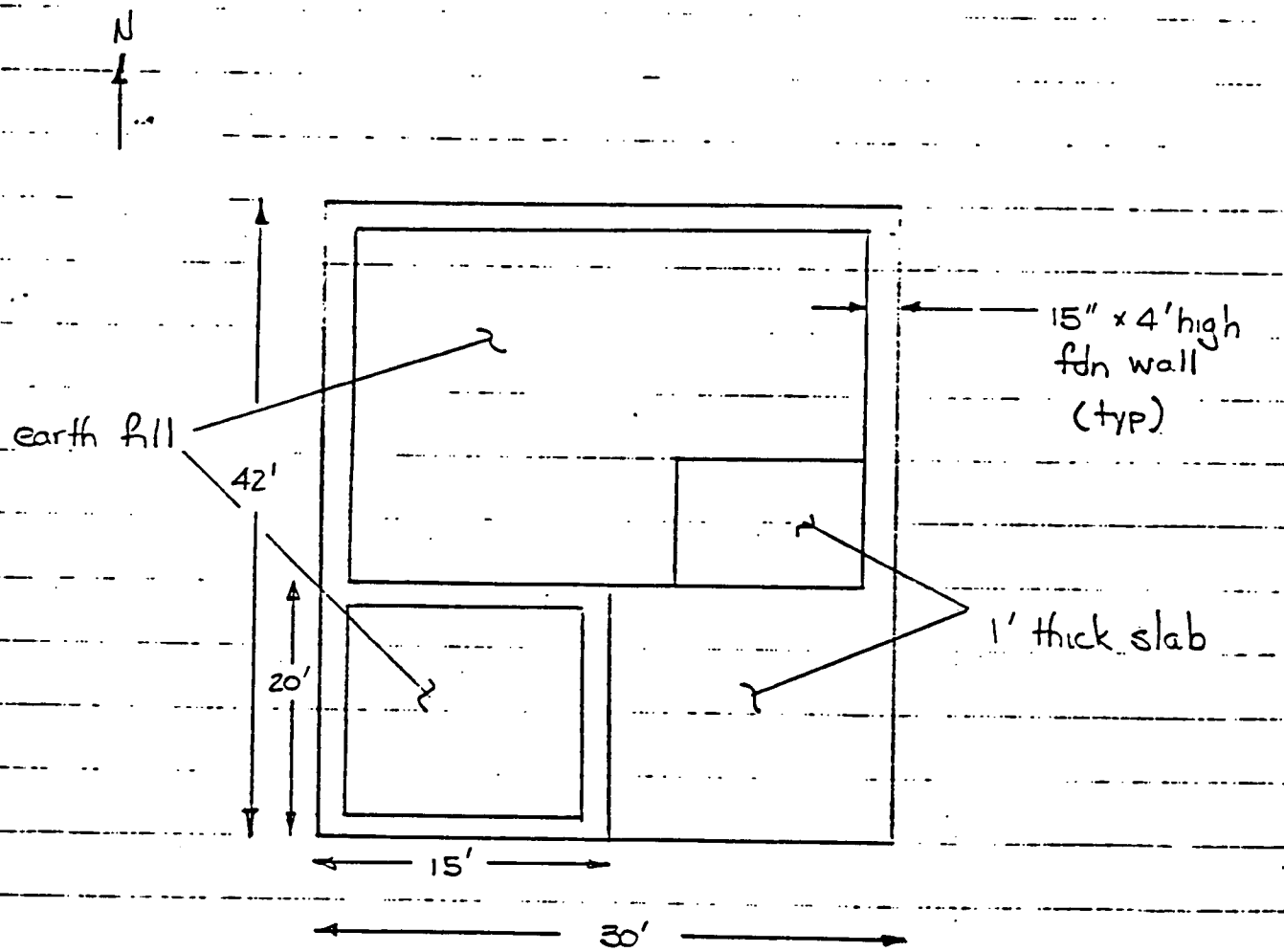
DETAIL No 2



Misc. Foundation - South of Shaft

Miscellaneous Foundations

DETAIL No 3

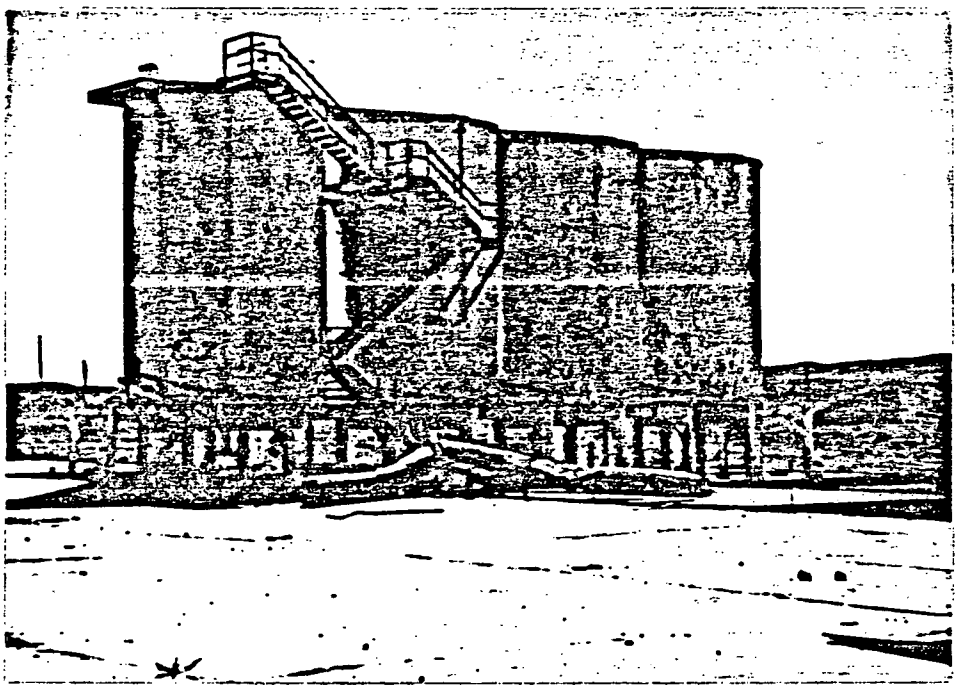


URANIUM STORAGE TANKS

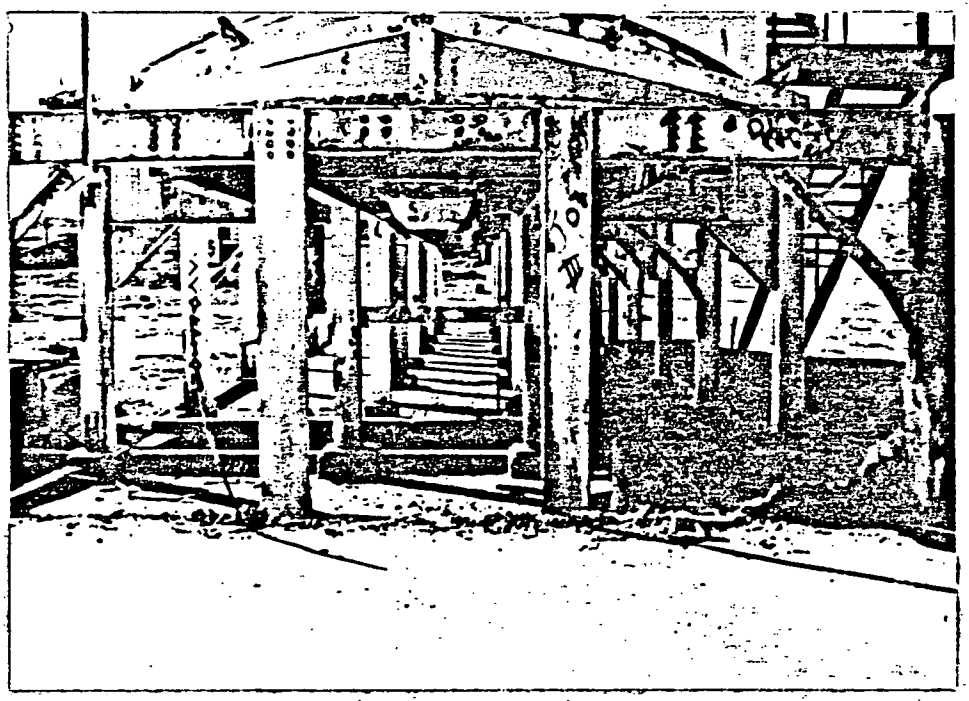
The foundation for the storage tanks consists of a 5" x 2-2 1/2' foundation wall with column piers. The piers are 1.5' square and support the W8 x 40 columns. The beams and girders that support the tanks are W24 and W28 sections. Various smaller miscellaneous metal sections provide lateral bracing. All connections are bolted.

The tanks (four each) are constructed of 3/8" metal plate and are 20 feet in diameter. A steel stairway in the northeast corner accesses the top of the tanks. An area of 25' x 120', consisting of 1/4" checkered plated covers the top of the tanks. There are two access hatches for each tank. One hatch is in the center and appears to be for filling, the other is on the north side and has ladder access to the bottom of each tank. The tanks also have a hopper type bottom for dispensing the contents. The tanks are presently empty.

Between the tanks and the crusher building are eight 1.5' x 1.5' concrete piers. They are on a 6 foot gage and approximately 50 feet on center. They appear to be supports for a conveyor tower that once carried material from the crusher to the tanks. The conveyor tower is no longer present.

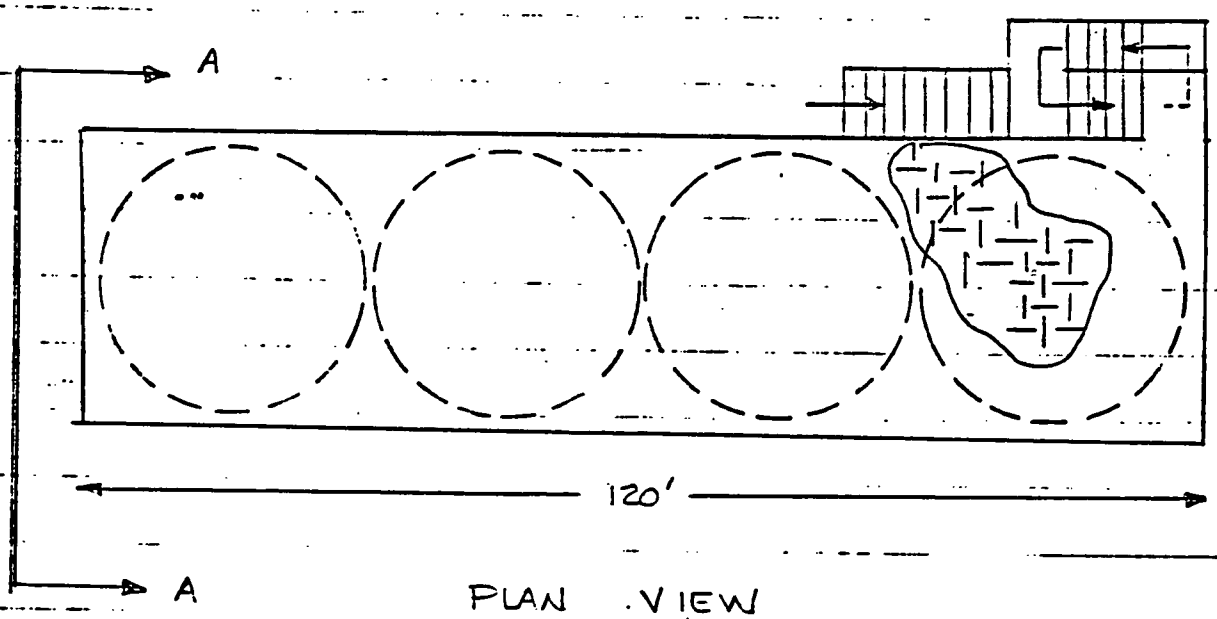


Storage Tanks - Looking West

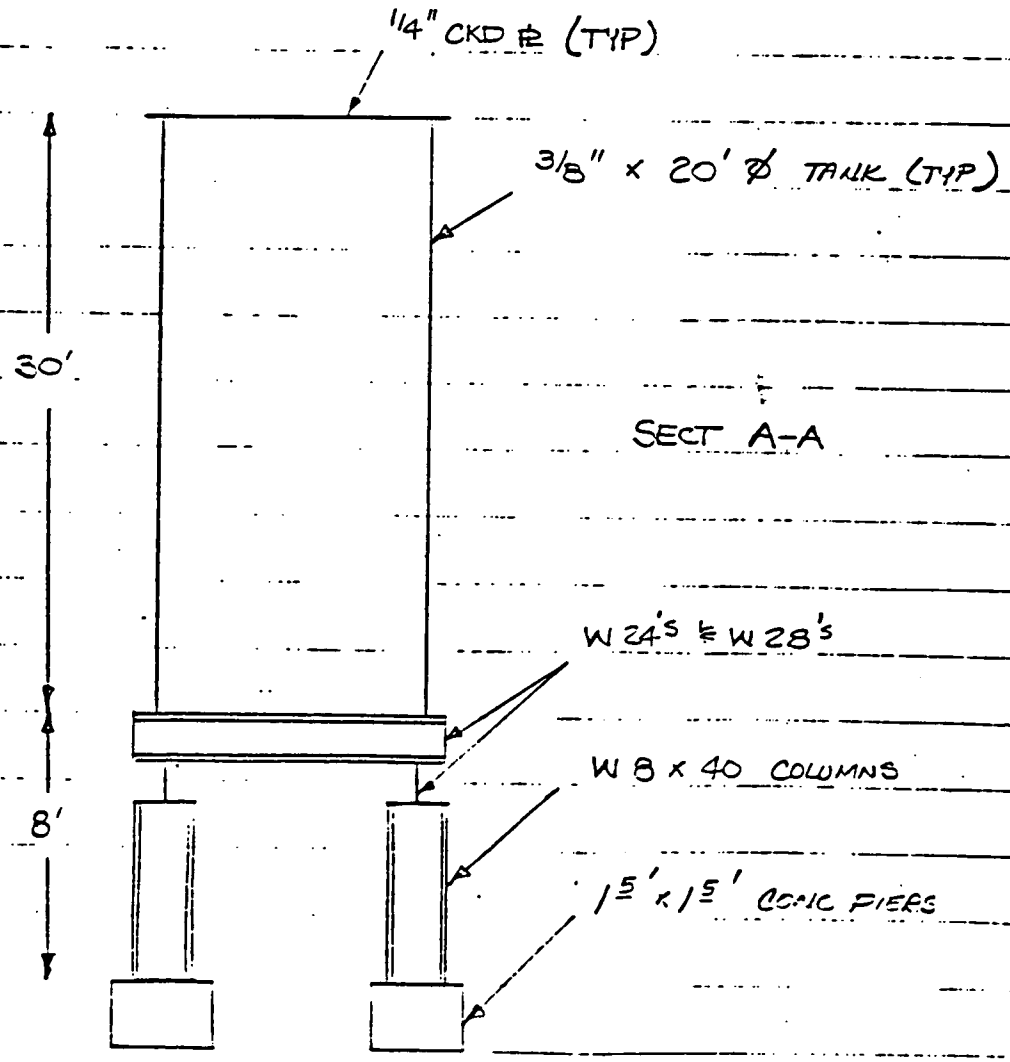


Tank Support Steel

Uranium Storage Tanks



PLAN VIEW

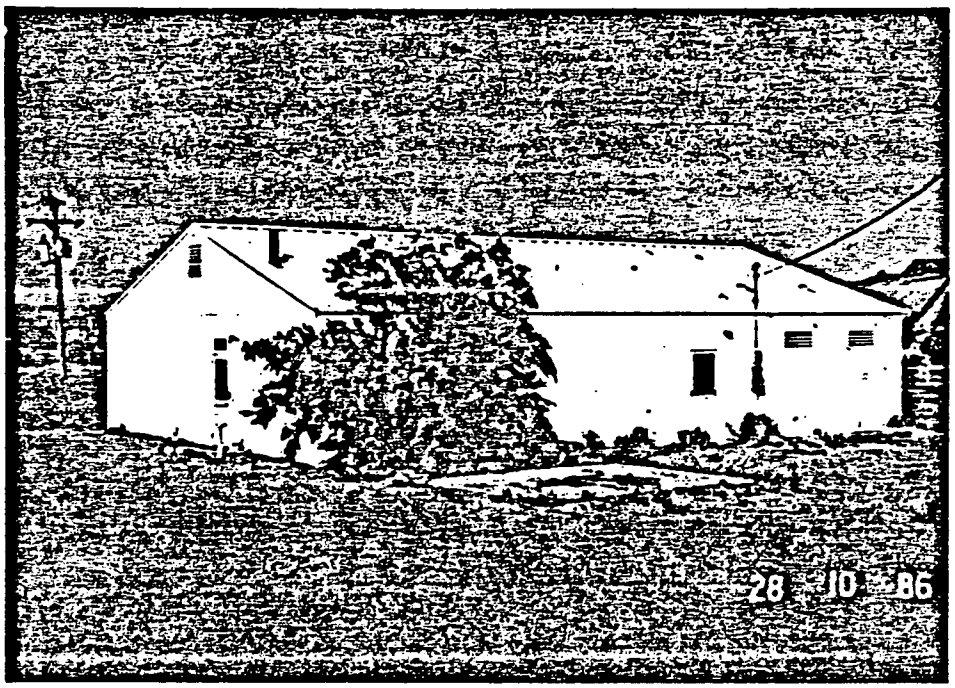


SECT A-A

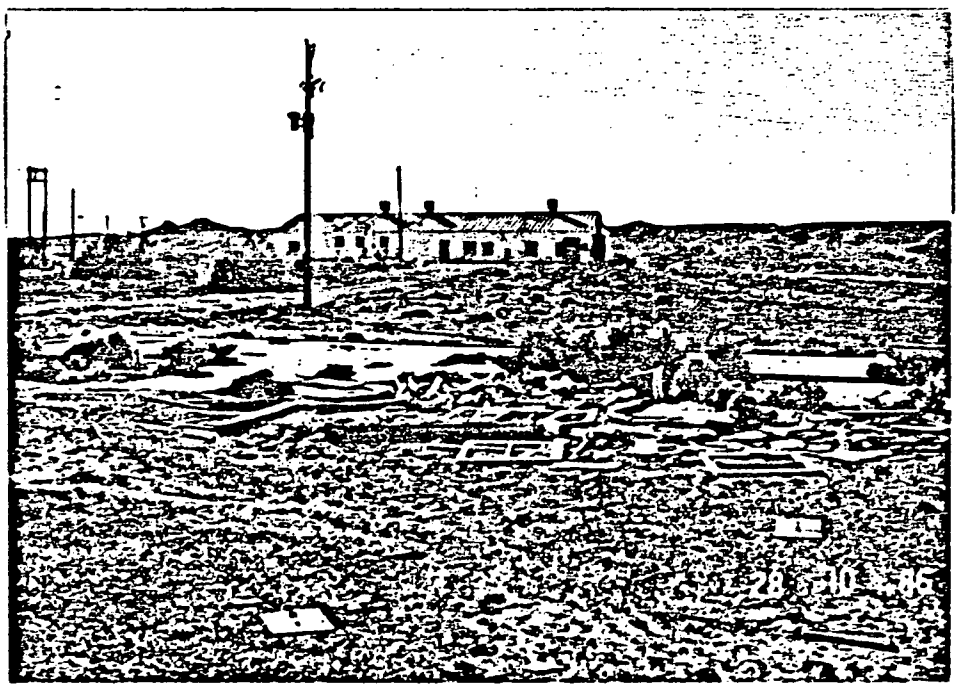
SHEET METAL BUILDING AREA

The sheet metal shop is a occupied structure. The sign in front reads Property of the U.S. Government. The building itself is 60' x 40', a pre-engineered metal building. It is about 12 feet high at the eaves and 20 feet high at the peak. There is gas service and a water well located at the west entrance to the building. There is a manhole just east of the shop, a 4'x 5' sump off the northwest corner and a 15' x 18' x 6" slab off the southwest corner.

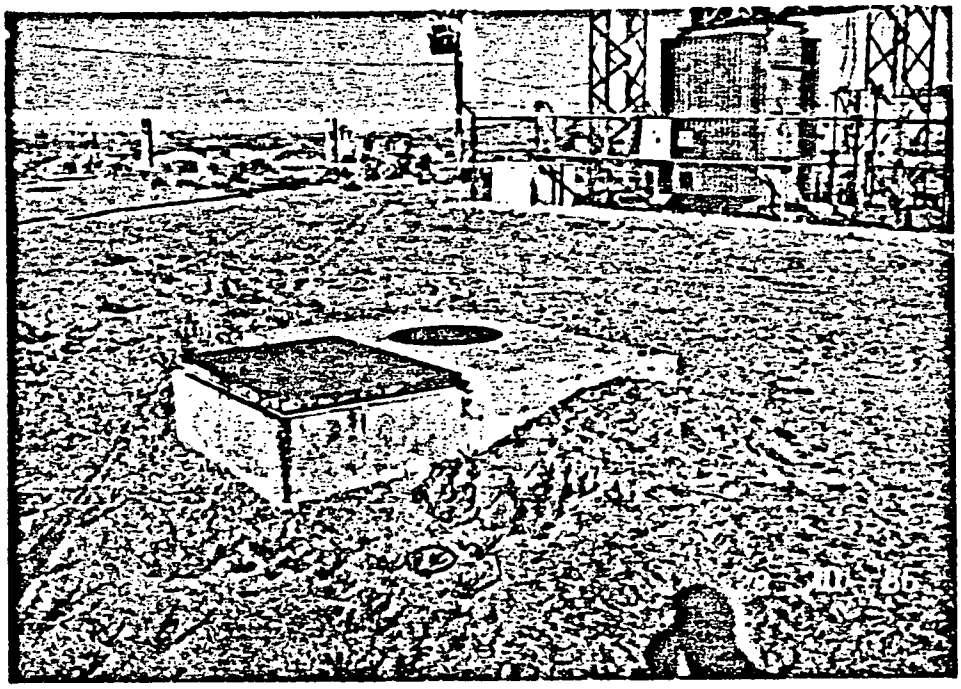
To the northwest of the sheet metal shop is a four inch slab that is 65' long x 35' wide. Also, north of the sheet metal shop is the diesel fuel storage tank foundation and earthen berm.



Sheet Metal Shop - Looking North

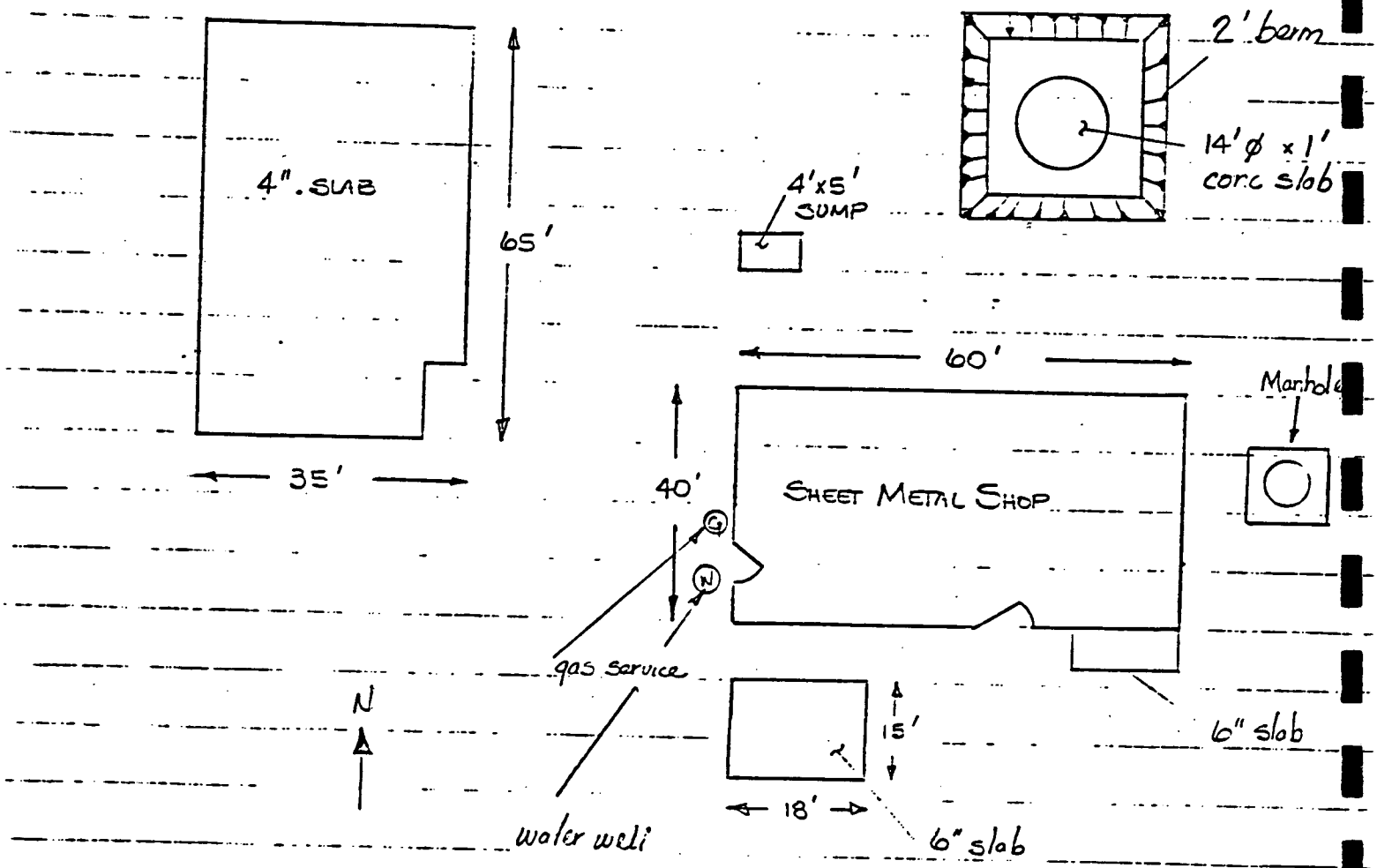


Slab West of S.M. Shop



Manhole West of S.M. Shop

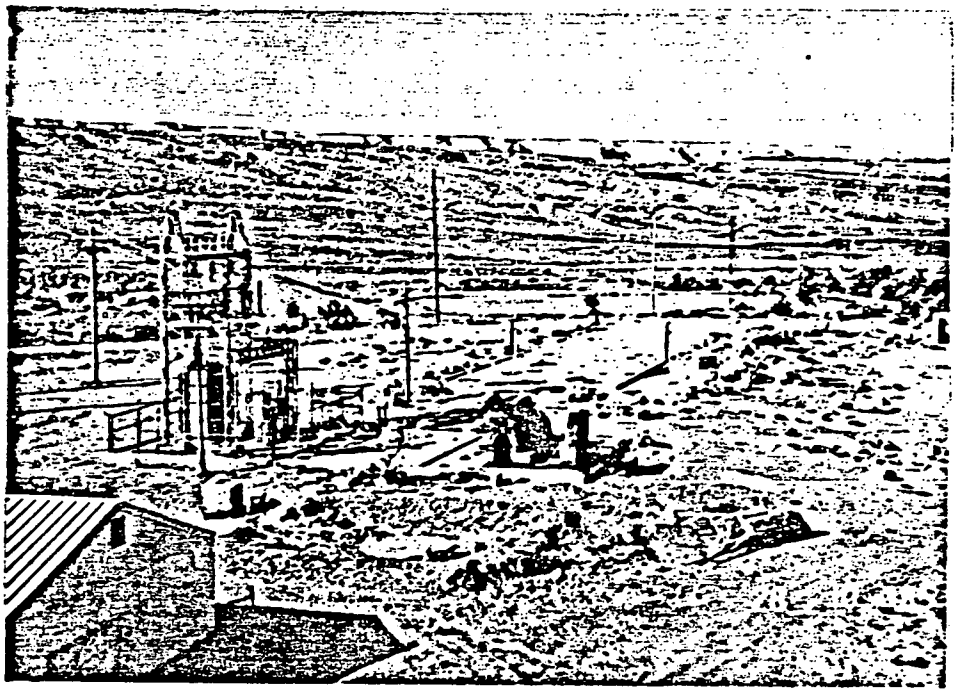
General Layout - Sheetmetal Building Area



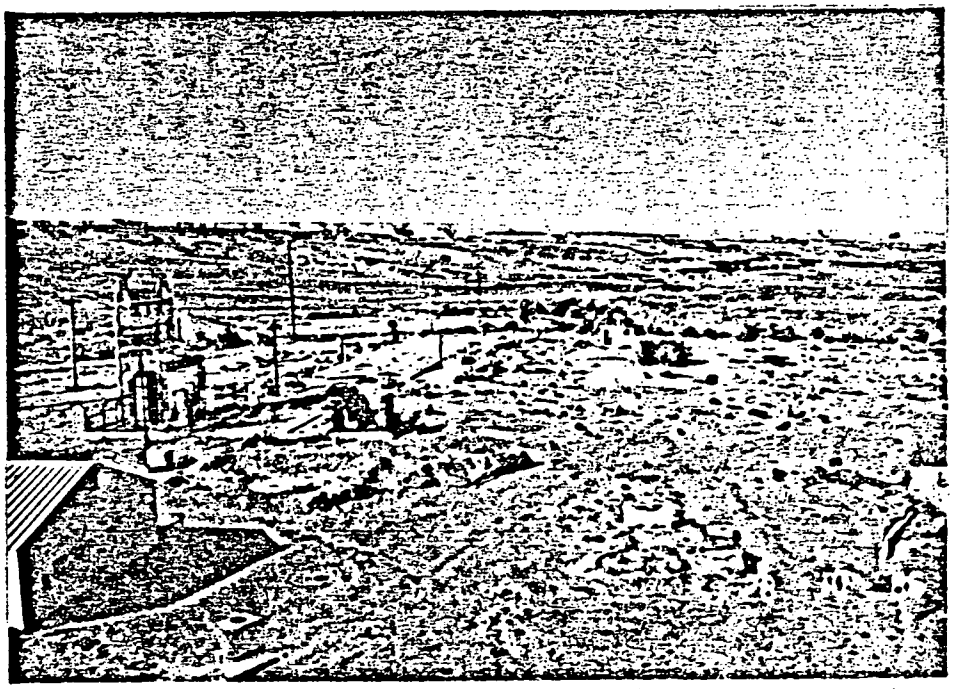
SUBSTATION

The substation areas consists of an on line substation approximately 60' x 40'. To the east is the foundation for and a diesel generator. The entire diesel generator pad is 70' x 45' and is built on 8" wide x 2' high foundation walls. The first ten feet of slab east of the substation is 8 inches thick and appears to be covering a ten foot deep pit. The remaining 60 feet of slab is on fill and is four inches in thickness. On the east end of the slab is the diesel generator and foundation. The foundation is of reenforced concrete and is 12' x 30' x 4' thick.

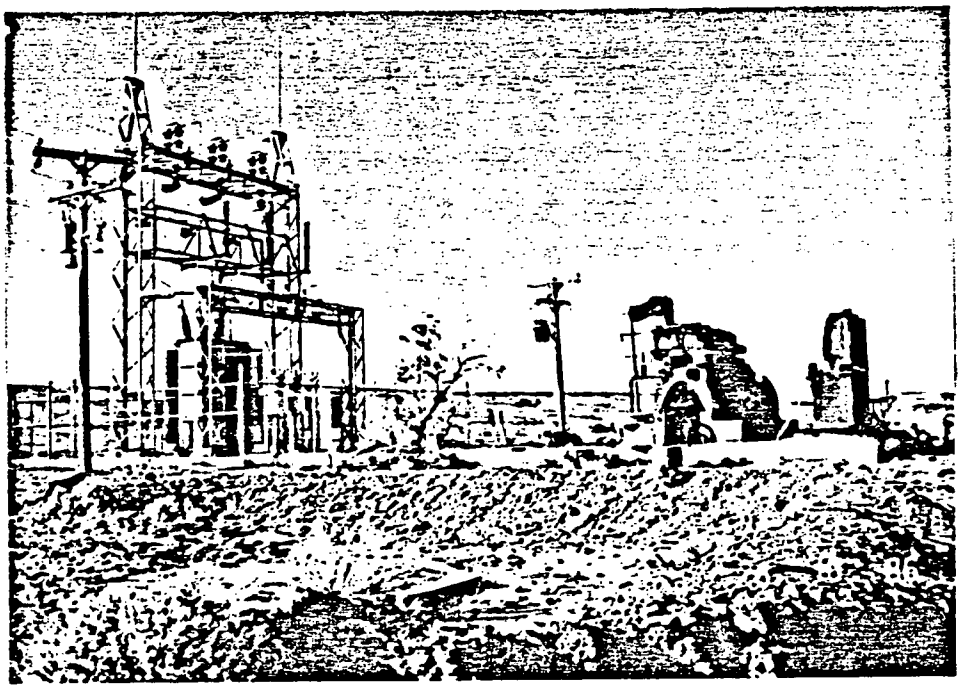
The diesel storage tank foundation is a concrete slab 14' diameter by 1' thick. The slab is surrounded by an earthen berm approximately 25 feet square and 2 feet high. The storage tank has been removed.



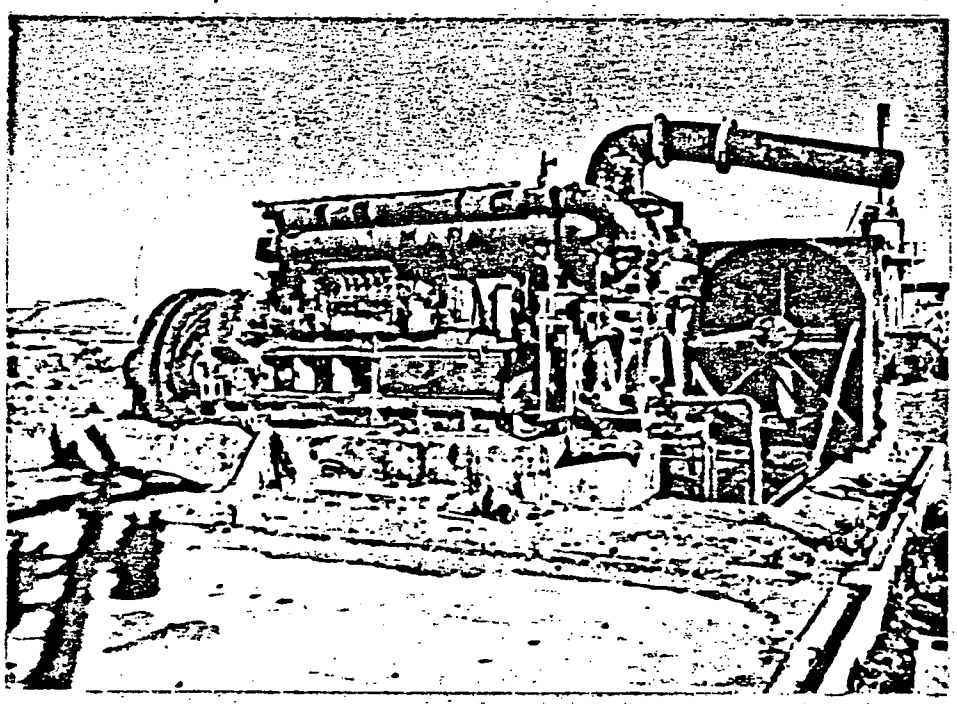
Aerial View - Substation and Warehouse



Aerial View - Substation and Warehouse

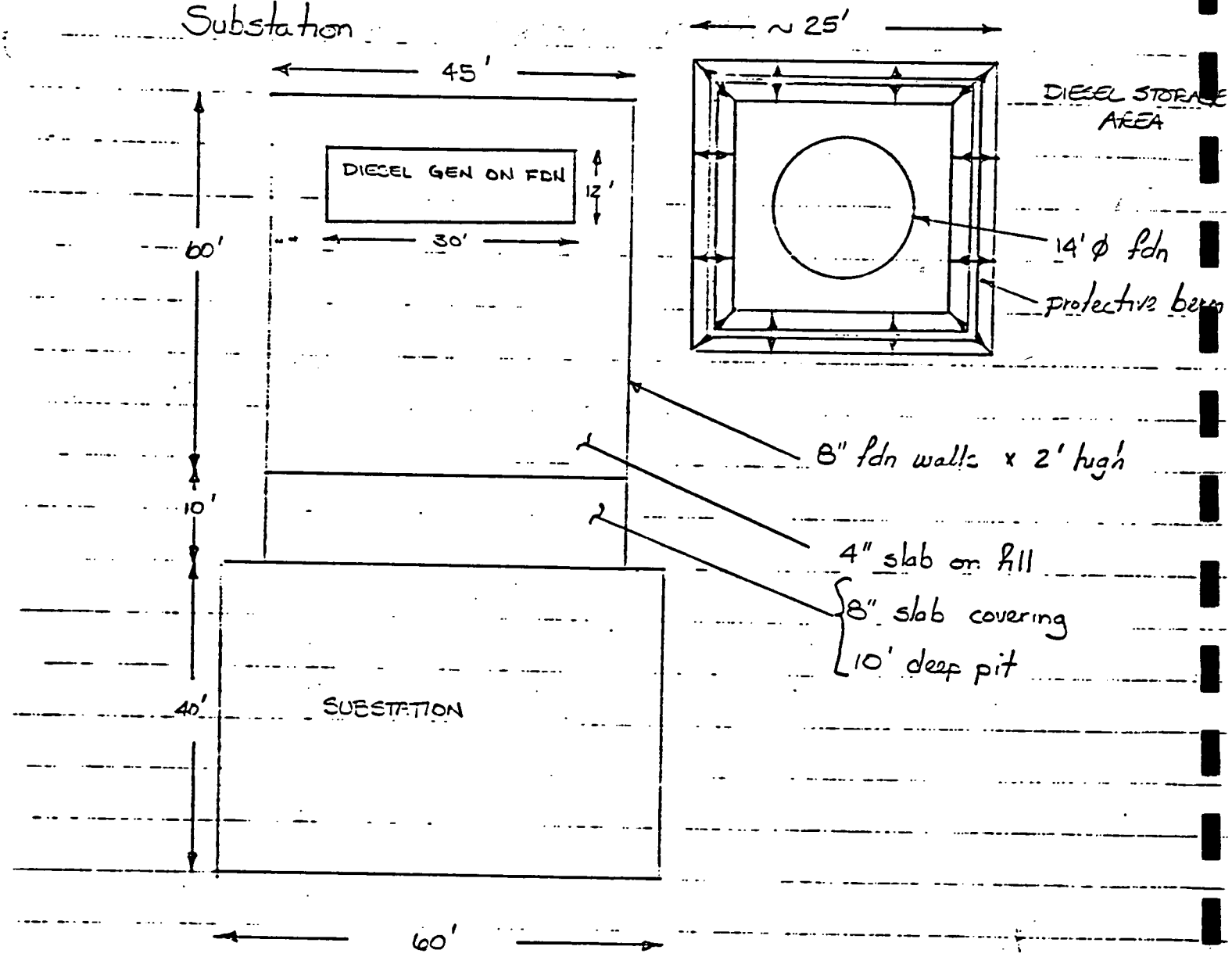


Substation and Generator -
Looking North



Diesel Generator at Substation

Substation

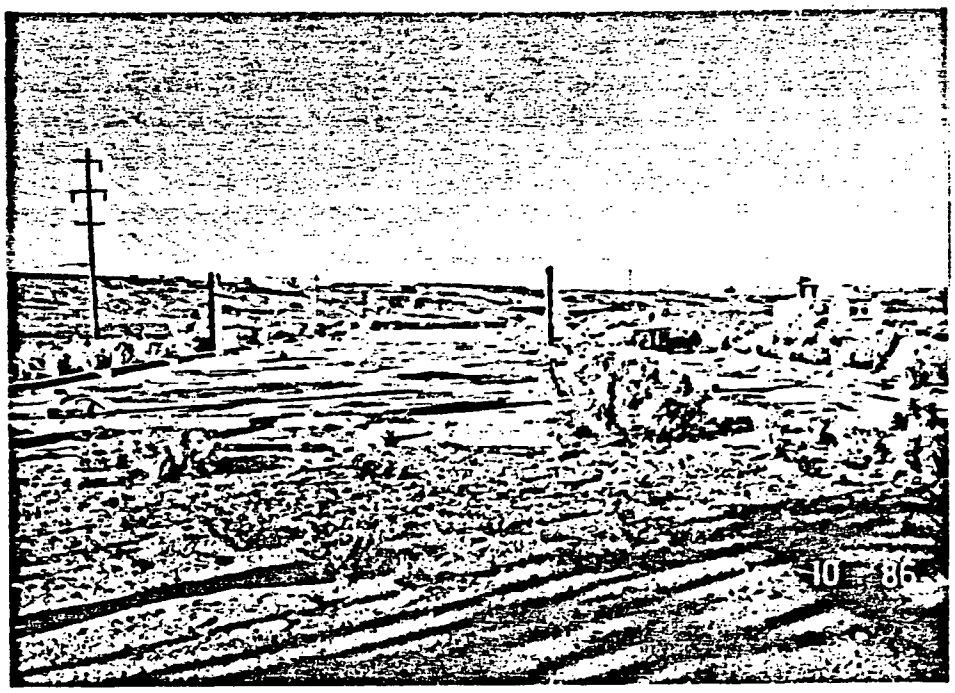


2

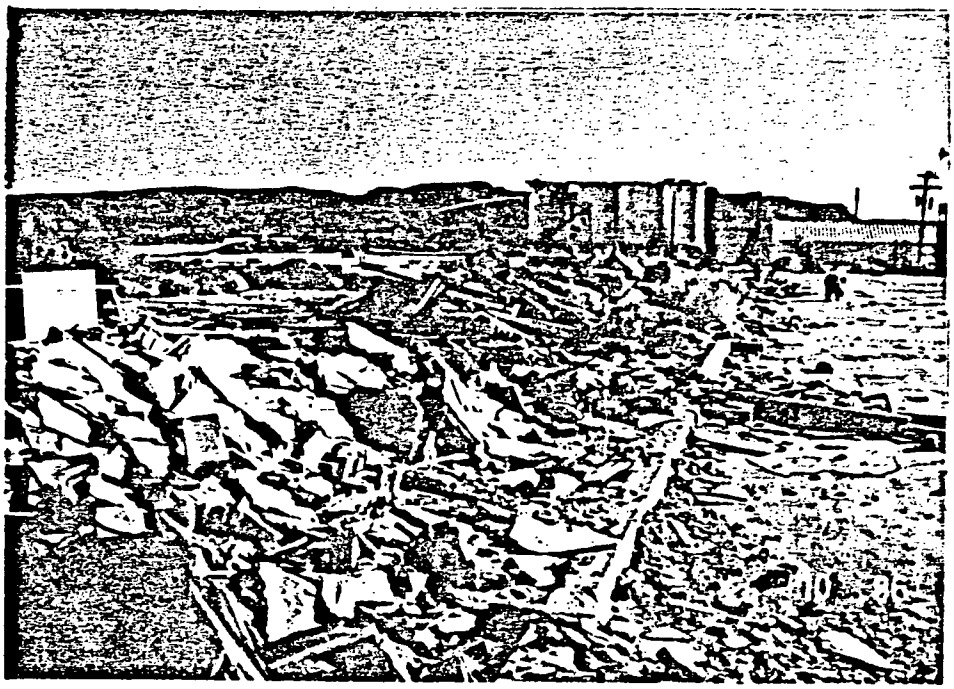
TRADE SCHOOL AND WAREHOUSE FOUNDATION

The trade school slab is constructed of 8 inch foundation walls, approximately 2' - 3' deep. The slab is probably six inches thick. The entire slab is 60' wide x 200' long. Along the east side of the building is a pile of junk which appears to be demolished building materials.

About 150 feet west of the trade school is a loading dock slab approximately 20' x 20'. The slab is four inches thick. Just west of the slab is a retaining wall constructed of rough timber and it is approximately 3 1/2 feet high.

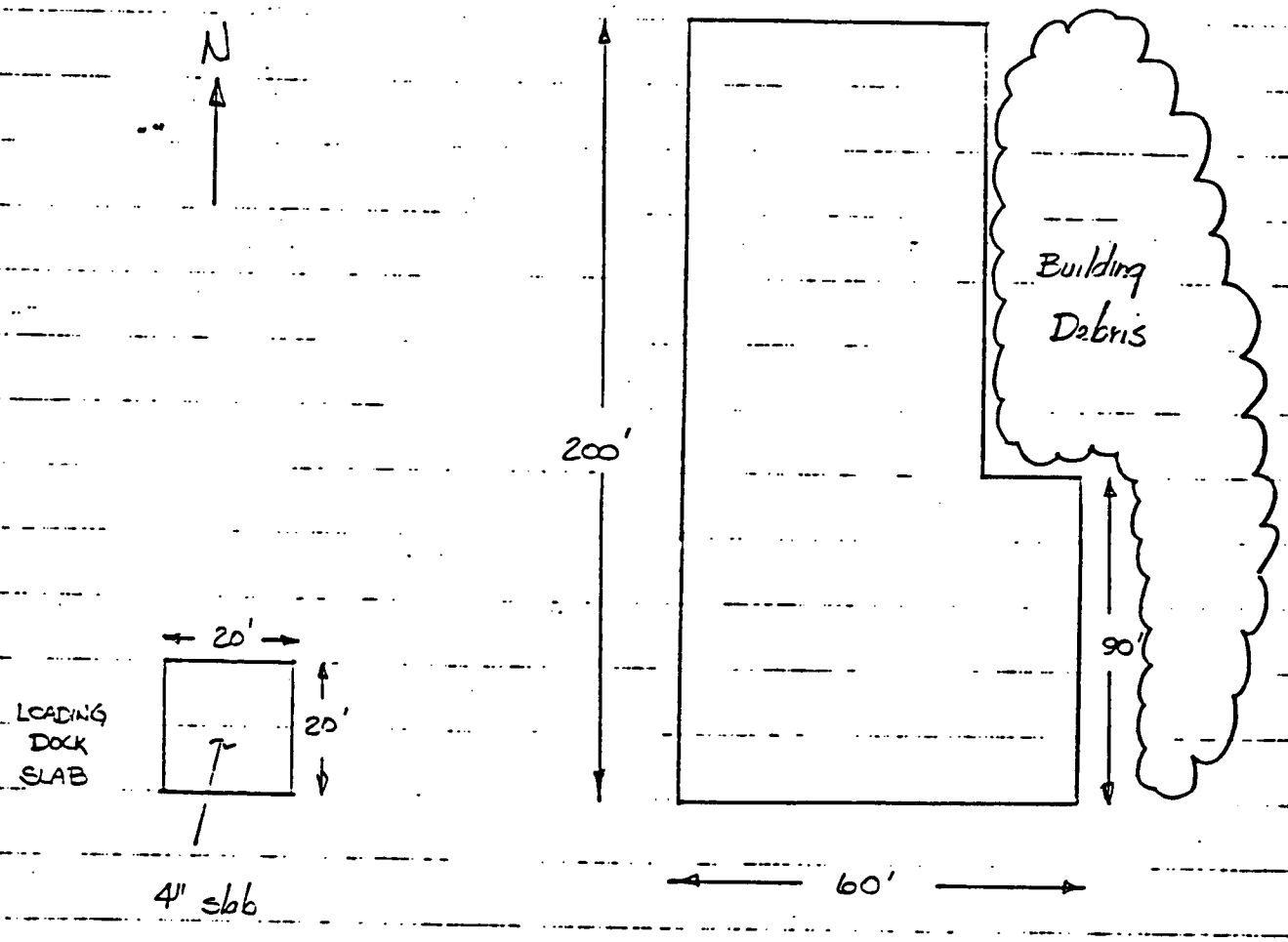


Trade School/Warehouse Slab -
Looking North



Debris Pile - East of Slab

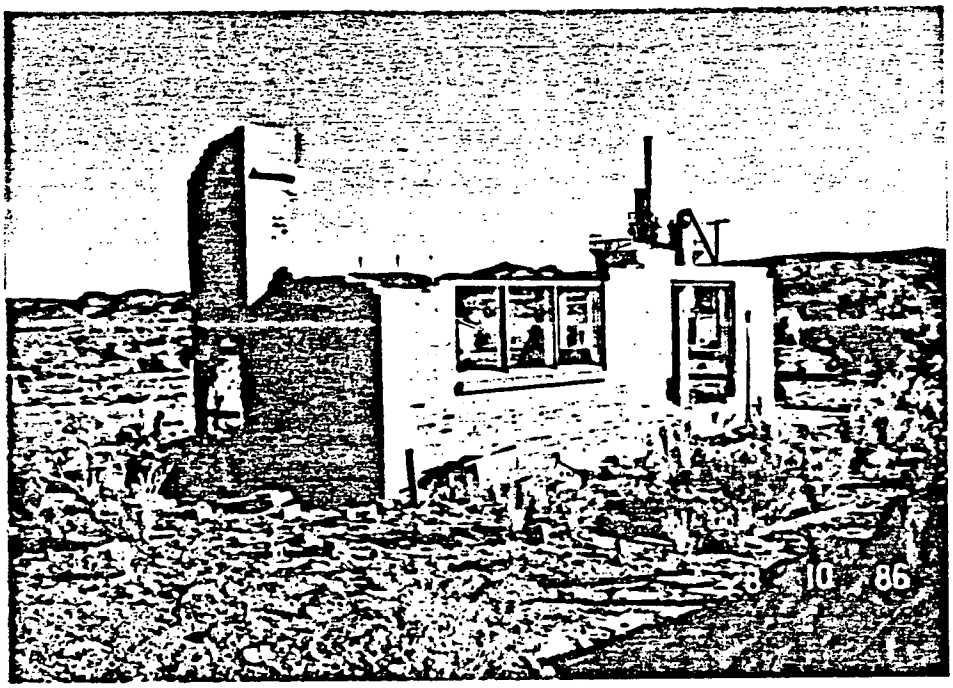
Trade School and Warehouse



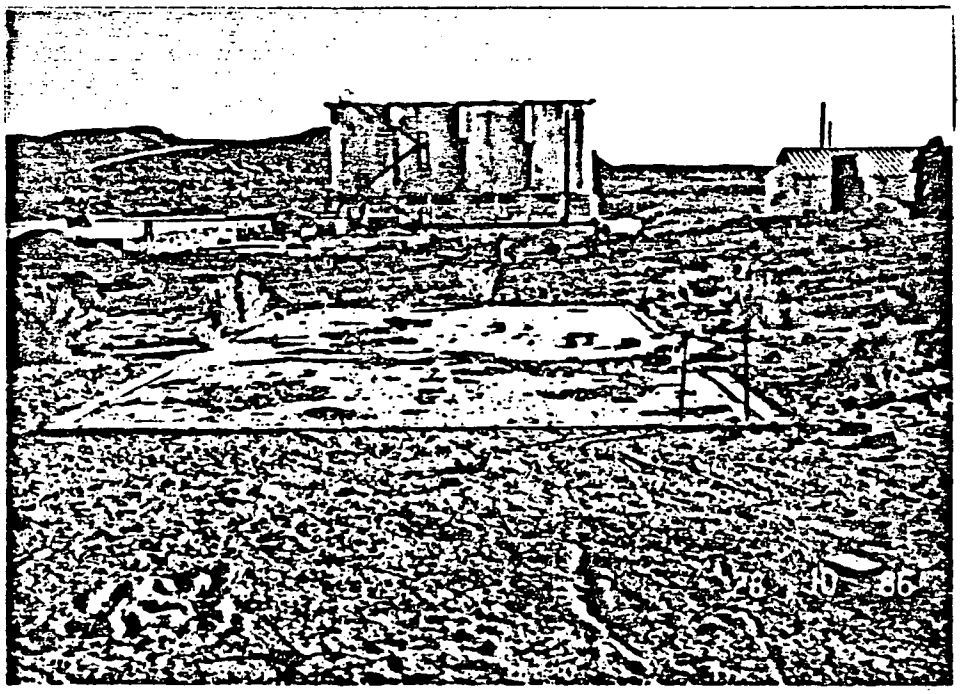
SECURITY BUILDING & MISCELLANEOUS SLAB

The security building is a one story brick structure approximately 30' x 20'. Three of the walls are still standing and the roof is gone. The slab is 4 inches thick.

South of the security building and 50 feet to 75 feet off the southeast corner of the trade school is a yard slab 25' x 45' x 4" thick.

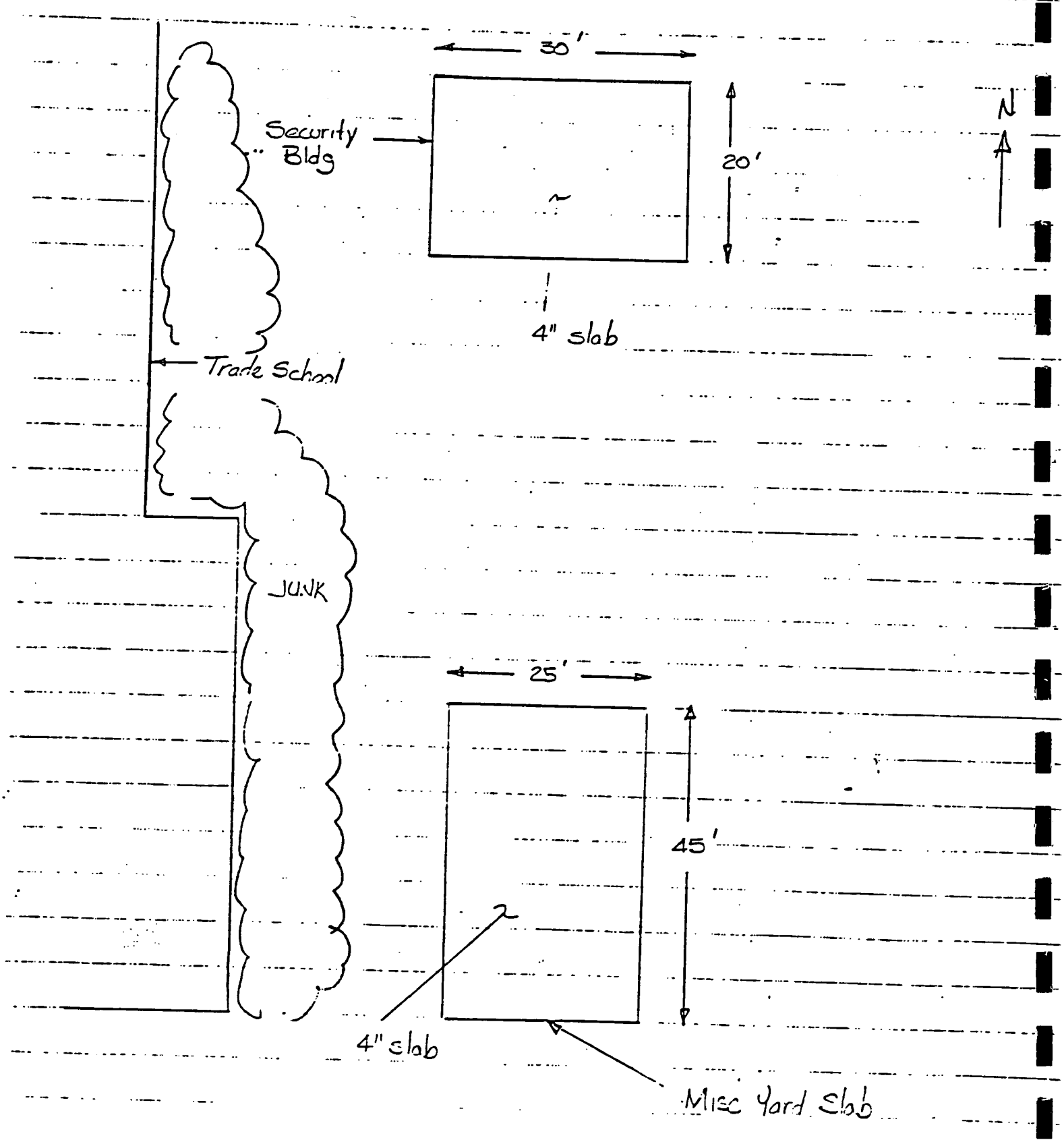


Guard House - Looking North



24' x 45' Slab - South of G. House

Security Building

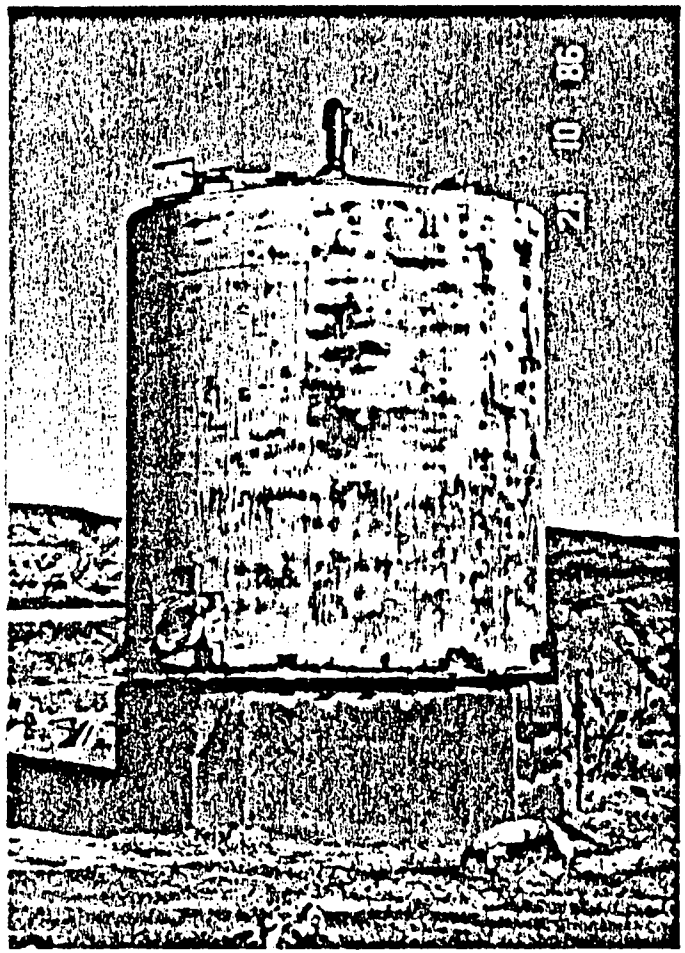


SULFUR STORAGE TANK AND BIN

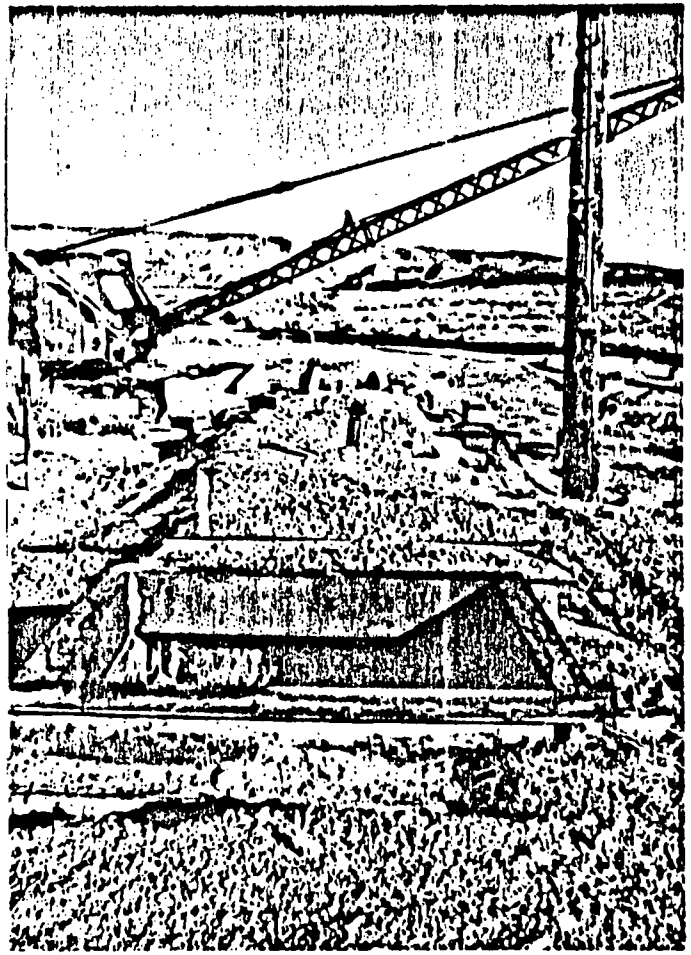
The sulfur storage tank is constructed on a two feet thick foundation slab. There are four concrete support walls, one inch foot with structural steel beams bearing on the walls and supporting the tank.

The tank itself is 18 feet in diameter by 22 feet high. It is of double wall steel construction and we suspect that the inbetween material is asbestos.

The steel bin is just south of the sulfur tank. It has one foot thick concrete-walls, approximately three feet high and is covered with steel hatches. The concrete walls inside are brick lined and a limited amount of small bore pipe was observed.

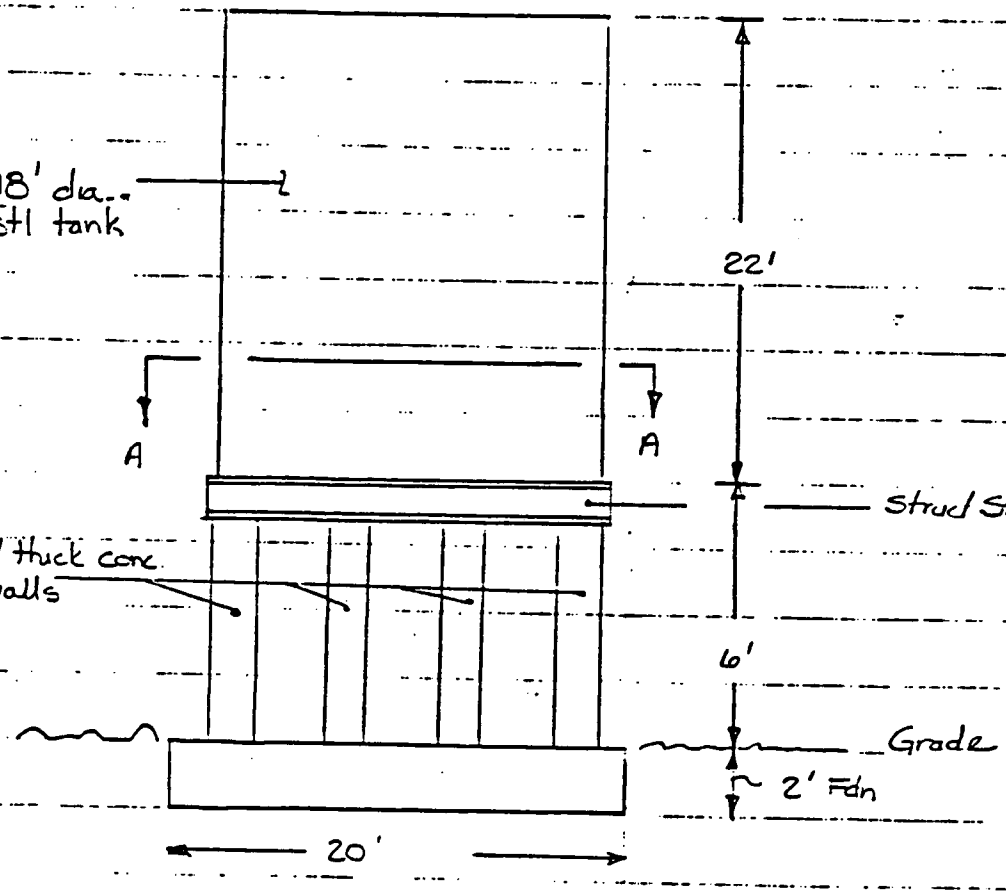


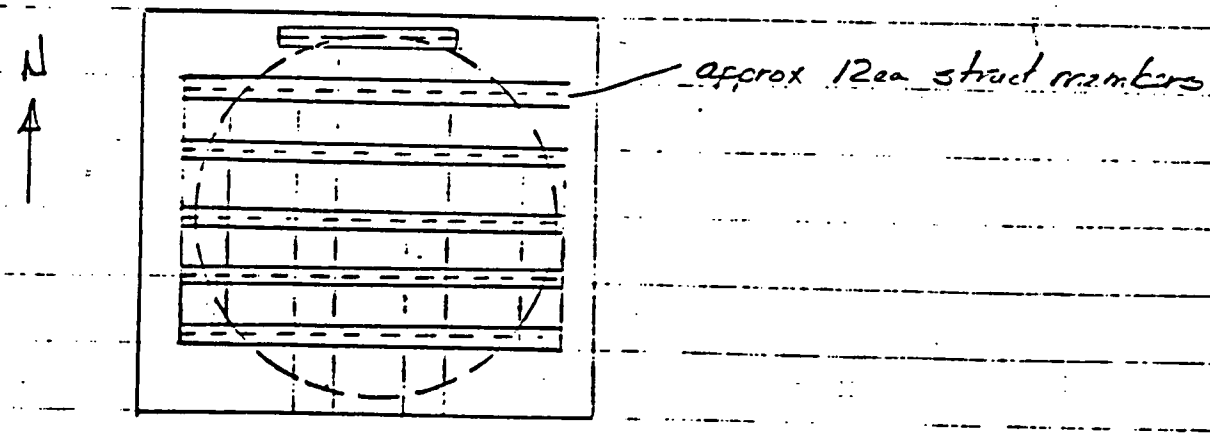
Sulfur Storage Tank



Steel and Conc. Bin - South of Tank

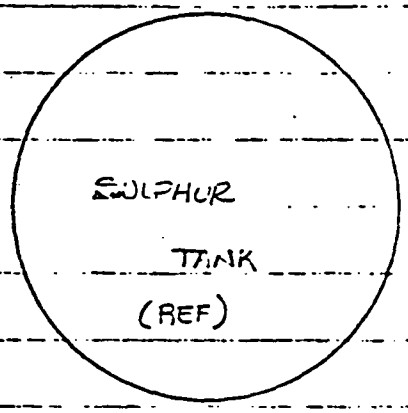
Sulphur Storage Tank

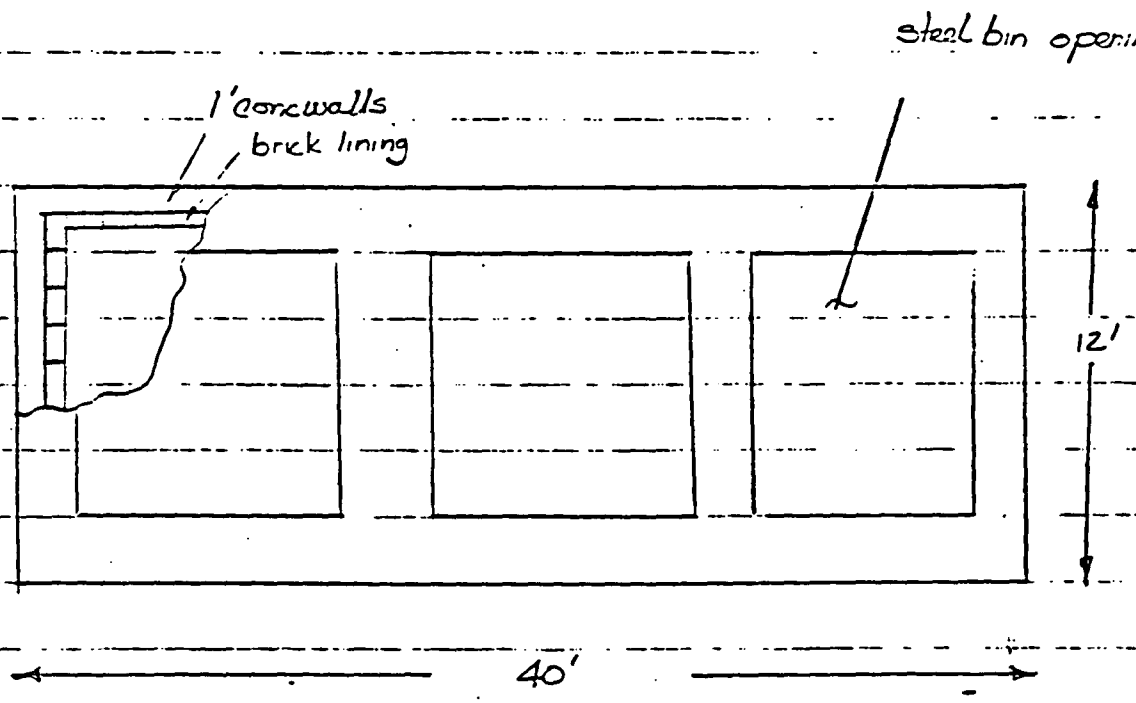




SECT A - A

Concrete and Steel Bin



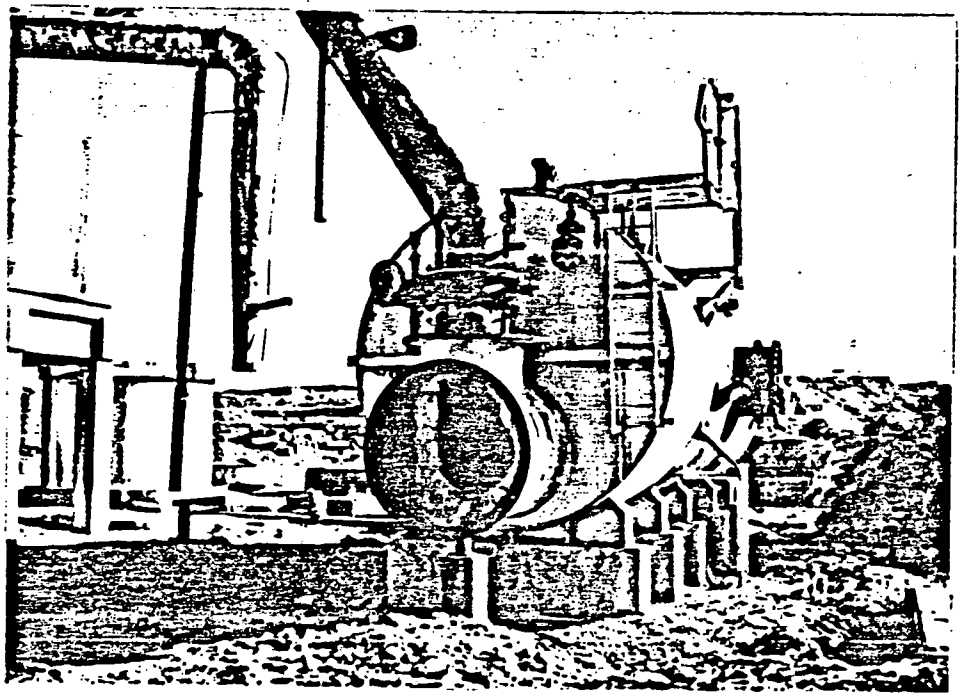


SULFUR FURNACE AND TANK

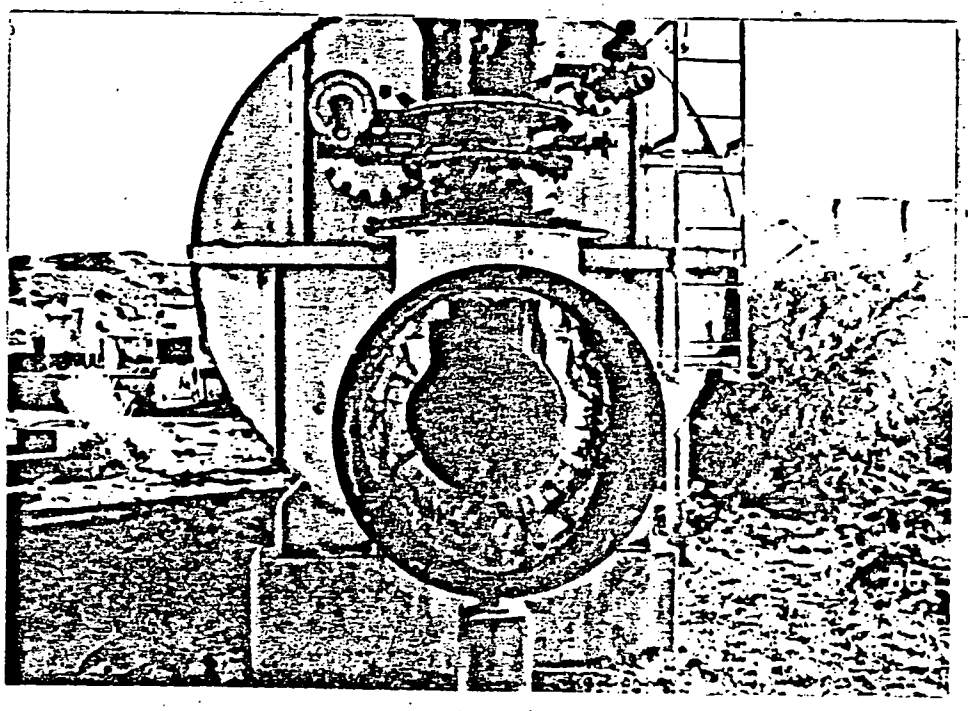
The sulfur furnace is a 10 foot in diameter brick and asbestos lined unit that is 25 feet in length. It sits on five concrete piers which are 1.5' wide x 10' long and is supported by five steel saddles.

The two acid tanks are 8 feet in diameter by 22 feet high. They sit on a four legged concrete foundation which is 12 feet tall. The legs on the concrete support are 16 inches square.

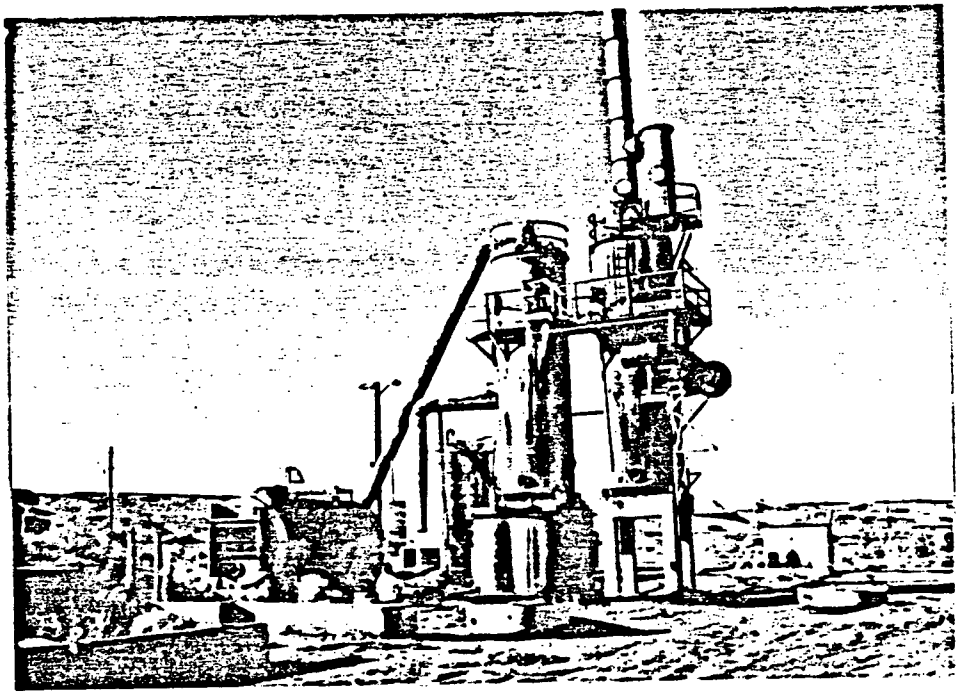
Another sulfur storage tank and foundation are just south of the acid tanks. The storage tank is 10 feet in diameter by 8 feet high and sits on two concrete grade beams and structural I-beams. The foundation is 12' x 18' with 8 inch foundation walls. The height of these walls is assumed to be three feet. There are three minor equipment pedestals on six inch slab.



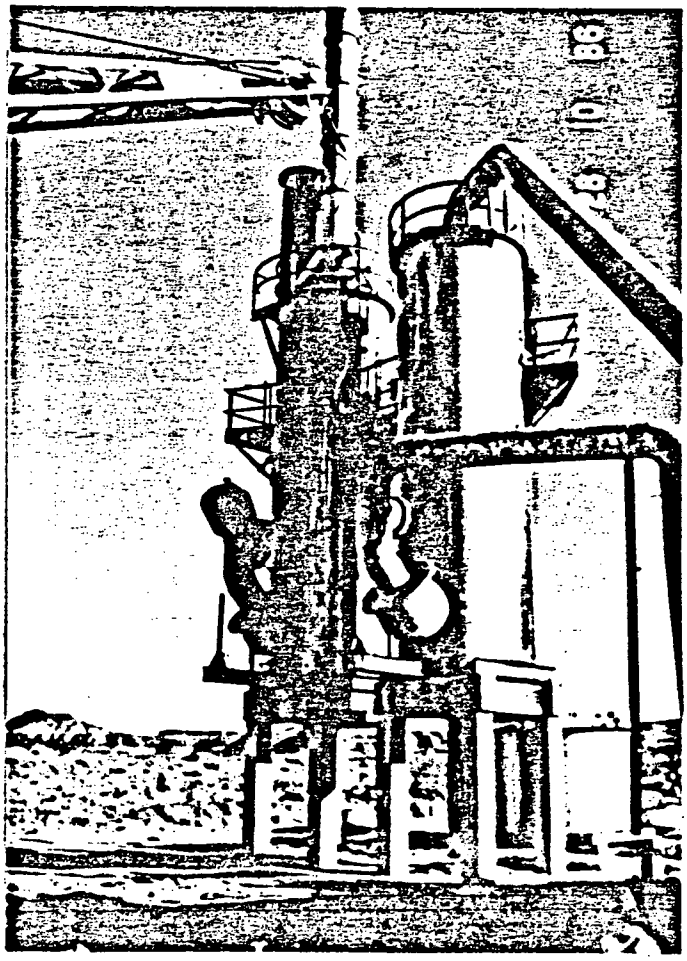
View of Sulfur Heating Furnace



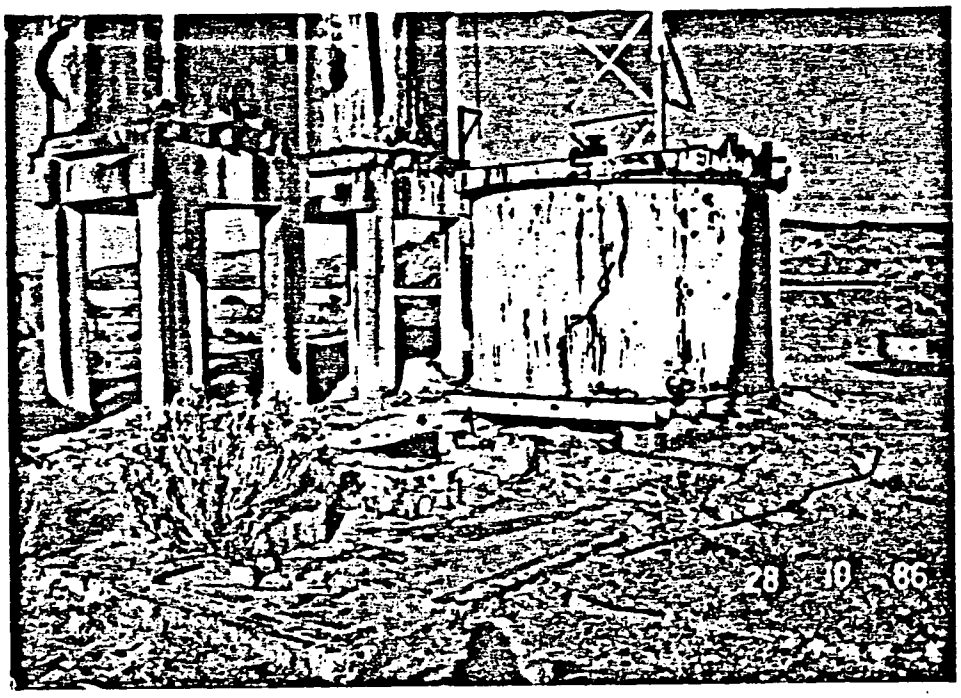
View of Sulfur Heating Furnace



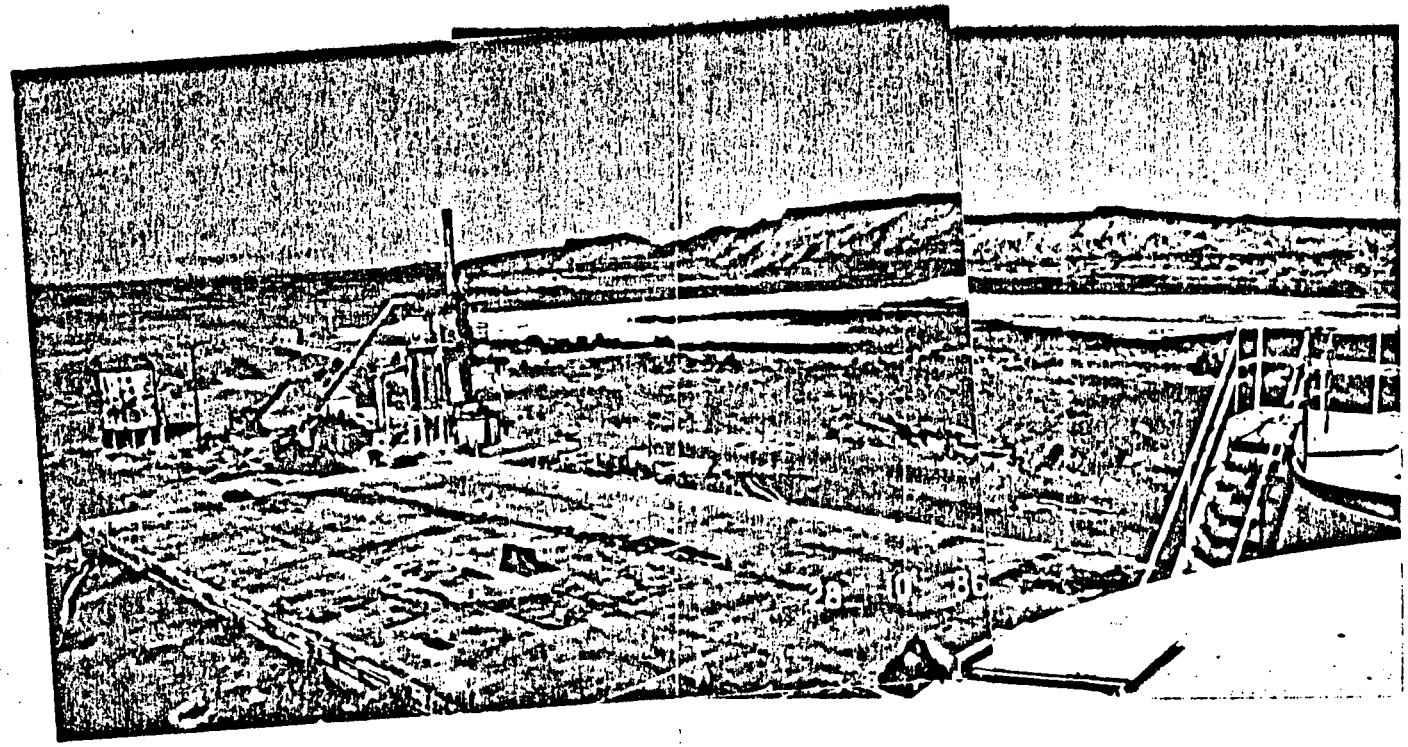
Furnace and S. Acid Tanks -
Looking North



View of Sulfuric Acid Tanks

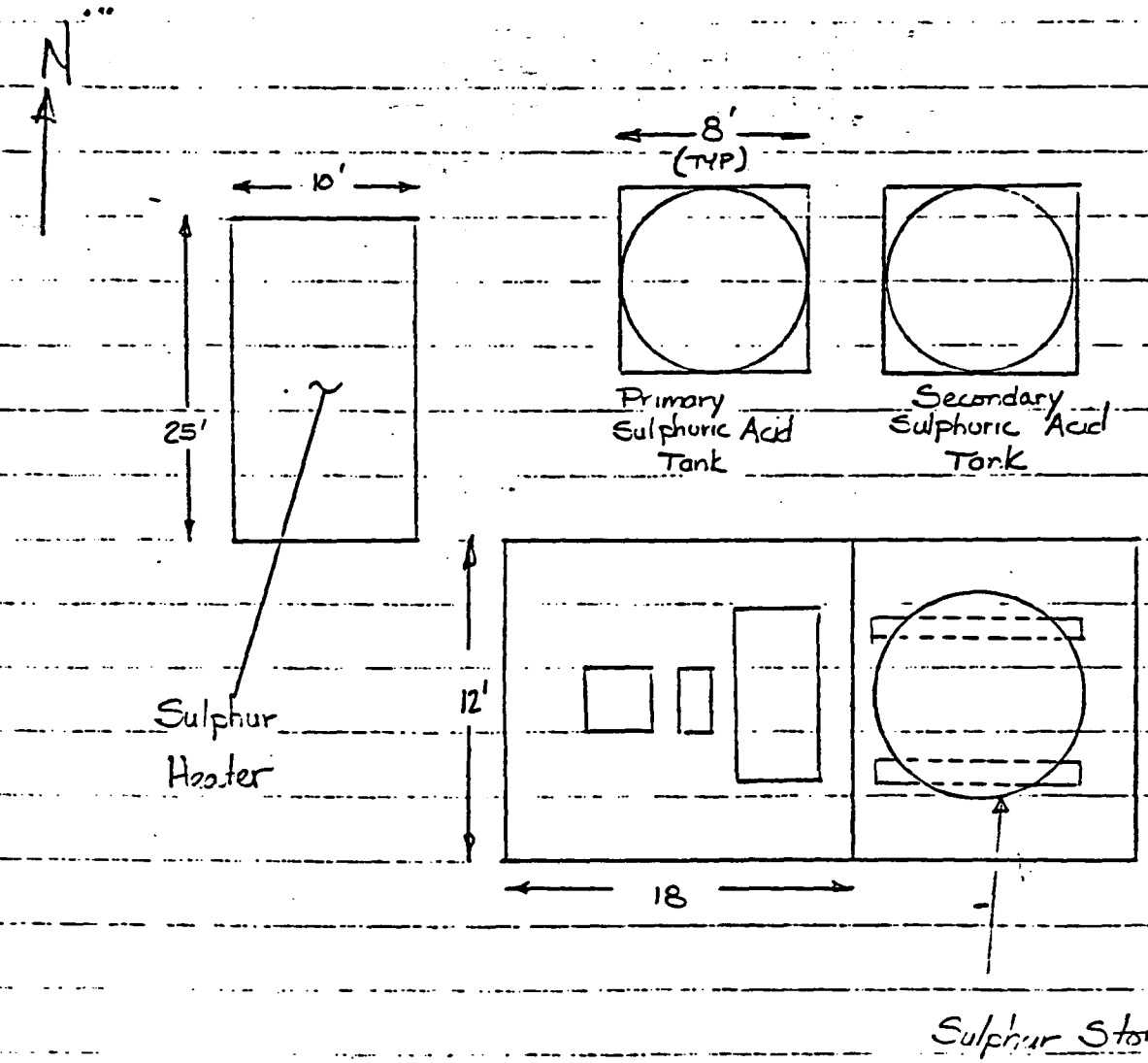


Acid Tank Fdns/Sulfur Storage Tank



Aerial View - Sulfur Processing Area

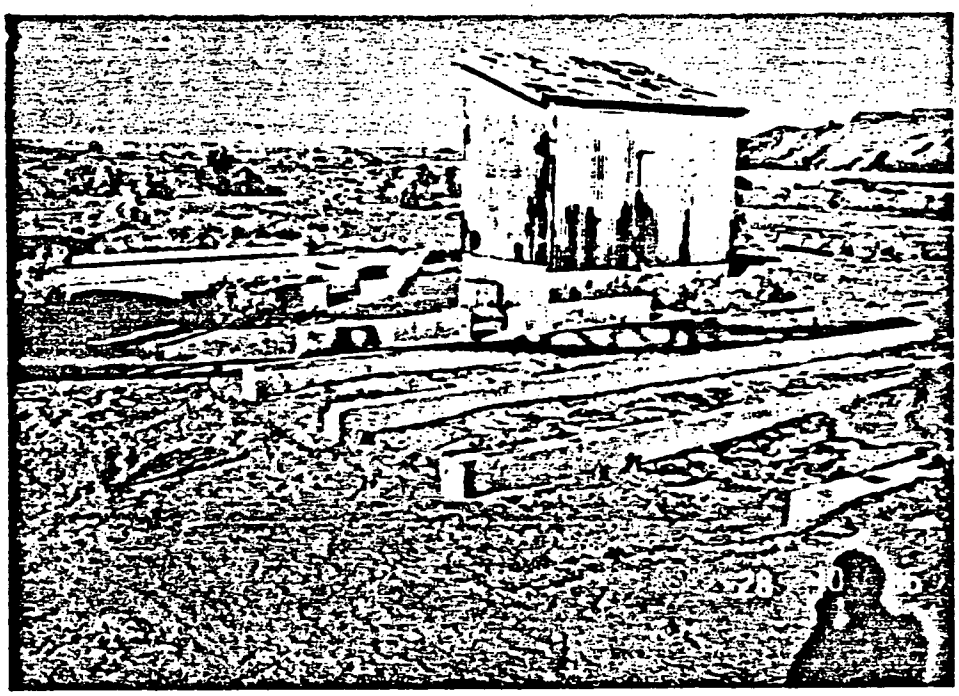
Sulphur Furnace and Tanks



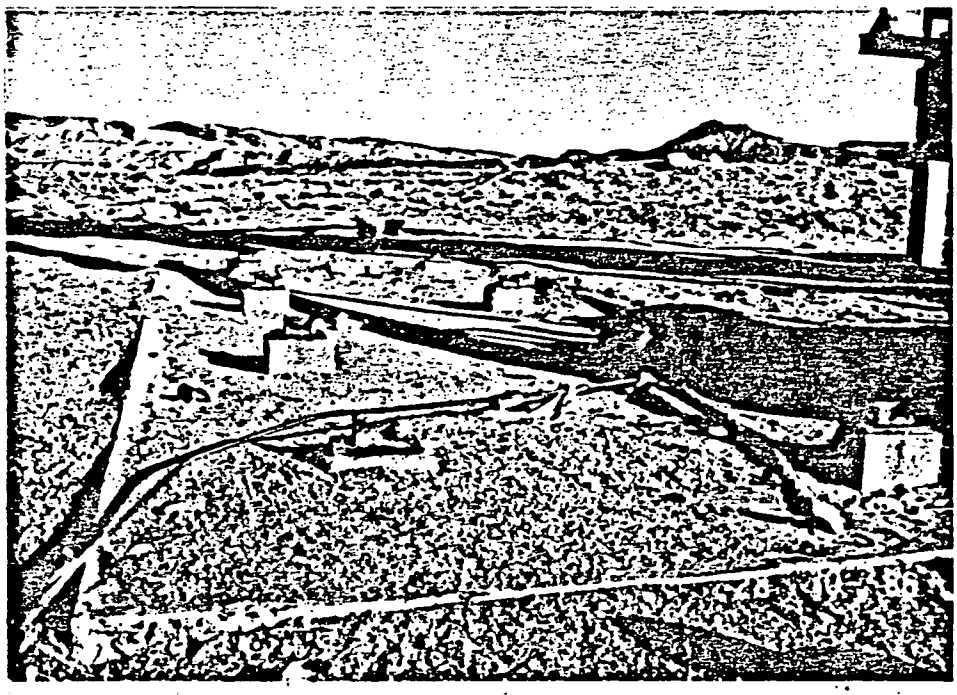
GRADE BEAMS AND MISCELLANEOUS FOUNDATIONS

The grade beams and foundation are located approximately 20 feet east of the sulfur storage tank and steel bin. There are ten grade beams which are 7" x 12" and they are spaced at about five feet. There is a corrugated metal shed on four inch concrete walls in the northeast corner. The building is approximately 8' x 6'x 10' high.

Just south of the grade beams is a foundation with eight inch walls that are about 2 feet high. Inside the walls are nine piers, which are 1.5' x 1'. There is also a sump that is approximately 5' x 5' with eight inch walls and eight feet deep.

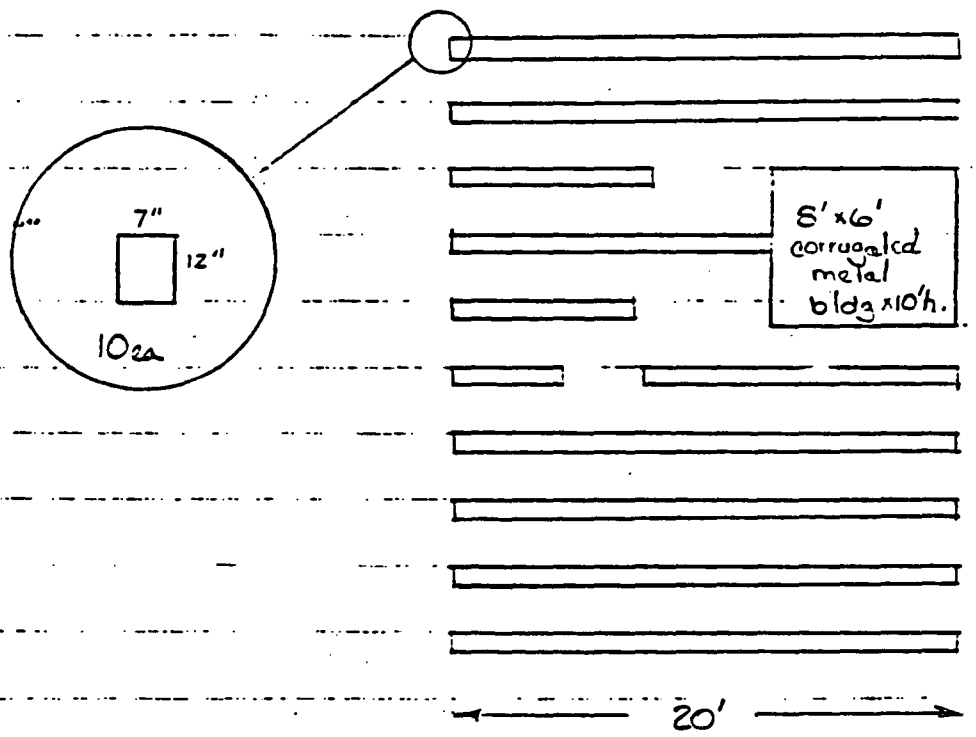


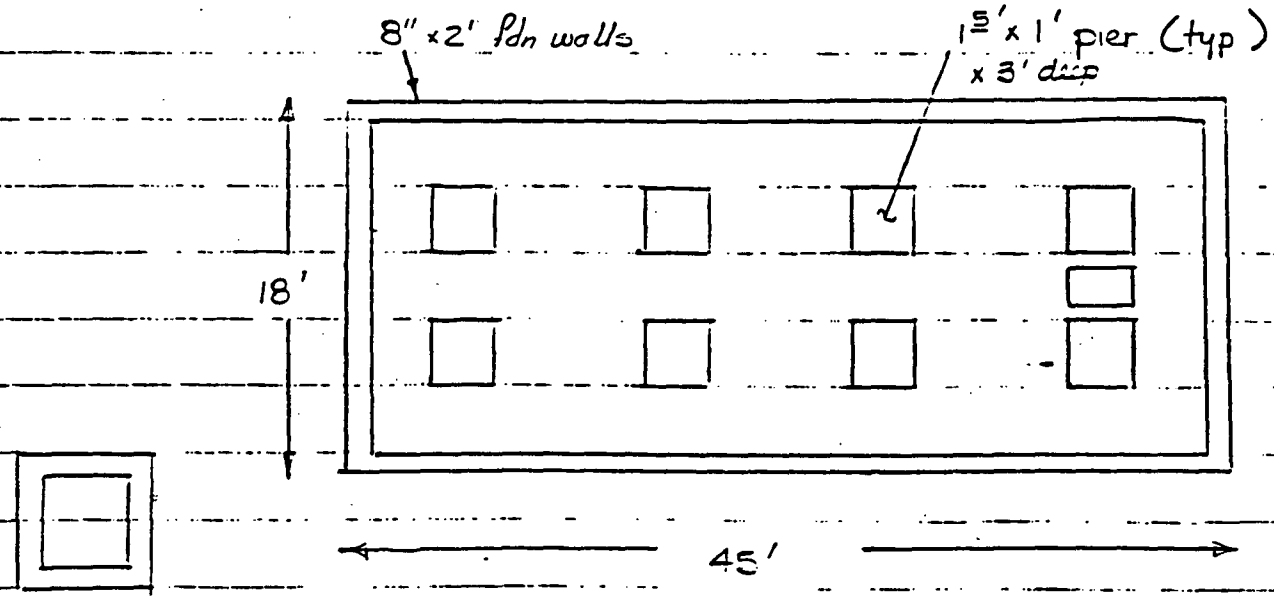
Bldg. and Tank Foundations



Misc. Foundation South of Above

Grade Beams & Foundations





sump 5' x 5'

8" walls x 8' deep

An additional walk down was performed in the tailings pile itself. It appears that the tailings were used as a berm to contain contaminated water in an upper (west) and lower (east) pond.

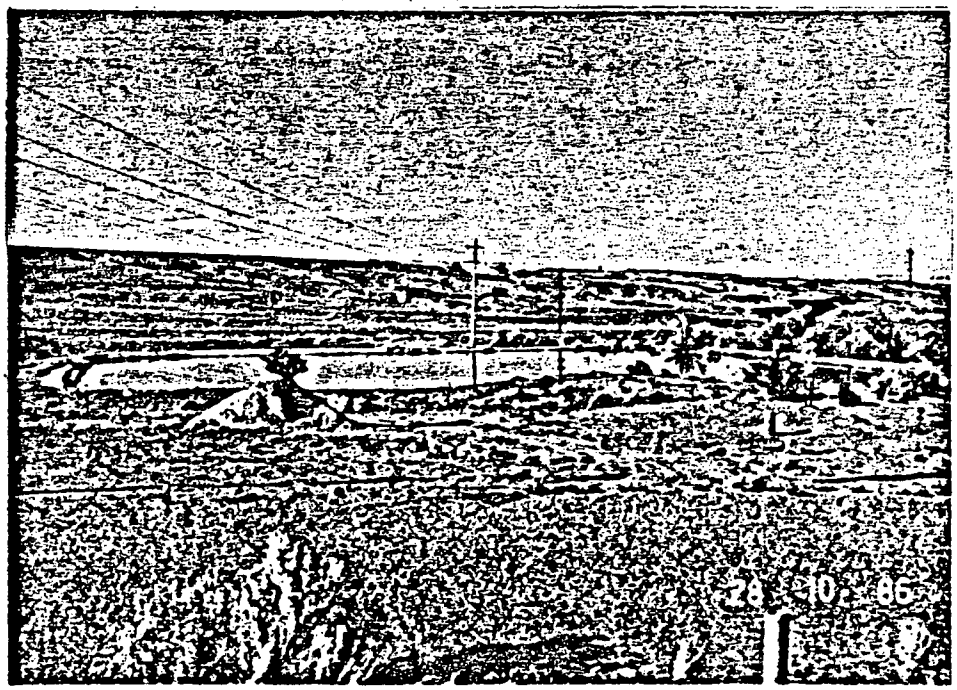
Between the two ponds is a dilapidated wooden water pipeline that runs from south to north. It is approximately 10 inches in diameter, wound spirally with wire and is supported by wooden H-frame structures.

At the low point in the upper pond, there is a 10' x 10' concrete overflow structure used to distribute excess water to the lower pond. A drain line opening was observed in the lower pond which we assume runs from this drain structure.

There is also a similar structure located in the lower pond. Although no drain line was observed, the presence of tailings material in the arroyo to the northeast might indicate that overflow from the lower pond may have been discharged into this area.

The tailings berm itself was eroded in many areas, perhaps by rain water or wind, and tailings were observed in the low laying areas outside of the containment dike. These areas need to be looked at for inclusion in the remedial action process.

View of Tailing Pile



View of Retention Pond North of Site

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

INTER-OFFICE CORRESPONDENCE

DATE: January 3, 1987

TO: Rob Cooney

FROM: Jerry Lyons

LOCATION: Albuquerque Office

LOCATION: Albuquerque, NM-3050

SUBJECT: Mexican Hat Narrative

The Industrial Hygiene portion of Mexican Hat has been completed, as far as the initial report.

1. In the original characterization study, identified asbestos was found to actually be deteriorated fiberglass insulation. However, lab analysis has confirmed the presence of Amosite, very friable asbestos between the double walls of both sulfur storage tanks. There are also approximately 200' linear feet of piping containing asbestos insulation.

2. Yellow material on the ground which originally was thought to be yellow-cake is solidified sulfur.

3. Sulfuric reactor tanks, (both units) are partially full of sulfuric sludge muds.

4. Potential of PCB's in transformers on power poles.

Hazards to be aware of during the Mexican Hat project.

1) Presence of asbestos fibres.

2) Sulfuric muds may cause mild burns if contacted with water.

3) Precautions during excavation for noise and dust.

4) Caution when working near existing power lines.

JLL/mjs

cc: Marv Henderson
J.G. Oldham
Bob Stearns

0111M

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

INTER-OFFICE CORRESPONDENCE

DATE: November 14, 1986

TO: Rob Cooney

FROM: Jerry Lyons Jerry

LOCATION: Albuquerque, NM-3050

LOCATION: Albuquerque, NM-3050

SUBJECT: Mexican Hat Lab Analysis

Attached, please find written lab analysis confirming asbestos from samples taken at Sulfur Storage.

The form is Amosite, very friable.

Other samples are no large concern, being sulfuric sludge muds, solidified sulfur and stagnant water from the pit below processed mill product tanks.

JLL/mjs

cc; J.G. Oldham
M.W. Henderson
Bob Stearns

NATIONAL STEEL AND SHIPBUILDING COMPANY

INTER-DEPARTMENT MEMO

Date 11/10/86

To: J. Lyons

Dept.

Subject: Bulk Analysis Report

Job No. 353

From: [illegible]

Dept. 46

The following samples submitted from MK-

were analyzed using standard polarizing light microscopy dispersion staining techniques with the results as follows:

Sample Date	Sample Location	Result
11/10/86	MK-New Mexico	Amosite - Asbestos

MK-FERGUSON CO.
ALBUQUERQUE

NOV 1 [illegible]

RECEIVED

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

INTER-OFFICE CORRESPONDENCE

DATE: October 30, 1986

TO: Marv Henderson

FROM: Jerry Lyons

LOCATION: Albuquerque Office

LOCATION: Albuquerque, NM-3050

SUBJECT: Mexican Hat Industrial Hygiene Survey

On October 28-29, 1986, myself, Rob Cooney, Mark Thomson and Carl Begley, Chem Nuclear traveled to Mexican Hat to do an evaluation for the upcoming project. Findings of the evaluation are indicated below:

1. 4 large elevated tanks contain hoppers on the bottom which are open. No material is contained within the tanks.

   Slight radiation readings were found by Chem Nuclear on interior framework, and is suspected that the tanks were used to store finished milled product.

2. Sulfuric Reactors

   A. 2 units, a primary and secondary reactor, approximately 8-10' above ground on steel platforms.

   B. Units are totally enclosed, except for opened bungs on the lower portions.

   C. Opened bungs indicate presence of solidified sulfuric sludge muds.

   D. Hazard would be primarily a reaction if contacted with water - minimal burns could occur if contact was made with sludge muds and not washed off soon.

3. Ground Level Tanks by Sulfuric Reactors

   A. 2 tanks, approximately 12-14' high and 10' in diameter.

   B. Appear to have been used for sulfur heating and storage.

   C. Tanks are double walled and appear to have an insulation barrier of asbestos material. (Samples & photo obtained)

   D. All tanks in the sulfuric area should be treated as containing asbestos.

   E. Hazards present would be from release of asbestos fibres.

4. There is approximately 200 linear feet of piping in the general sulfuric plant area that appears to contain asbestos insulation.

5. The original report indicated presence of asbestos material on the ground. However, the majority of the ground material appears to be weathered and corroded fiberglass insulation.

6. Diesel Generator.

   A. No hazard identified with generator.

   B. There is a small transformer packet on the ground next to the diesel generator which could contain PCB material and should be treated accordingly.

7. Tailings Ponds.

   A. Several areas are apparent where dike failure had occured, causing spillage several hundred feet onto lower plains.

   B. Chem-Nuclear readings show wind blown radiological contamination in all directions from the tailings area.

Conclusion:

Yellow material on the grounds of the sulfuric area appear to be solidified sulfur. Samples were obtained, and no radiological readings of the product were detected.

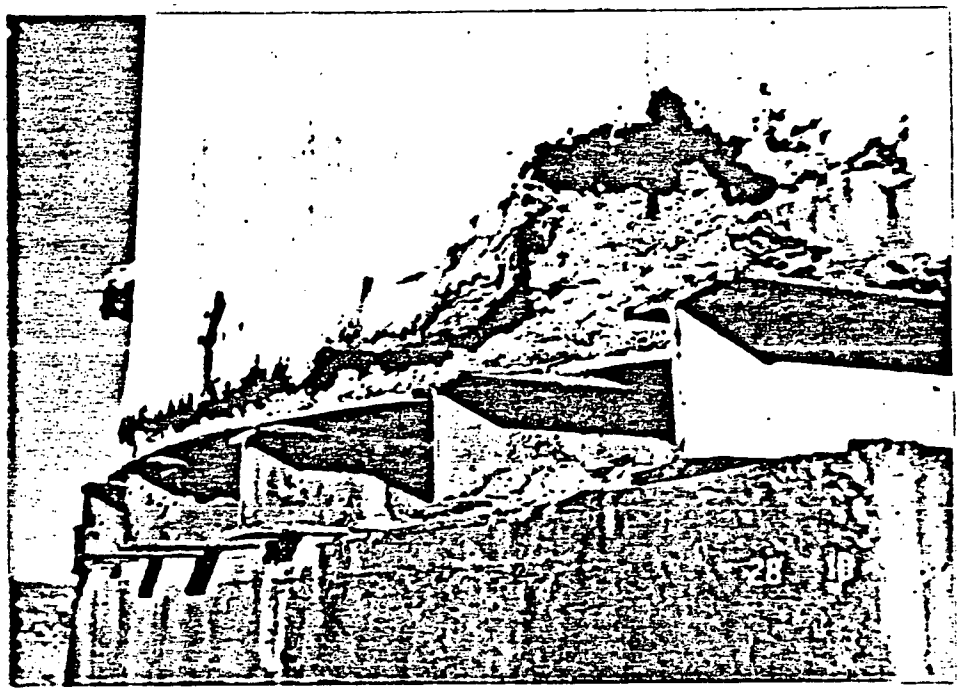
Asbestos as originally reported in the sulfuric area appears to be fiberglass insulation in a deteriorated state.

Asbestos insulation is suspected between double walls of sulfur storage tanks, and on approximately 200' linear feet of piping. Ideally, tanks would be filled with sand or gravel and buried intact in tailings pile. Cutting and dismantling could create high fibrous asbestos release.

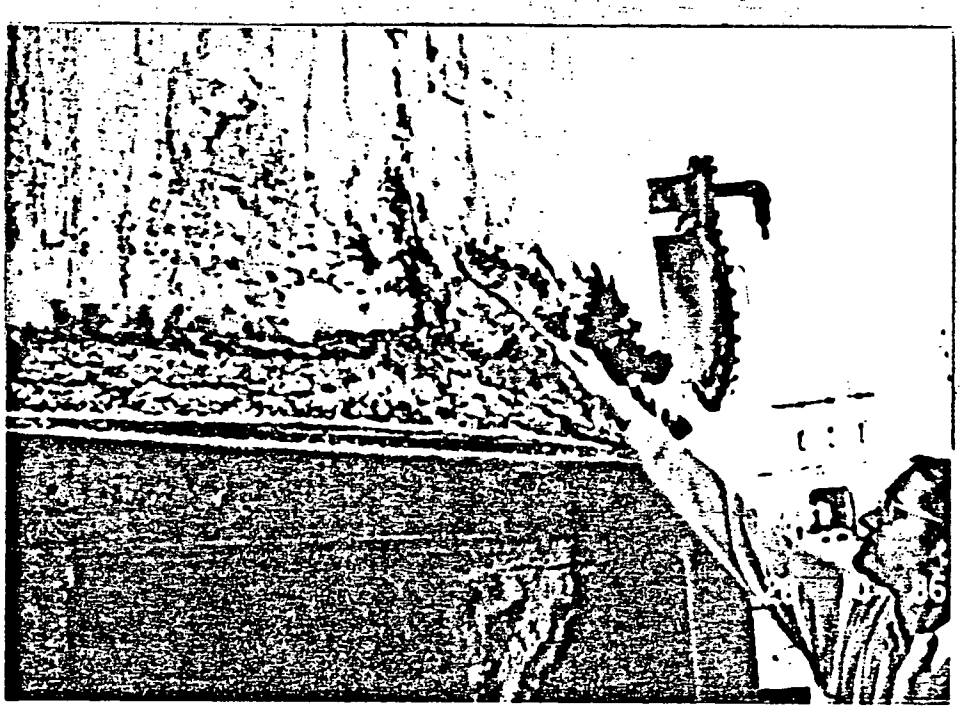
Photos and sampling of all above information were obtained. Lab analysis of suspected asbestos material will be provided on completion.

JLL/mjs

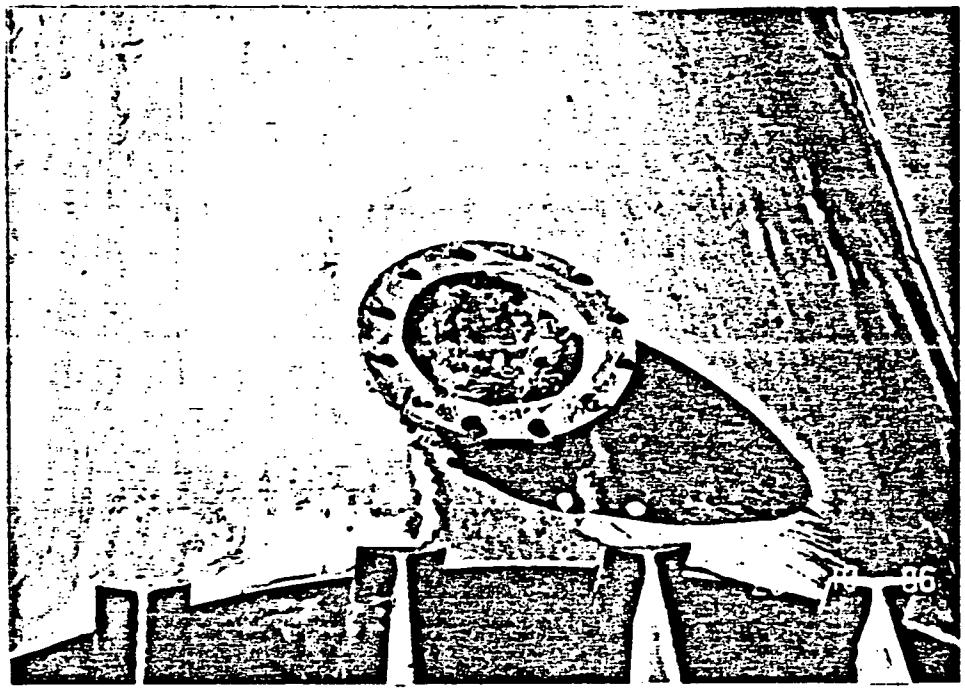
xc: Jim Oldham
Bob Stearns
Rob Cooney
File



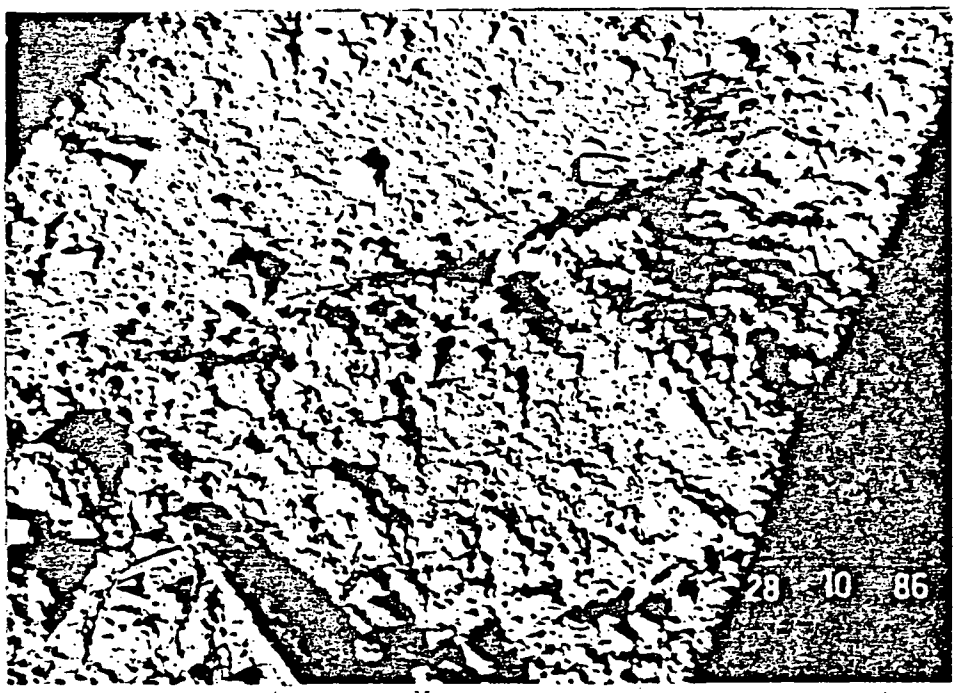
Sulfur Tank Showing Asbestos



Sulfur Tank Showing Asbestos



Sulfuric Sludge Mud
Reactor Tank



Acid Sludge on Ground

Survey of Existing Structures at
Mexican Hat for Surface Contamination

A radiological survey of existing structures not previously surveyed at Mexican Hat was conducted on October 28 and 29, 1986. Portable instrument surveys were conducted using a Ludlum 222D and 44-40 (α, β, γ). Smears were collected at all instrument reading locations and in some areas where access was too difficult to get instrument readings (inside the large storage tanks).

The only significant portable instrument readings were noted in the gates of the storage tanks and on the firebrick in the north end of the sulfur heat exchanger. Elevated smear results were noted inside the storage tanks and on the firebrick in the north end of the heat exchanger. Swipe numbers and instrument survey numbers correspond to the same locations.

The contamination inside the large storage tanks appears to be dust residue from ore storage. It may be possible to decontaminate the tanks economically by high pressure washing.

Portable instrument counts greater than 100 per 0.5 minutes represent values greater than permissible for unrestricted release. This is based upon an average background of 100 cpm and a cut off count rate of 100 cpm above background (memo from Jim Purvis regarding contamination release limits, dated 12-5-86).

Removable activity greater than 600 dpm/100 cm^2 are also above the applicable release limits. A note of caution - the interior smear survey of the large storage tanks was very limited due to access. It would be reasonable to assume that higher activity smears could be collected with better access.

Note: Any of the existing structures that are desired to be used for any purposes will have to be cleaned out. Contaminated windblown material is present on all structure's slabs.

PORTABLE INSTRUMENT SURVEY

LOCATION	COUNTS/0.5 min.
Sulfur Heat Exchanger	
#1 N. End Firebrick Interior	129
#2 N. End Metal Interior	55
#3 Exterior - NE Side	44
#4 Duplicate Swipe Location of #3	
#5 Exterior - SE Side	40
#6 Duplicate Swipe Location of #5	
#7 S. End Metal Interior	34
#8 N. End Firebrick Interior - Hot Spot	480
#8 Sulfur Storage Tank*	
#1 N. Side	28
#2 E. Side	30
#3 S. Side	35
#4 W. Side	31
#5 Sulfur Storage Tank	
#1 N. Side	33
#2 E. Side	24
#3 S. Side	30
#4 W. Side	31
Large Ore Storage Tanks (Taken at Bottom Gates)	
Tank #1	571
Tank #2	969
Tank #3	880
Tank #4	295

*See Map for Numbered Tank Locations

SMEAR DATA

LOCATION	DPM/100 cm^2
Ore Storage Tanks	
#1 Interior	397
#1 Bottom Gate	31.3
#2 Interior	665
#2 Bottom Gate	12.7
#3 Interior	87.8
#3 Bottom Gate	12.5
#4 Interior	79.6
#4 Bottom Gate	21.3
#8 Sulfur Storage Tank	
#1	1.0
#2	1.3
#3	2.1
#4	< 0.7
#5 Sulfur Storage Tank	
#1	< 0.7
#2	3.5
#3	4.6
#4	1.3
Sulfur Heat Exchanger	
#1	148
#2	< 0.7
#3	< 0.7
#4	< 0.7
#5	< 0.7
#6	< 0.7
#7	21.1
#8	< 0.7

DATE: April 16, 1986
HS-040-04-86

TO: Jim Williams — LOCATION: Albuquerque

FROM: Jim Purvis/Marv Henderson — LOCATION: Albuquerque

SUBJECT: Mexican Hat Buildings — RESPONSE DUE: N/A

REFERENCE: IOC Wathen to Oldham
5025-HAT-I-01-00192-00

An evaluation of the subject buildings was conducted by Rich Richey, DOE and Marv Henderson, MKF on April 9, 1986. A limited removable radiological contamination survey was conducted by Jim Purvis on the same date. The conditions are as follow:

There are only two buildings left standing. One of these is the sheet metal shop and the other is a larger metal building just southwest of the sheet metal shop. The larger building is really deteriorated and looks vandalized. The radiological swipe survey also indicates that this building is contaminated. The costs to salvage this building would probably exceed its worth.

The sheet metal shop has been stripped of electrical wiring but is still somewhat secure. The removable radiological contamination survey indicates that there is some residual contamination. It is believed that this contamination could be easily removed with water. It would be quite costly to utilize this building for office space but it could be very useful for storage of equipment and samples.

Based on the above, it is our recommendation that the larger building be razed and placed in the pile and that the sheet metal shop be cleaned up and used for storage.

JP/MH/eg

cc: B. Meyer
J. Oldham

1448B

MORRISON KNUDSEN

MEXICAN HAT

SWIPE LOGGING DATA

DATE TAKEN: _____ SHEET _____ OF _____ PAGE _____

APPROX. TIME _____ DATE: 4-10-86

MDA - 100cm² .015 PROPERTY ID: _____

INSTR. ID NO.: Lud 2000 #32302 w/43-10 #19579 SURVEY CREW:

EFFICIENCY OF INSTR.: 34.5%

CALCULATED BY: James Stubblemen

BACKGROUND: 5 @ 20 MIN.

CALIBRATION SOURCE: 230Th 11681

SWIPE LOCATION	GROSS (CPM)	BACKGROUND (CPM)	NET (CPM)	ACTIVITY (DPM)
1	12	.25	11.75	34.06
2	4	.25	3.75	10.87
3	8	.25	7.75	22.46
4	9	.25	8.75	25.36
5	8	.25	7.75	22.46
6	16	.25	15.75	45.65
7	25	.25	24.75	71.74
8	20	.25	19.75	57.25
9	16	.25	15.75	45.65
10	46	.25	45.75	132.61
11	3	.25	2.75	7.97
12	6	.25	5.75	16.67
13	2	.25	1.75	5.07
14	2	.25	1.75	5.07
15	4	.25	3.75	10.87
16	3	.25	2.75	7.97
17	0	.25	N/A	<MDA
18	0	.25	N/A	<MDA
19	2	.25	1.75	5.07
20	3	.25	2.75	7.97
21	2	.25	1.75	5.07
22	1	.25	.75	2.17
23	0	.25	N/A	<MDA
24	3	.25	2.75	7.97
25	2	.25	1.75	5.07

HP-011A

MORRISON KNUDSEN

SWIPE LOGGING DATA

DATE TAKEN: _____

APPROX. TIME _____

MDA - 100cm² .015

INSTR. ID NO.: Lud 200032302 4/4310 19579

EFFICIENCY OF INSTR.: 34.5%

CALCULATED BY: James Stuckleman

BACKGROUND: 5 @ 20 MIN.

CALIBRATION SOURCE: ^{230}Th 11681

SHEET _____ OF _____ PAGE _____

DATE: 4-10-86

PROPERTY ID: _____

SURVEY CREW: _____

SMSDOINE

SWIPE LOCATION	GROSS (CPM)	BACKGROUND (CPM)	NET (CPM)	ACTIVITY (DPM)
I1	0	.25	N/A	<MDA
I2	2	.25	1.75	5.07
I3	6	.25	5.75	16.67
I4	5	.25	4.75	13.77
I5	2	.25	1.75	5.07
I6	0	.25	N/A	<MDA
I7	0	.25	N/A	<MDA
I8	0	.25	N/A	<MDA
I9	1	.2	.75	2.17

HP G11A

OPERATION

LOCATION MAP

COMPANY

FORM ENG 6-A/74

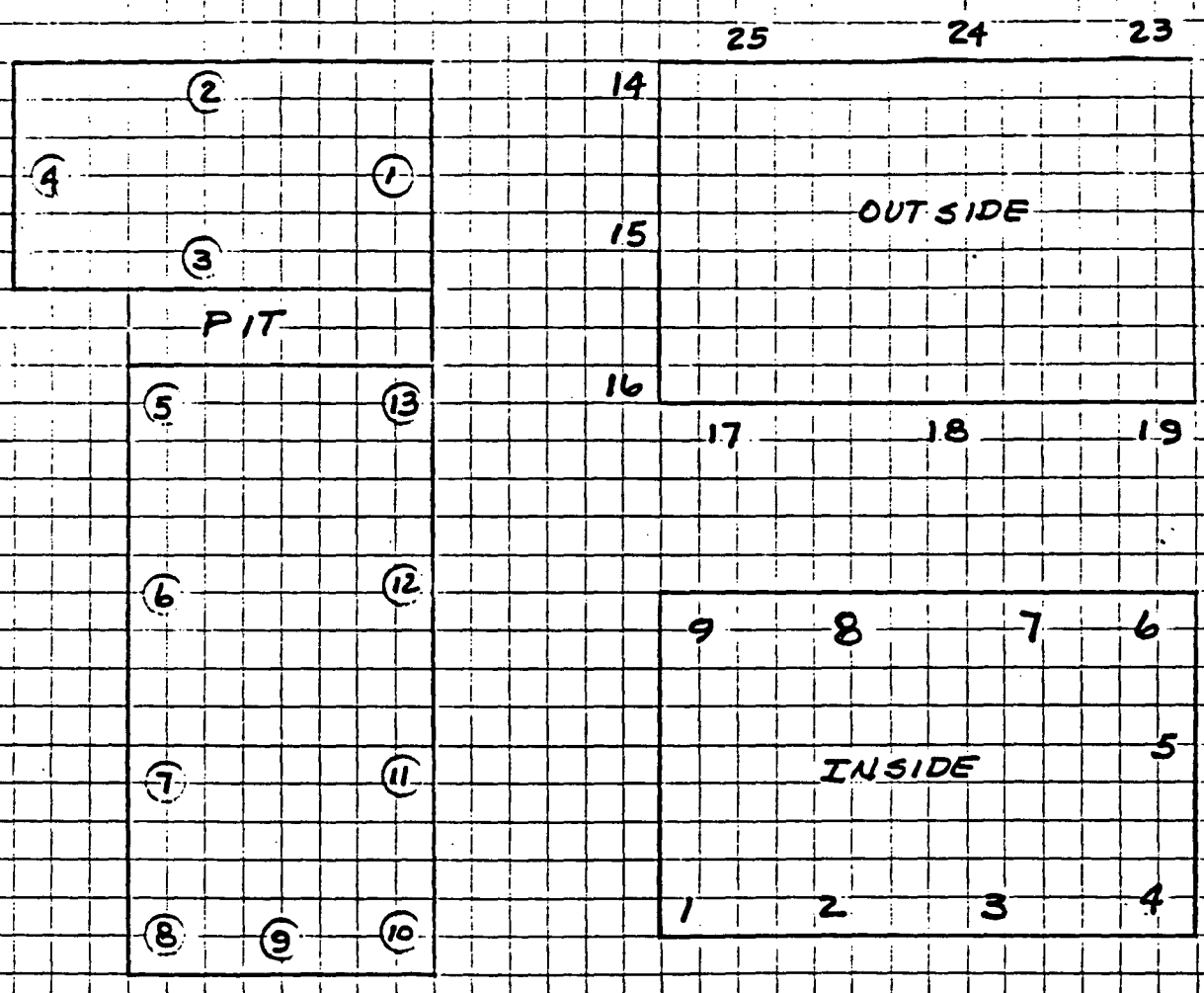
ITEM NO.

JOB

EST. BY

SHEET ____ OF ____ PAGE ____

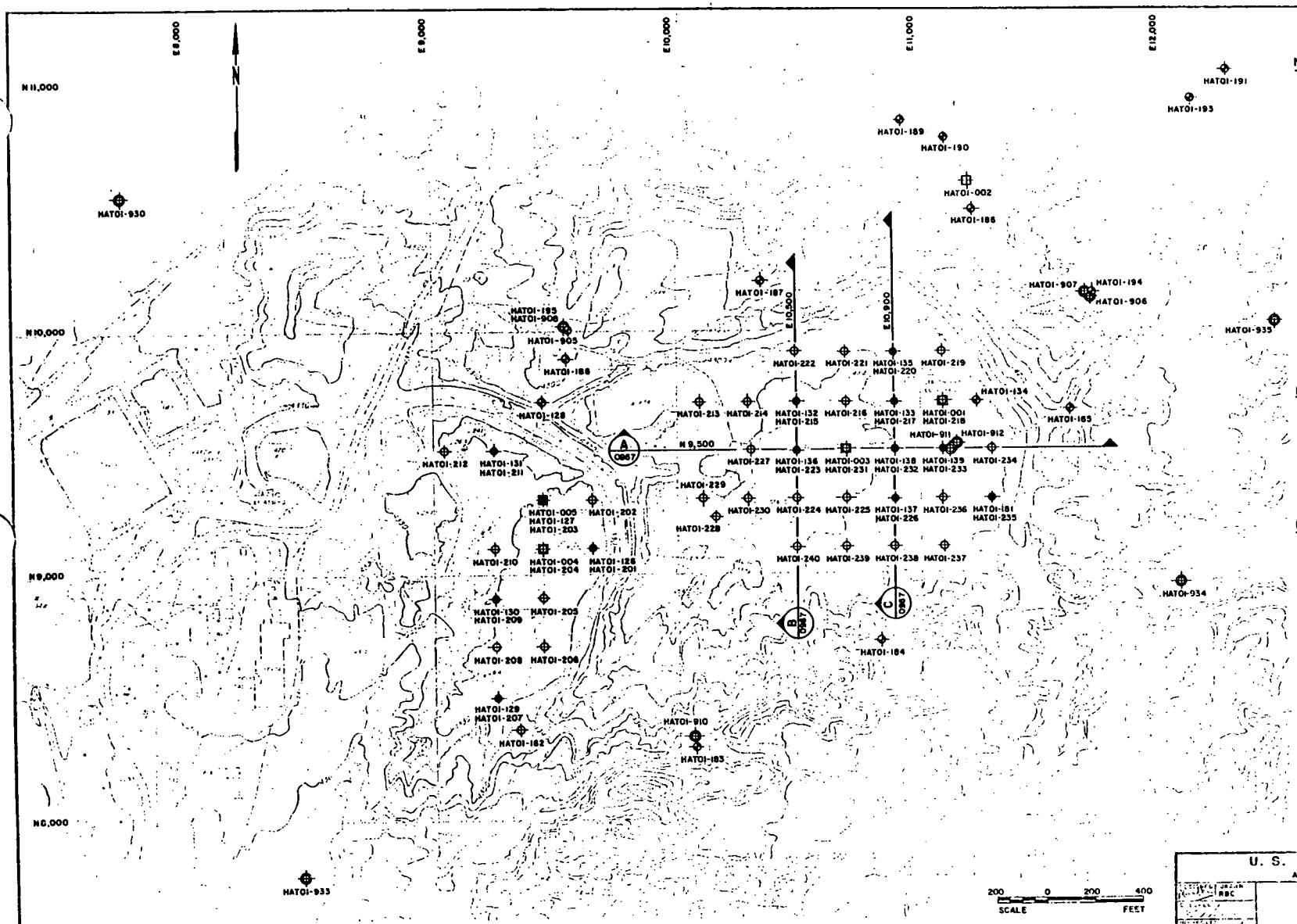
DATE



CRUSHER BUILDING

SHEET METAL SHOP

N



NOTES:

1. GEOTECHNICAL INVESTIGATIONS WERE CONDUCTED BY DOE IN LATE 1984 AND EARLY 1985. A TOTAL OF 40 PIEZOCONE SOUNDINGS, 17 BORINGS AND FOUR TESTS PITS WERE MADE ON THE EXISTING TAILINGS PILES. ADDITIONAL 27 BORINGS AND ONE TEST PIT WERE MADE IN THE VICINITY OF THE PILES. FOURTEEN OF THE BORINGS WERE CASED AND COMPLETED AS MONITORING WELLS. THREE BORINGS AND FOUR MONITORING WELLS WHICH ARE LOCATED AWAY FROM THE TAILINGS PILE AREA ARE NOT SHOWN.

2. LOCATION COORDINATES OF WELLS THAT ARE TO BE SEALED AND ABANDONED ARE AS FOLLOWS:

HATOI-906	N 10,137	E 11,703
HATOI-907	N 10,154	E 11,692
HATOI-908	N 10,019	E 9,539
HATOI-905	N 10,019	E 9,558
HATOI-910	N 8,526	E 10,067
HATOI-911	N 9,508	E 11,114
HATOI-912	N 9,527	E 11,133
HATOI-930	N 10,550	E 7,753

REFERENCE DRAWINGS:

HAT-PS-10-0967 GEOLOGIC CROSS SECTIONS

LEGEND:

- PIEZOCONE SOUNDINGS
- BORINGS
- BORING AND PIEZOCONE SOUNDING IN SAME LOCATION
- TEST PITS
- TEST PIT AND PIEZOCONE SOUNDING IN SAME LOCATION
- TEST PIT, BORING AND PIEZOCONE SOUNDING IN SAME LOCATION
- MONITORING WELLS

REGISTERED ENGINEER NO. 4719 EDWIN S. SMITH STATE OF UTAH

NO	DATE	REVISIONS	BY	CK				
0	8-84	ISSUED FOR CONSTRUCTION						

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT SITE
MEXICAN HAT, UTAH
PHASE II CONSTRUCTION

BORING LOCATION PLAN

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT

DE-AC04-83AL18796

HAT-PS-10-0966 REV 0

Table D4.1

	Field or lab number	DBMS ID number
Piezocone data:	HAT01-01 through 40	HAT01-200 through 240
Boring and lab data:		
	HAT01-01	HAT01-126
	HAT01-03	HAT01-127
	HAT01-06	HAT01-128
	HAT01-07	HAT01-129
	HAT01-09	HAT01-130
	HAT01-11	HAT01-131
	HAT01-15	HAT01-132
	HAT01-17	HAT01-133
	HAT01-19	HAT01-134
	HAT01-20	HAT01-135
	HAT01-23	HAT01-136
	HAT01-26	HAT01-137
	HAT01-32	HAT01-138
	HAT01-33	HAT01-139
	HAT01-35	HAT01-181
	HAT01-41-47	HAT01-182-188
	HAT01-50-56	HAT01-189-195
Test pits:	HAT01-TP1 to TP5	HAT01-001 to 005

Table D6.1 Geochemical analyses of Colorado State University borings

Boring Number[a]	Sample depth (feet)	pH	Electrical conductivity (mhos/centimeter)	Constituent[b] SO_4	Fe	Ca	Mg	Na	Cl	Al	Mn	As	Se	$CaCO_3$ equivalent (percent)
MH-200	2.5	8.1	1.8	3650	158	2660	782	323	130	812	252	4	3	10.4
MH-200	3.0	8.0	1.8	3140	130	2500	507	118	60	778	224	4	2	21.8
MH-200	3.5	8.1	2.0	4240	128	4260	473	161	60	675	183	4	4	19.3
MH-200	4.0	8.0	1.9	3870	110	3380	378	69	<20	781	159	4	4	21.8
MH-200	4.8	8.2	0.2	200	118	222	29	30	272	288	390	3	5	36.0
MH-200	6.0	8.6	0.1	111	84	131	21	16	<20	363	296	2	4	17.5
MH-200	10.0	8.6	0.2	270	115	217	53	41	<20	336	191	3	4	36.0
MH-200	15.0	8.6	0.1	67	106	114	30	49	<20	348	138	3	4	49.8
MH-200	19.0	8.5	0.1	134	82	155	35	29	<20	248	224	2	3	18.7
MH-205	5.5	8.5	0.2	173	112	167	65	35	<20	278	222	3	5	41.0
MH-205	6.0	8.3	0.8	160	215	1460	186	50	<20	325	610	2	3	29.6
MH-205	7.0	8.5	0.2	190	144	149	55	81	<20	306	228	3	2	36.4
MH-205	10.0	7.9	1.7	3050	96	2110	541	268	<20	931	194	2	<1	18.0
MH-205	12.5	8.1	0.2	300	78	105	60	29	30	609	89	1	1	11.5
MH-205	17.0	8.4	0.1	150	67	131	44	35	20	276	237	1	<1	12.8
MH-205	22.0	8.3	0.2	170	38	53	23	300	30	671	45	1	3	6.1
MH-205	25.5	8.6	0.1	155	87	130	37	36	20	277	193	13	<1	18.4
MH-208	27.0	6.4	2.0	5070	430	5470	177	96	<20	549	72	13	<1	0.84
MH-208	27.5	8.0	0.2	348	304	340	47	22	<20	253	271	4	6	34.4
MH-208	30.2	8.5	0.1	90	130	131	26	24	<20	263	231	4	6	32.0
MH-208	36.0	8.4	0.1	89	93	116	32	31	<20	260	208	2	3	31.4
MH-208	38.0	8.1	0.2	370	74	289	91	72	<20	845	128	2	<1	9.8
MH-208	43.0	8.6	0.1	67	119	111	32	35	<20	342	202	2	2	29.8
MH-208	49.0	8.1	0.2	120	52	124	47	98	<20	671	103	3	<1	18.0

[a]Boring numbers currently do not have DOE identification numbers; CSU boring numbers represent NX rock core samples.
[b]Analysis done by solute extraction; values are expressed in milligrams per gram of dry soil; SO_4 - sulfate; Fe - iron; Ca - calcium; Mg - magnesium; As - arsenic; Se - selenium.

HAT-201

SITE ID: HAT01 LOCATION ID: 001

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	16.4	0.2	0.0	1.0	S-SL*	5	39	30	57	1965	
2	1.3	4.1	2.8	7.3	0.1	0.1	1.4	SLIM	4			25	870	9.6
3	4.2	8.0	3.8	22.6	0.3	0.1	1.1	S-SL*	7	48	31	79	2709	
4	8.0	10.1	2.1	14.2	0.4	0.2	2.6	SLIM	9			50	1709	5.8
5	10.1	11.1	1.0	24.5	0.3	0.2	1.4	S-SL*	8	44	31	86	2937	
6	11.1	12.5	1.4	14.3	0.4	0.2	2.7	SLIM	9			50	1718	4.2
7	12.5	13.7	1.2	25.7	0.4	0.4	1.5	S-SL*	8	41	30	90	3086	
8	13.8	18.5	4.8	13.2	0.4	1.1	2.8	SLIM	8			46	1585	2.6
9	18.6	23.3	4.7	30.6	0.6	0.5	1.9	S-SL*	10	37	29	107	3671	
10	23.3	25.2	1.9	18.0	0.6	1.4	3.2	SLIM	12			63	2164	2.0
11	25.3	28.3	3.1	6.2	0.1	2.7	2.1	SLIM	4			22	742	0.8
12	28.3	30.7	2.3	21.8	0.5	1.0	2.2	SLIM	14			76	2615	1.8
13	30.7	33.8	3.1	11.8	0.4	6.6	3.3	SLIM	7			41	1414	1.0
% THK:		35	11.9	25.6	0.4	0.3	1.5	S-SL	8	41	30	89	3071	
% THK:		64	21.5	12.7	0.3	1.9	2.5	SLIM	7			44	1527	3.3

SITE ID: HAT01 LOCATION ID: 002

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	48.0	0.3	-0.1	0.7	SAND*	9	72	35	168		
2	0.8	9.8	9.1	23.7	0.2	0.0	0.8	S-SL*	7	49	31	83	2845	
3	9.9	13.2	3.3	13.4	0.4	1.6	2.7	SLIM	8			47	1611	4.1
4	13.2	17.0	3.8	30.4	0.4	0.5	1.2	S-SL*	10	43	30	106	3647	
5	17.1	18.6	1.6	43.1	0.3	0.1	0.8	SAND*	8	50	31	151		
6	18.7	19.6	0.9	22.2	0.4	0.2	1.9	S-SL	7	30	29	78	2662	
7	19.6	21.0	1.4	56.3	0.5	0.3	1.0	SAND*	11	55	32	197		
% THK:		17	3.7	49.0	0.4	0.1	0.9	SAND	9	56	32	171		
% THK:		66	13.8	25.4	0.3	0.2	1.0	S-SL	7	46	31	89	3053	
% THK:		15	3.3	13.4	0.4	1.6	2.7	SLIM	8			46	1611	4.1

SITE ID: HAT01 LOCATION ID: 003

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.2	1.1	6.7	0.0	-0.0	0.6	SLIM*	4			23	800	25.6
2	1.2	14.8	13.6	24.9	0.2	0.1	1.0	S-SL*	8	48	31	87	2985	
3	14.8	18.1	3.3	8.8	0.3	0.3	3.4	SLIM	5			31	1057	1.9
4	18.2	20.1	1.9	27.5	0.4	0.4	1.4	S-SL*	9	36	29	96	3302	
5	20.1	21.0	0.9	52.8	0.4	0.2	0.7	SAND*	10	53	32	185		
6	21.1	23.9	2.8	27.4	0.4	0.2	1.5	S-SL*	9	33	29	96	3287	
7	23.9	25.8	1.9	4.8	0.2	0.4	4.0	SLIM	3			17	574	0.7
% THK:		3	0.9	52.8	0.4	0.2	0.7	SAND	10	52	32	185		
% THK:		71	18.2	25.6	0.3	0.1	1.1	S-SL	8	44	31	89	3064	
% THK:		24	6.3	7.2	0.2	0.3	3.1	SLIM	4			25	866	5.7

SITE ID: HAT01 LOCATION ID: 004

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.5	2.~~4~~5	17.3	0.1	-0.0	0.6	S-SL*	5	41	30	61	2076	
2	2.5	10.8	8.3	7.6	0.2	0.0	2.5	SLIM	5			27	917	4.9
3	10.~~9~~8	14.9	4.~~0~~1	21.7	0.4	0.3	1.7	S-SL	7	37	29	76	2598	
4	14.9	17.7	2.8	8.4	0.3	0.6	3.5	SLIM	5			29	1007	1.9
5	17.~~8~~7	19.2	1.~~4~~5	40.7	0.6	1.2	1.4	S-SL*	13	47	31	142	4882	
% THK:		41	7.8	23.8	0.3	0.4	1.3	S-SL	7	40	30	83	2847	
% THK:		58	11.1	7.8	0.2	0.2	2.8	SLIM	5			27	939	4.1

SITE ID: HAT01 LOCATION ID: 005

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.7	2.6 7	13.8	0.1	-0.0	0.6	S-SL*	4	35	29	48	1661	
2	2.8 7	19.7	16.9 17.0	6.0	0.2	0.1	3.9	SLIM	3			21	718	2.5
% THK:		13	2.6	13.8	0.1	0.0	0.6	S-SL	4	35	29	48	1660	
% THK:		86	16.9	6.0	0.2	0.1	3.9	SLIM	3			21	718	2.5

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 006
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	DCR
1	0.1	3.0	3.0 2.9	16.8	0.1	-0.0	0.5	S-SL*	5	40	30	59	2014	
2	3.0	5.1	2.1	6.5	0.2	-0.1	3.0	SLIM	4			23	778	6.5
3	5.1	9.1	4.0	21.0	0.2	-0.0	1.2	S-SL*	7	45	31	74	2520	
4	9.2	11.8	2.67	12.6	0.1	-0.0	1.1	S-SL*	4	27	29	44	1518	
5	11.8	19.2	7.3	7.1	0.2	0.5	3.1	SLIM	4			25	857	1.8
% THK:		50	9.5	17.4	0.1	0.0	1.0	S-SL	5	38	30	61	2091	
% THK:		49	9.4	7.0	0.2	0.4	3.1	SLIM	4			24	839	2.8

SITE ID: HAT01 LOCATION ID: 007

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	9.9	0.2	0.0	2.0	SLIM	6			34	1182	39.5
2	1.0	3.9	2.89	15.5	0.2	0.0	1.2	S-SL*	5	38	30	54	1864	
3	3.9	13.0	9.1	7.4	0.3	-0.0	4.2	SLIM	4			26	887	3.8
% THK:		21	2.8	15.5	0.2	0.0	1.2	S-SL	5	38	30	54	1863	
% THK:		78	10.1	7.6	0.3	0.0	4.0	SLIM	4			26	916	7.3

SITE ID: HAT01 LOCATION ID: 008

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	9.5	0.1	-0.0	1.4	SLIM	6			33	1144	32.2
2	1.3	3.9	2.6	22.4	0.2	-0.0	1.0	S-SL*	7	48	31	78	2690	
3	3.9	7.2	3.3	11.6	0.3	-0.0	2.8	SLIM	7			41	1393	7.8
4	7.2	16.3	9.1	5.1	0.2	-0.1	3.3	SLIM	3			18	608	2.0
% THK:		16	2.6	22.4	0.2	0.0	1.0	S-SL	7	48	31	78	2690	
% THK:		83	13.6	7.1	0.2	-0.1	3.0	SLIM	4			24	845	6.1

SITE ID: HAT01 LOCATION ID: 009

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	3.4	3.3	18.2	0.1	-0.0	0.7	S-SL*	6	42	30	64	2183	
2	3.4	4.8	1.4	9.9	0.3	0.0	2.8	SLIM	6			35	1194	8.8
3	4.9	6.0	1.2	33.2	0.2	0.1	0.7	S-SL*	11	60	33	116	3980	
4	6.1	6.5	0.4	12.9	0.3	0.1	2.1	SLIM	8			45	1553	7.8
% THK:		71	4.5	22.2	0.1	0.0	0.7	S-SL	7	46	31	77	2662	
% THK:		28	1.8	10.6	0.3	0.0	2.6	SLIM	6			37	1273	8.6

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 010
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.0	1.9	14.2	0.1	-0.1	0.5	S-SL*	4	35	29	50	1701	
2	2.0	3.6	1.6	7.0	0.1	-0.0	1.6	SLIM	4			25	842	9.0
% THK:		54	1.9	14.2	0.1	-0.1	0.5	S-SL	4	35	29	50	1701	
% THK:		45	1.6	7.0	0.1	0.0	1.6	SLIM	4			25	842	9.0

SITE ID: HAT01 LOCATION ID: 011

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	36.1	0.6	0.0	1.7	S-SL*	12	63	33	126	4326	
2	0.8	2.5	1.67	56.8	0.5	0.0	0.8	SAND*	11	78	36	199		
3	2.5	9.8	7.3	26.2	0.2	0.2	0.7	S-SL*	8	52	32	92	3147	
4	9.9	10.8	0.9	15.8	0.2	3.0	1.5	S-SL	5	32	29	55	1891	
5	10.8	12.2	1.4	21.5	0.3	1.5	1.5	S-SL*	7	39	30	75	2583	
6	12.3	16.3	4.0	7.0	0.0	1.4	0.7	SLIM*	4			24	839	1.9
% THK:		10	1.6	56.8	0.5	0.0	0.8	SAND	11	78	36	199		
% THK:		64	10.3	25.3	0.2	0.6	0.9	S-SL	7	49	32	88	3040	
% THK:		25	4.0	7.0	0.0	1.4	0.7	SLIM	4			24	839	1.9

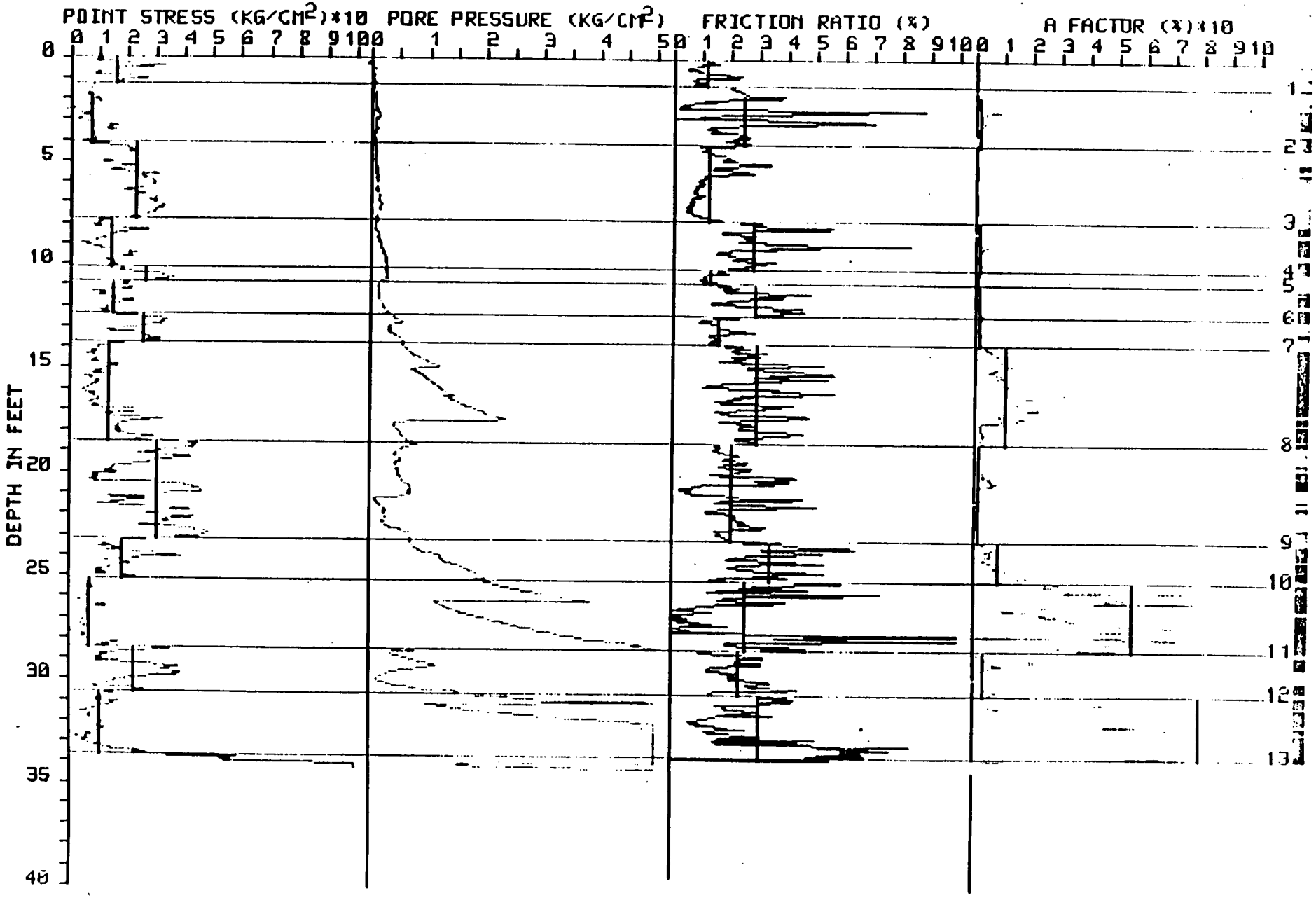
SITE ID: HAT01 LOCATION ID: 012
GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	17.4	0.2	-0.0	1.4	S-SL*	5	41	30	61	2086	
2	0.8	1.5	0.7	53.2	0.5	0.1	0.9	SAND*	10	76	35	186		
3	1.5	2.7	1.2	28.7	0.3	0.0	1.1	S-SL*	9	56	32	101	3448	
4	2.7	3.6	0.9	37.3	0.3	0.1	0.7	SAND*	7	64	34	131		
5	3.7	6.8	3.1	21.9	0.2	0.1	1.0	S-SL*	7	47	31	77	2631	
6	6.8	7.4	0.7	9.5	0.2	0.2	1.9	SLIM	6			33	1138	5.6
7	7.5	8.2	0.7	18.4	0.2	0.2	0.9	S-SL*	6	42	30	64	2207	
8	8.2	8.9	0.7	32.1	0.3	0.2	0.8	S-SL*	10	57	33	112	3852	
9	8.9	11.1	2.1	19.7	0.2	0.3	1.2	S-SL*	6	39	30	69	2360	
10	11.1	12.0	0.9	7.1	0.1	0.6	1.9	SLIM	4			25	855	2.6
% THK:		13	1.6	44.3	0.4	0.1	0.8	SAND	8	69	34	155		
% THK:		72	8.5	22.5	0.2	0.1	1.1	S-SL	7	46	31	78	2700	
% THK:		13	1.6	8.2	0.1	0.4	1.9	SLIM	4			28	978	3.9

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

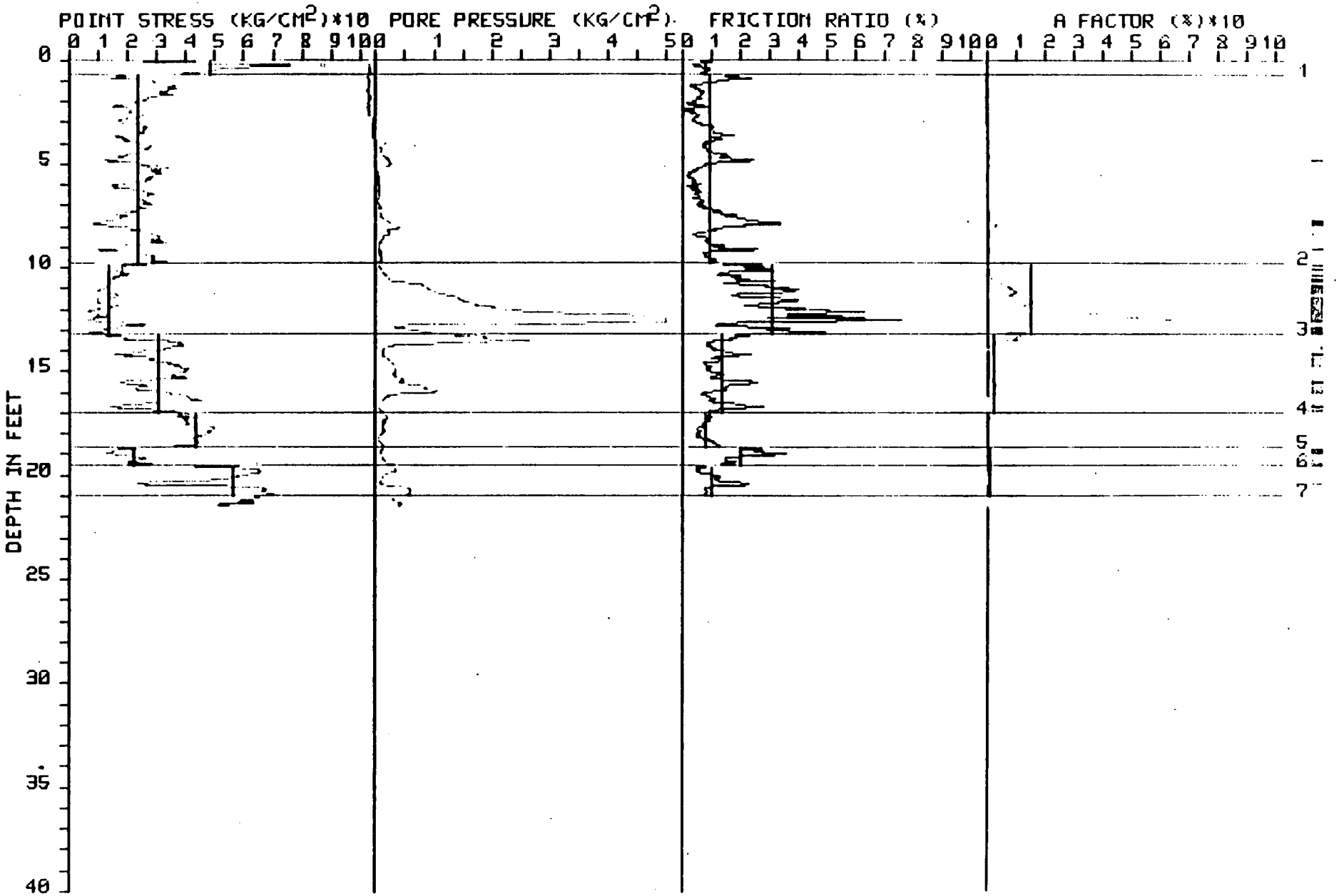
LOCATION ID: 001



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

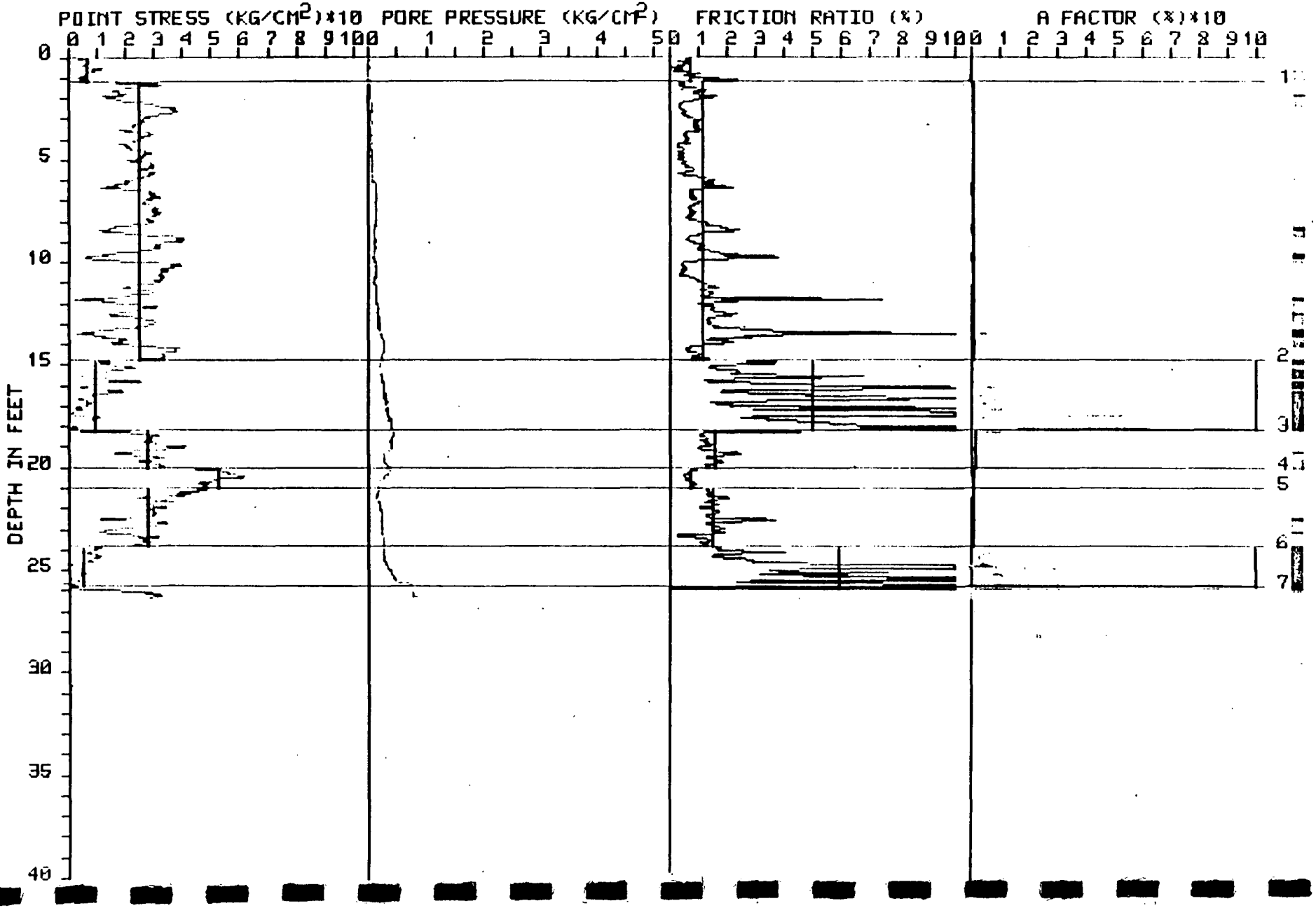
LOCATION ID: 002



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

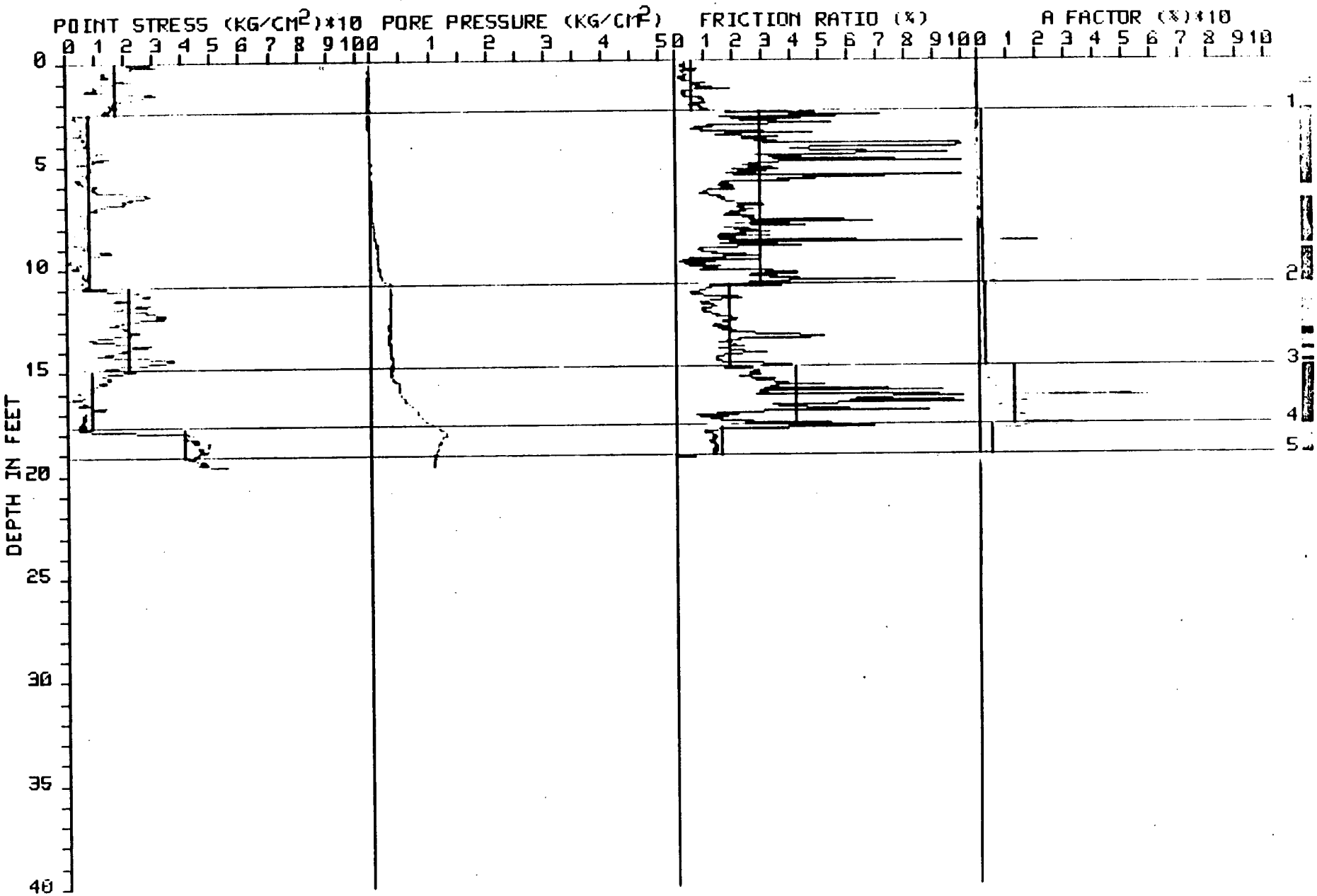
LOCATION ID: 003



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

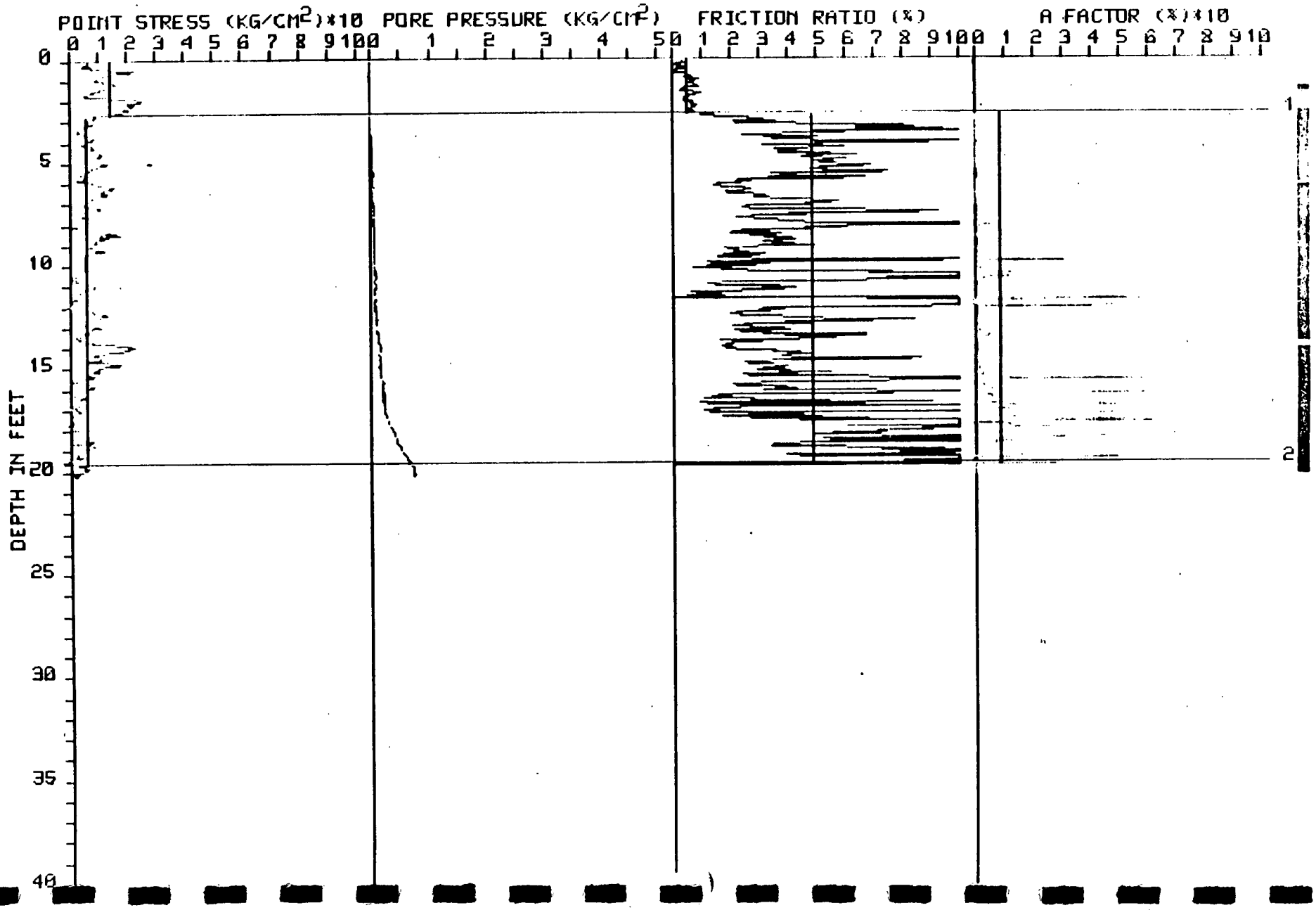
LOCATION ID: 004



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

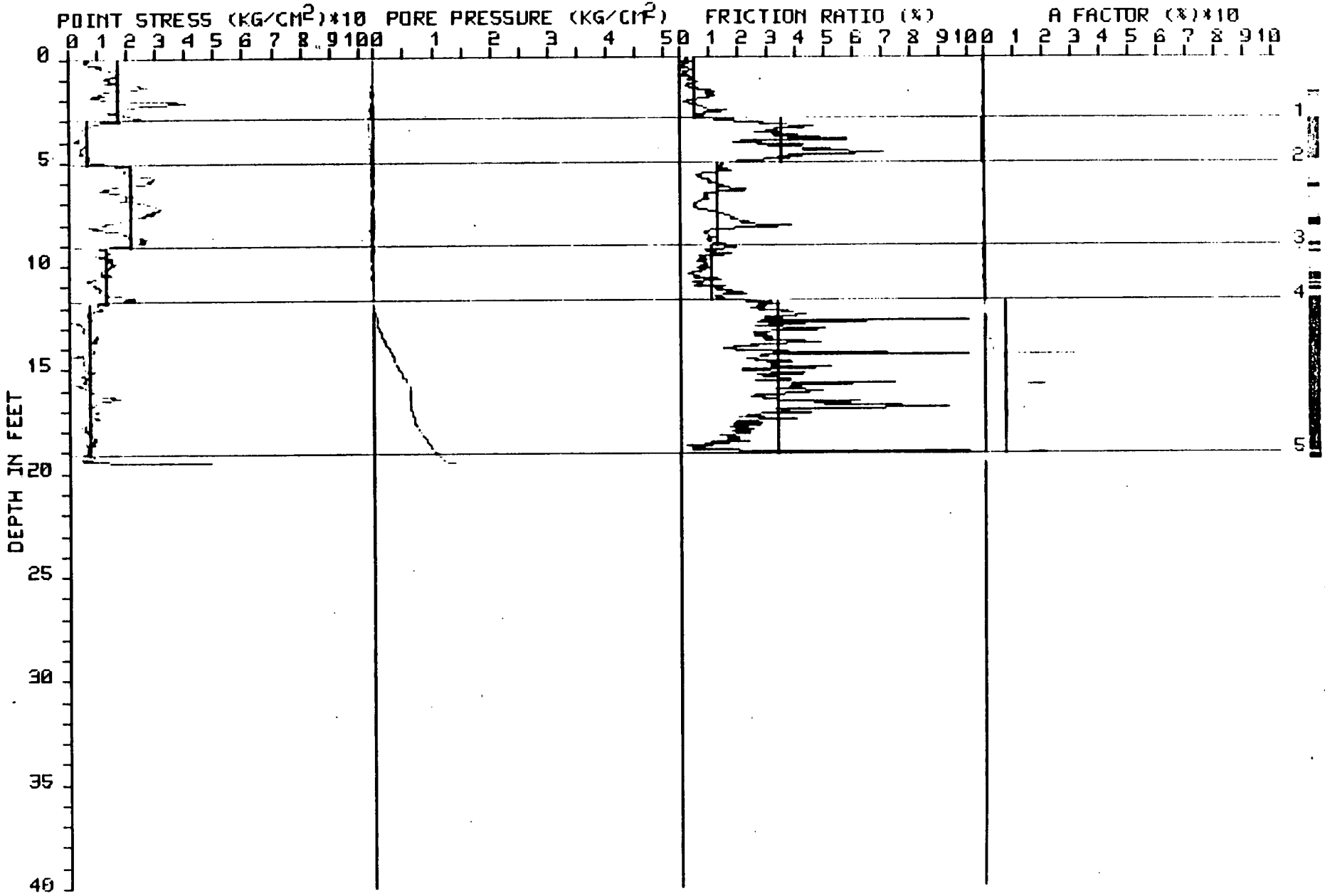
LOCATION ID: 005



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

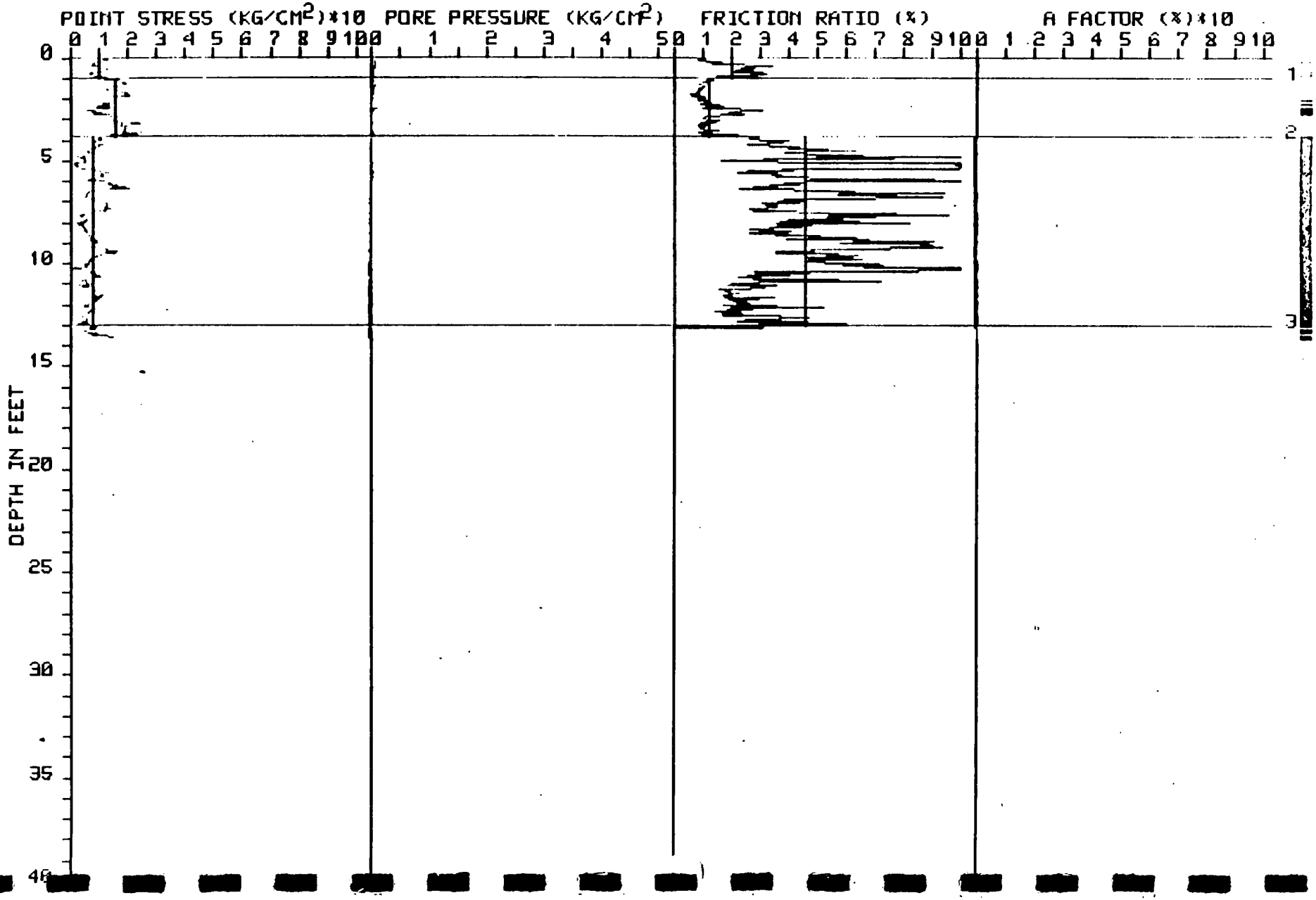
LOCATION ID: 006



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

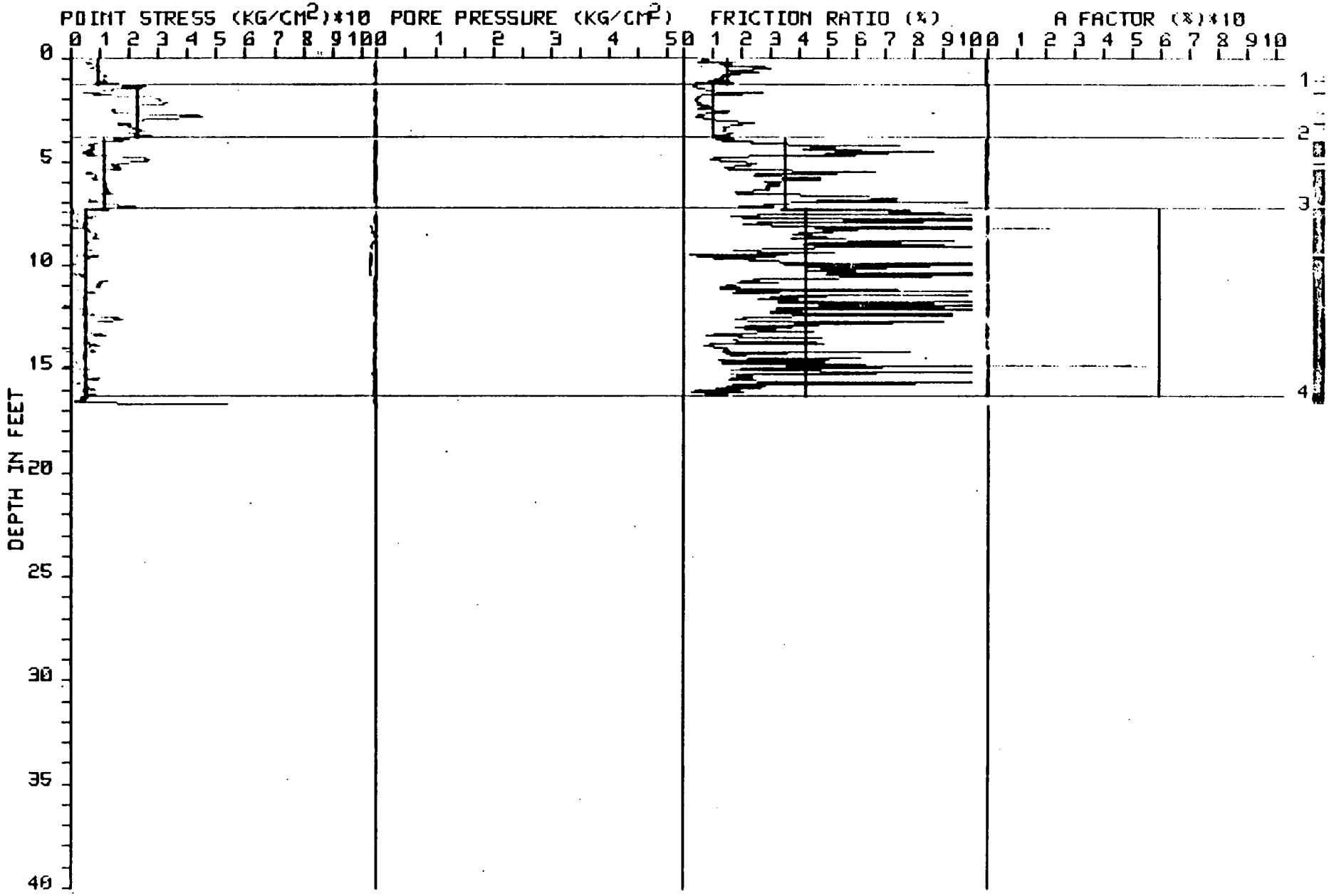
LOCATION ID: 007



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

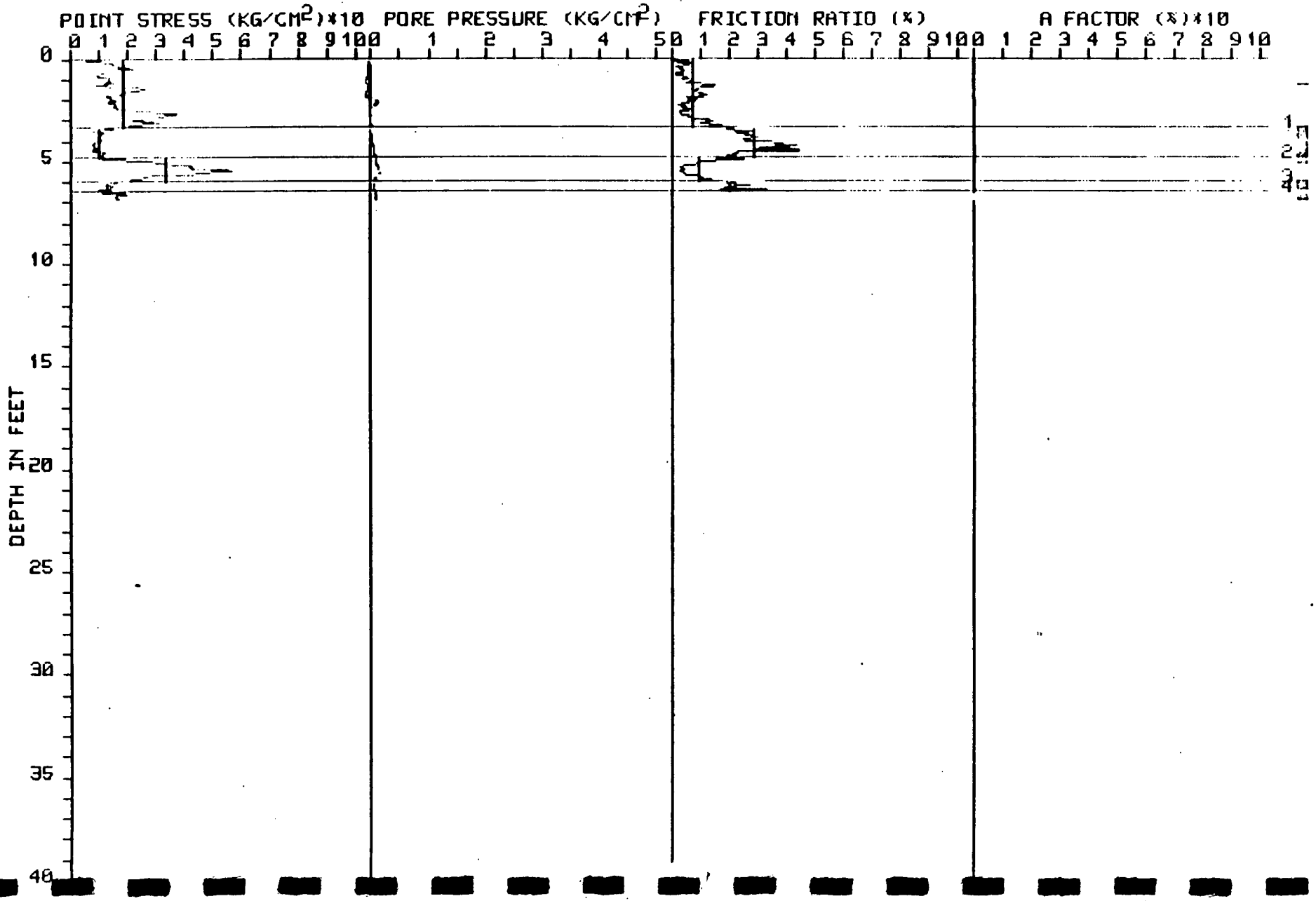
LOCATION ID: 008



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

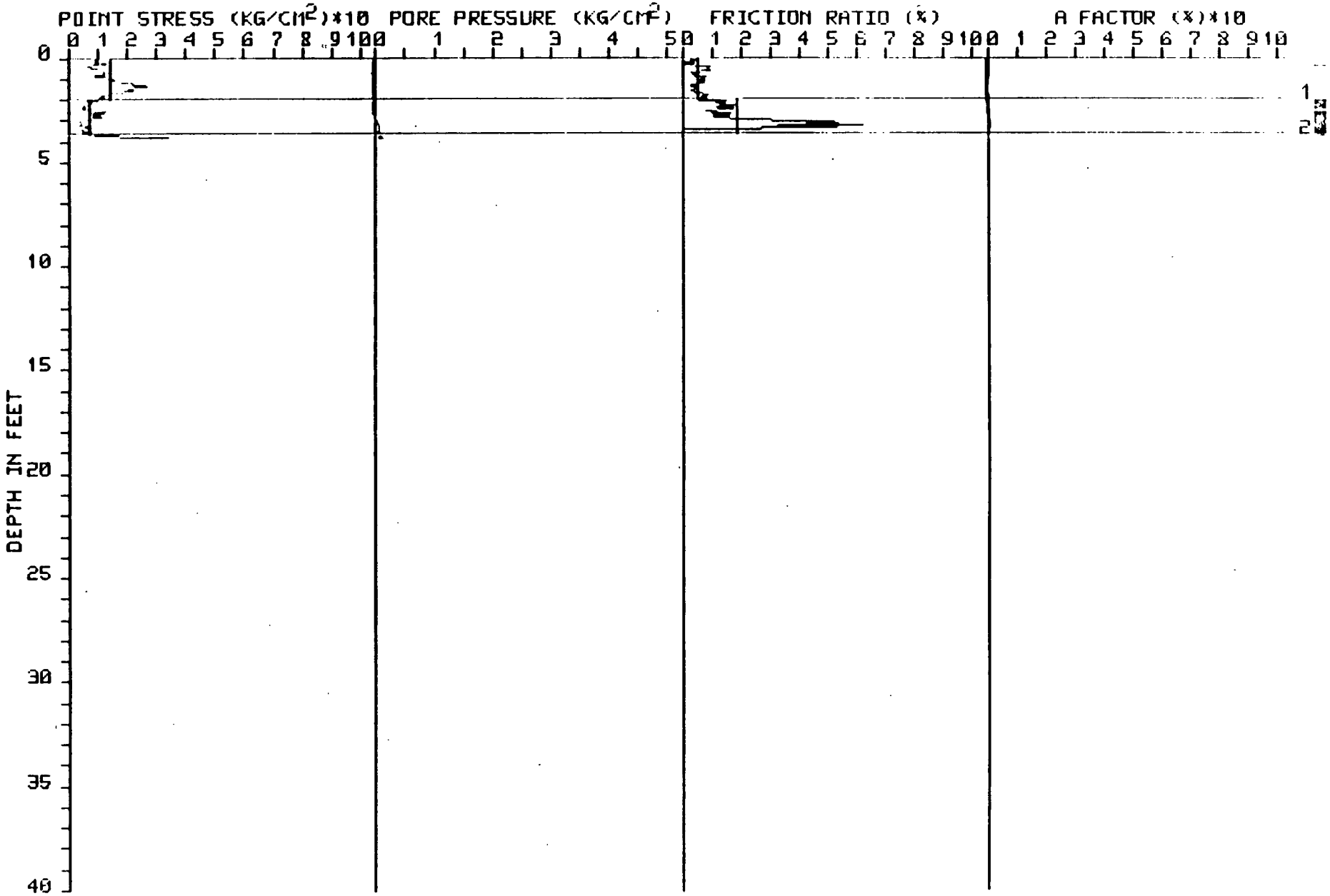
LOCATION ID: 009



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

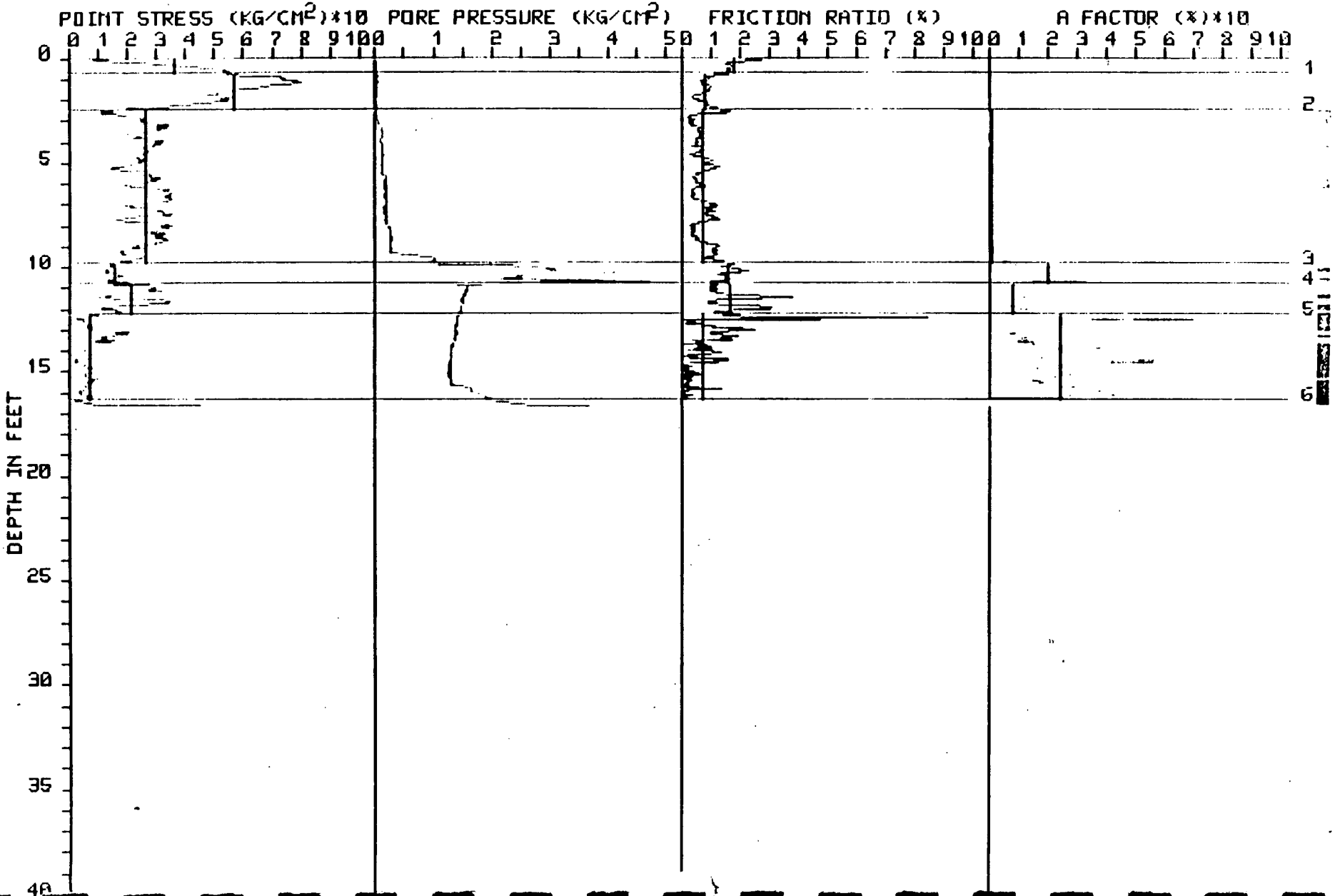
LOCATION ID: 010



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

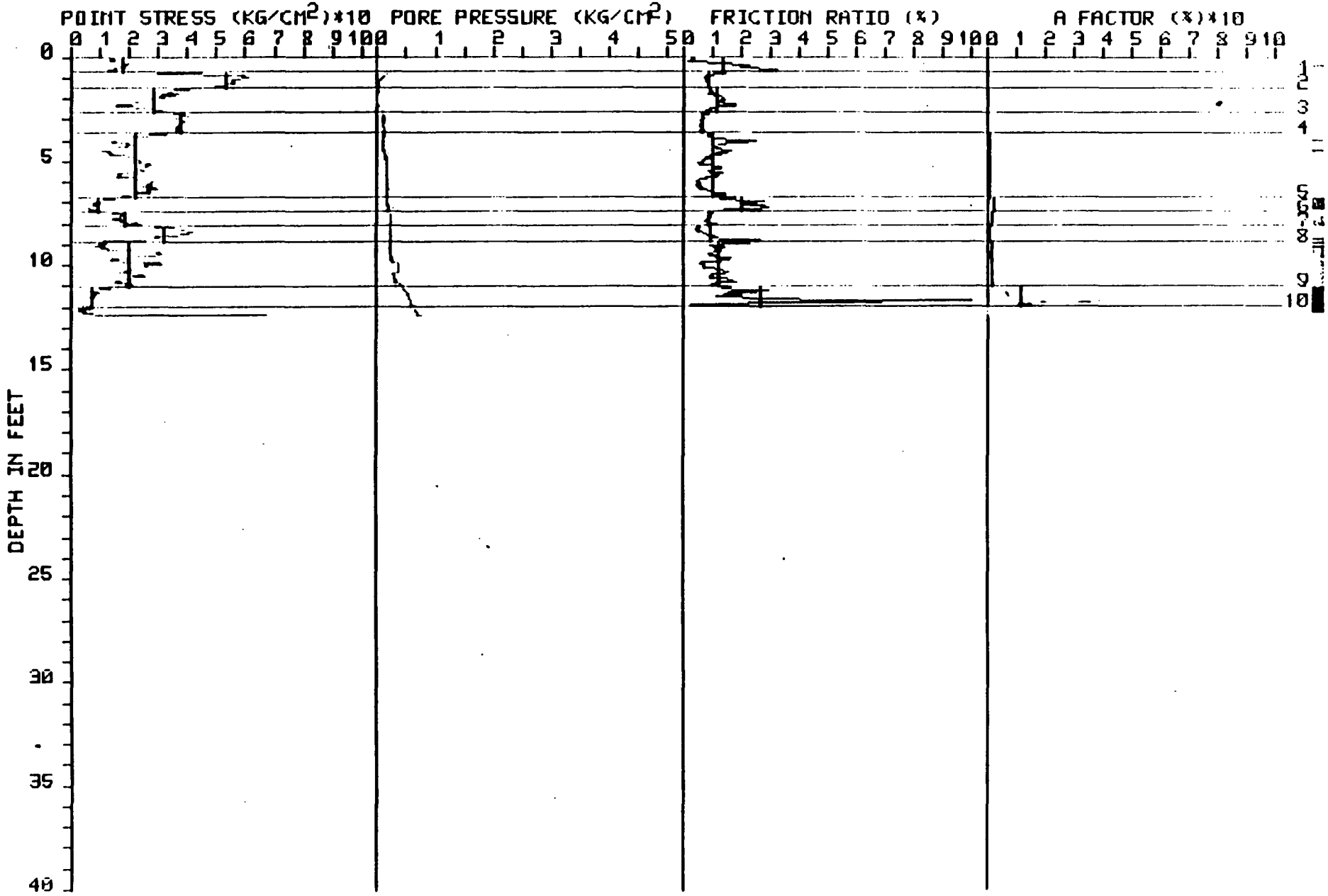
LOCATION ID: 011

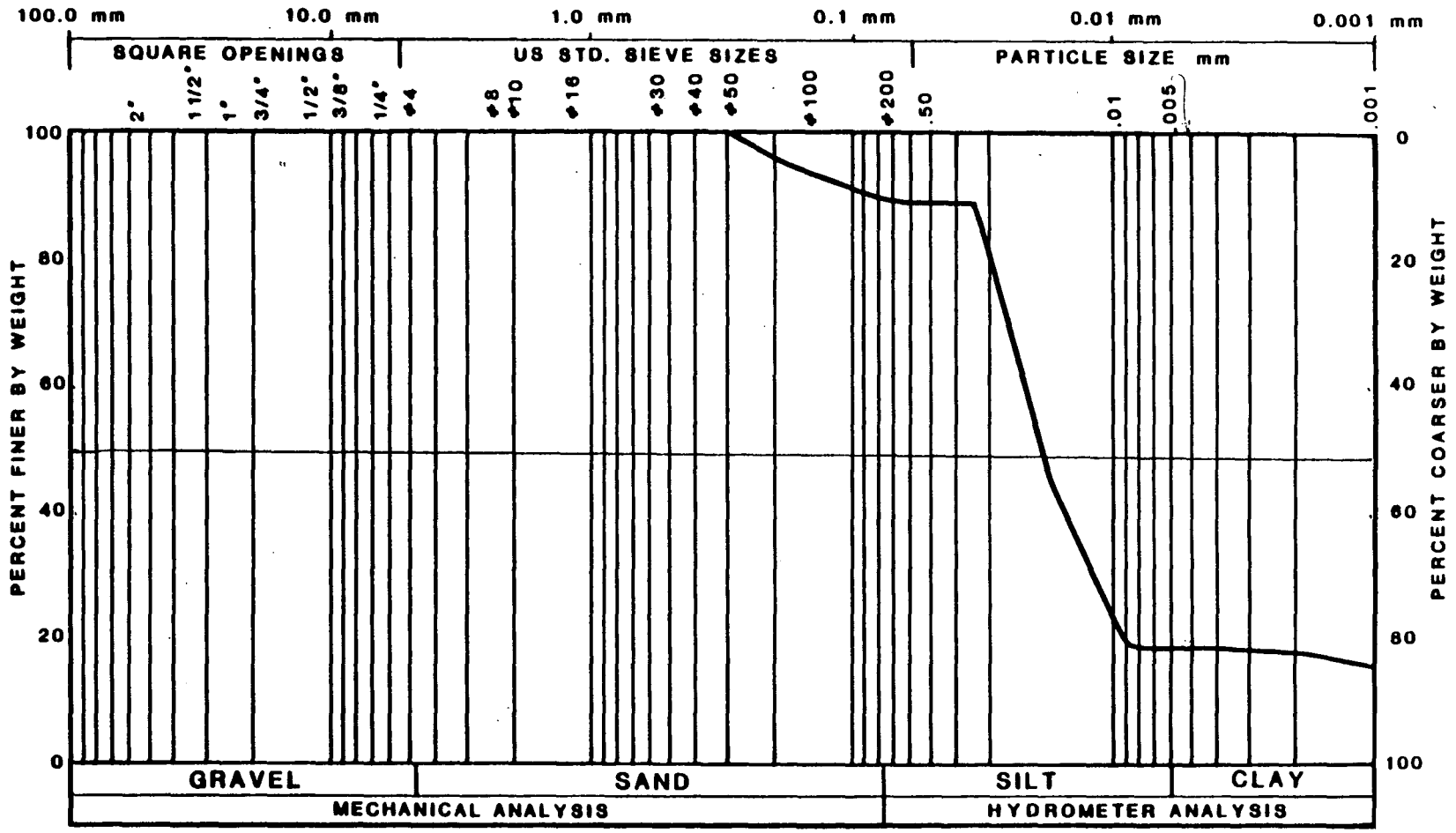


PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 012



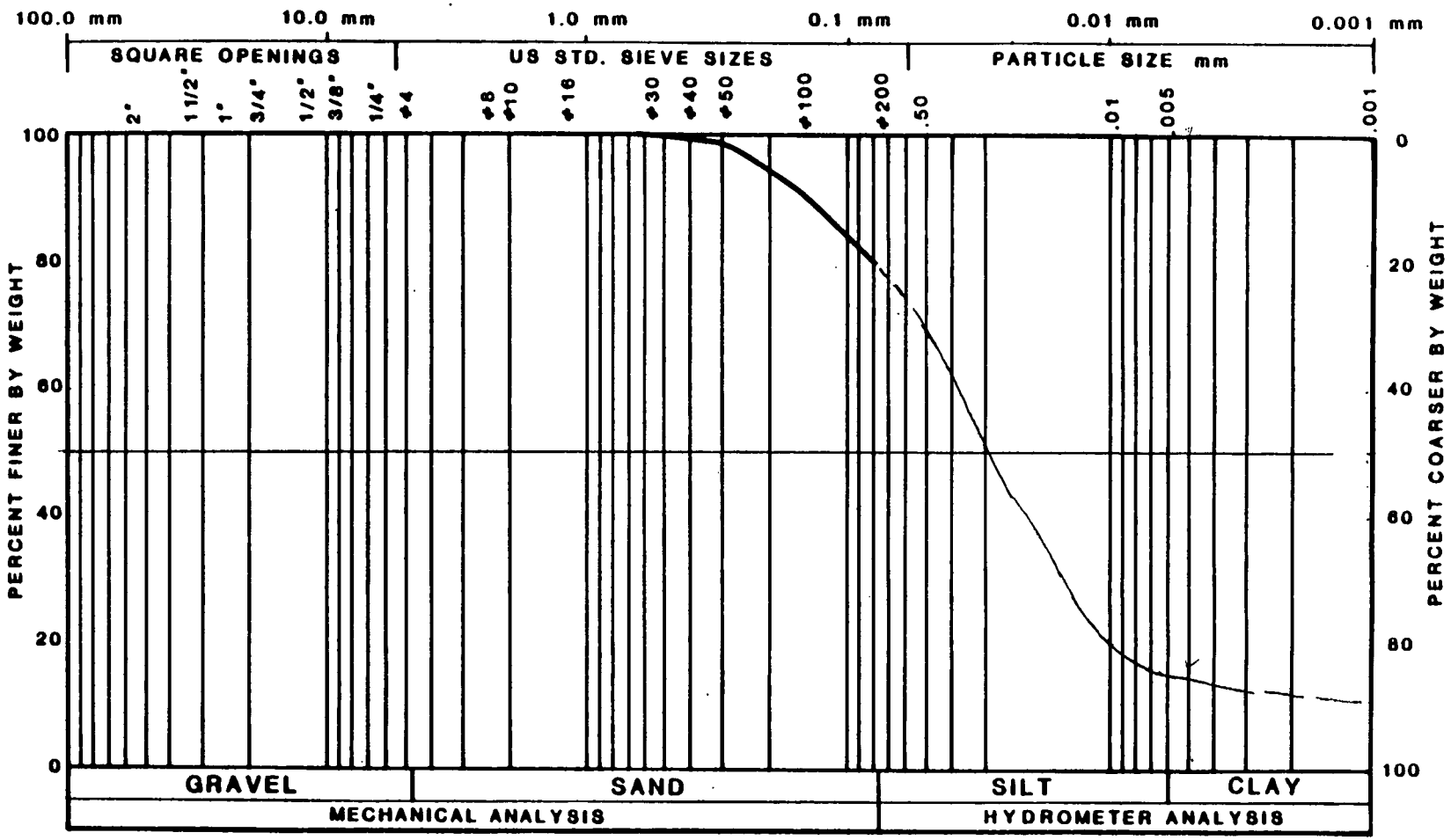


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	127	0.0-2.5	ML

0-1.2: slime
1.2-2.5 S-SL

HAT01-203 (UP)

FIGURE D5.5
PARTICLE SIZE DISTRIBUTION CURVE



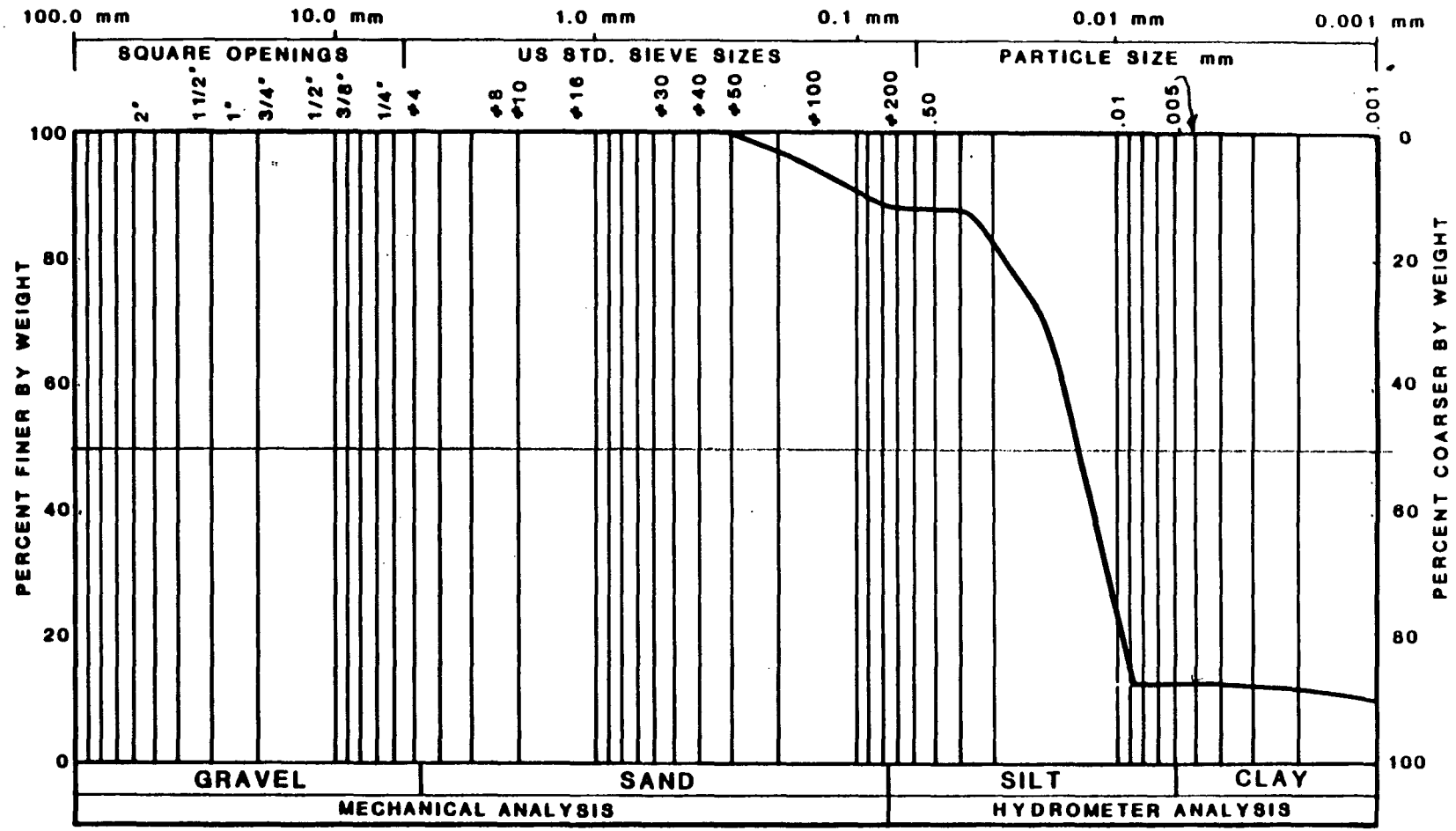
LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
127	14.5-16.0	CL

S lime!

HAT01- 203 (UP)

FIGURE D5.6

PARTICLE SIZE DISTRIBUTION CURVE

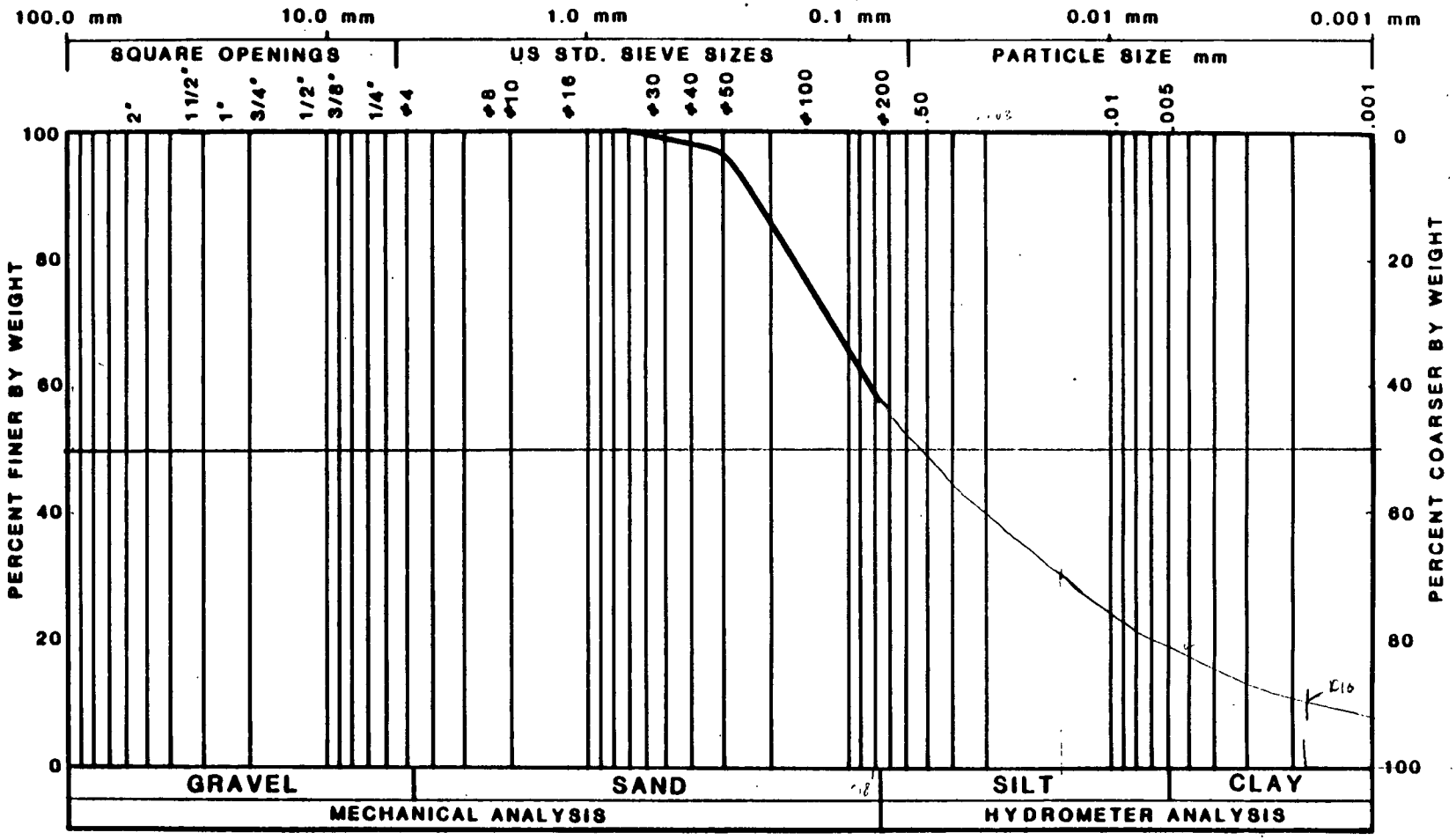


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
127	16.0-18.5	CL-ML

Slime / Trim S-SL

HAT 01-203 (UP)

FIGURE D5.7
PARTICLE SIZE DISTRIBUTION CURVE



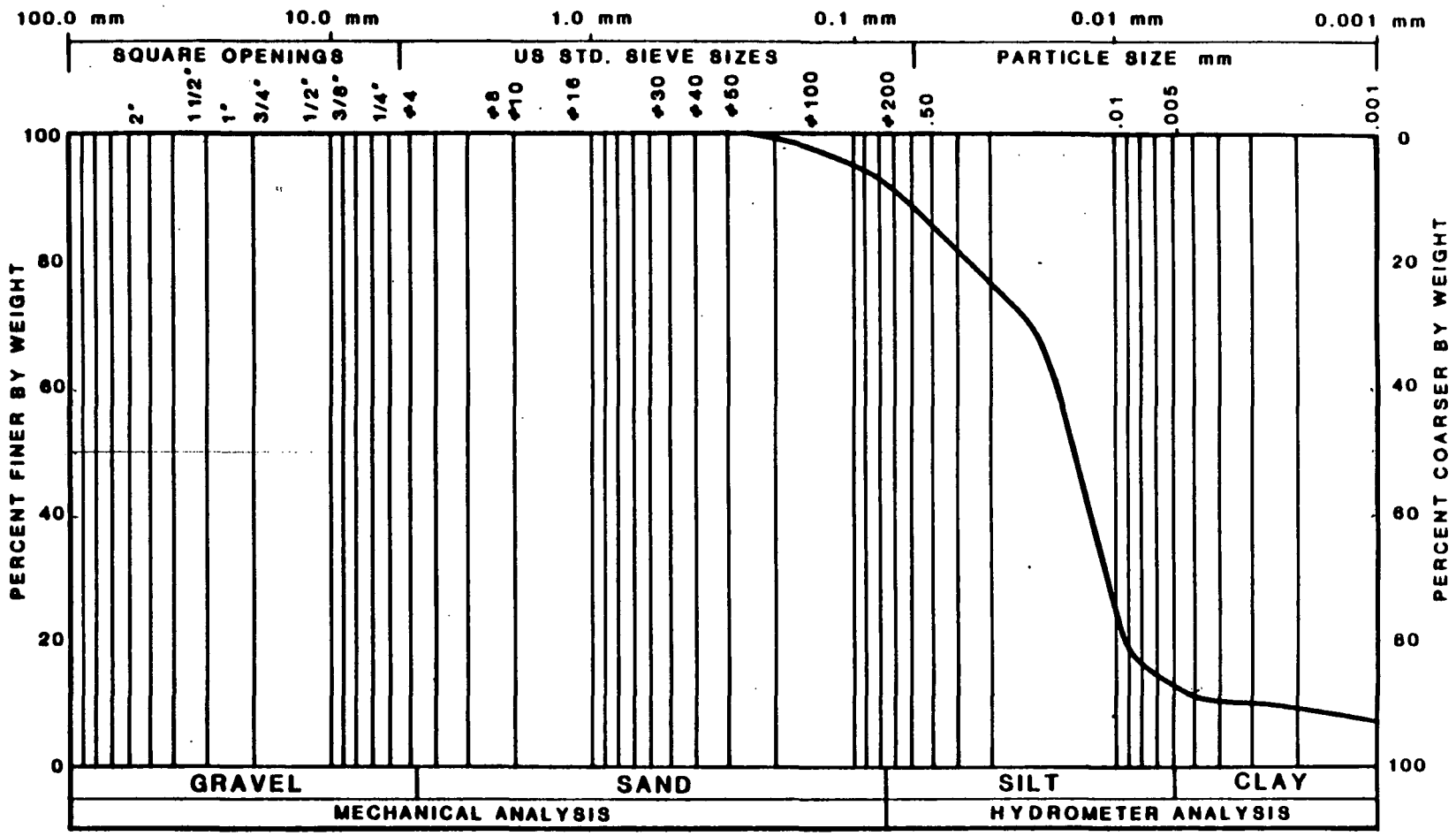
LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
127	19.0-20.5	ML

S-SL, Trace Sand

HAT01-203(UP)

FIGURE D5.8

PARTICLE SIZE DISTRIBUTION CURVE

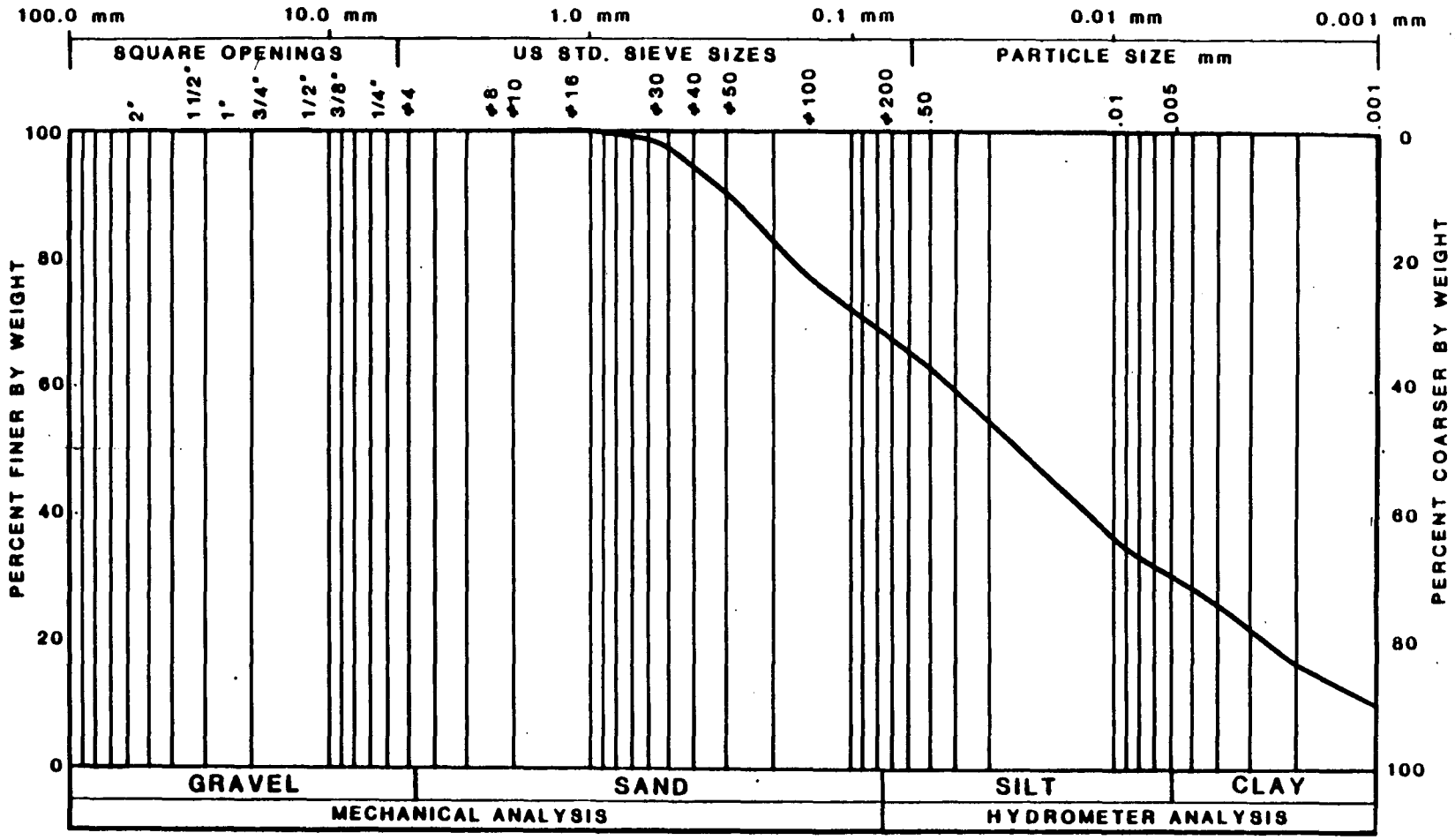


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	131	10.0-17.0	CL

HAT01 - 211 (UP)

10.0 - 12.2 : S-SL
12.2 - 17.0 : Silt

FIGURE D5.13
PARTICLE SIZE DISTRIBUTION CURVE

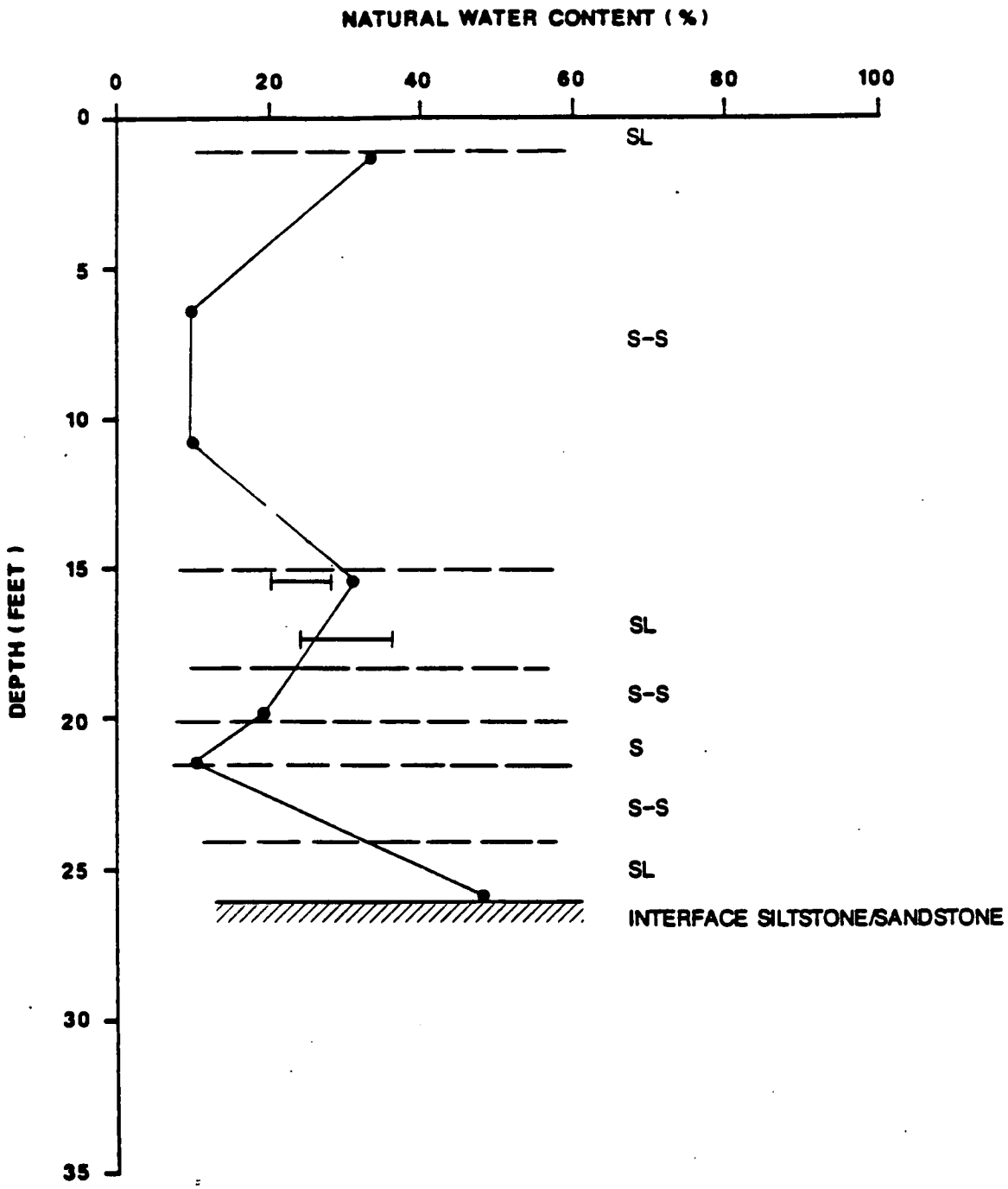


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
131	16.5-17.0	ML

HAT01-211(UP)

?

FIGURE D5.14
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND

● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.2
WATER CONTENT VS DEPTH
HAT01-127

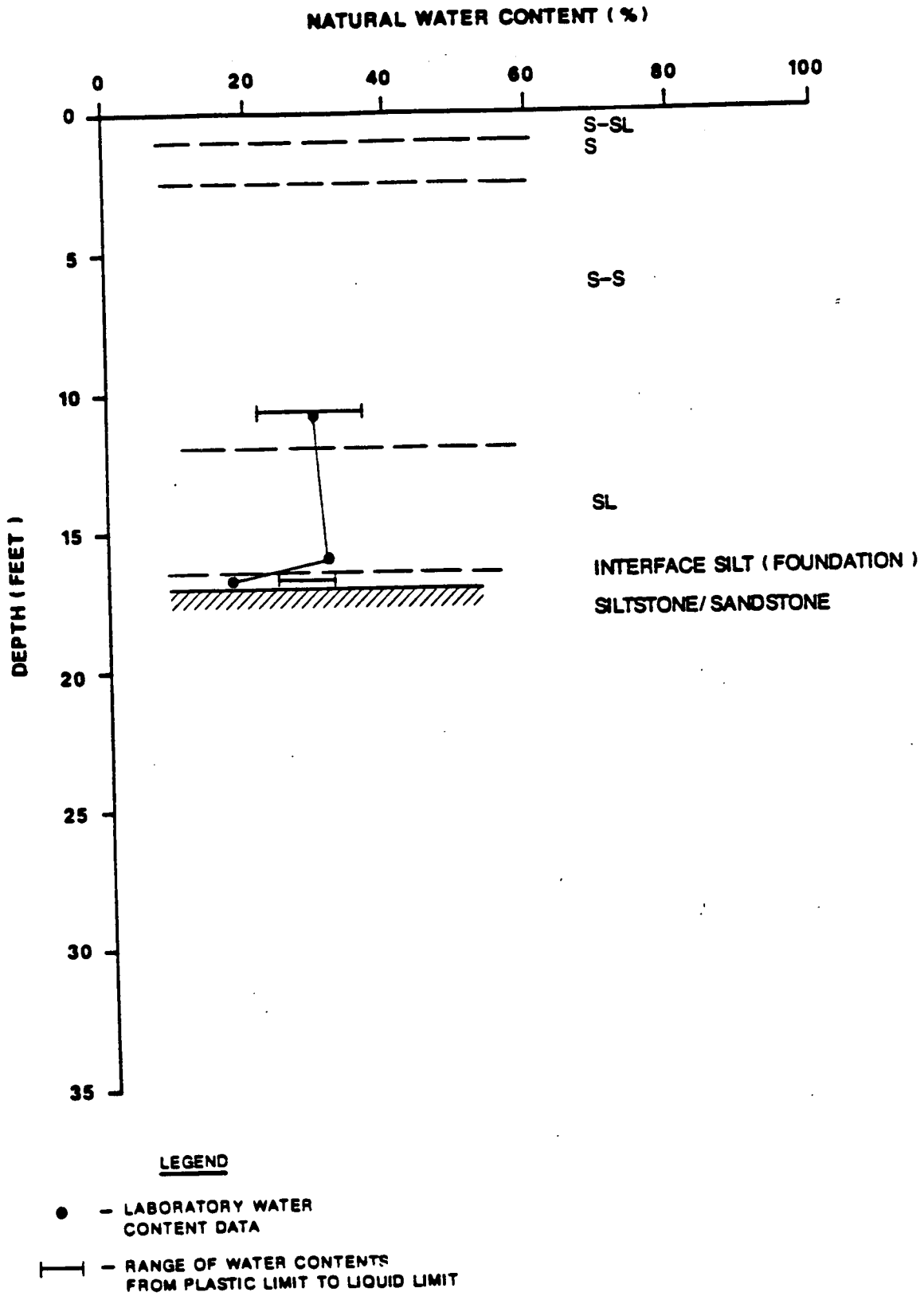


FIGURE D.5.5
WATER CONTENT VS DEPTH
HAT01-131

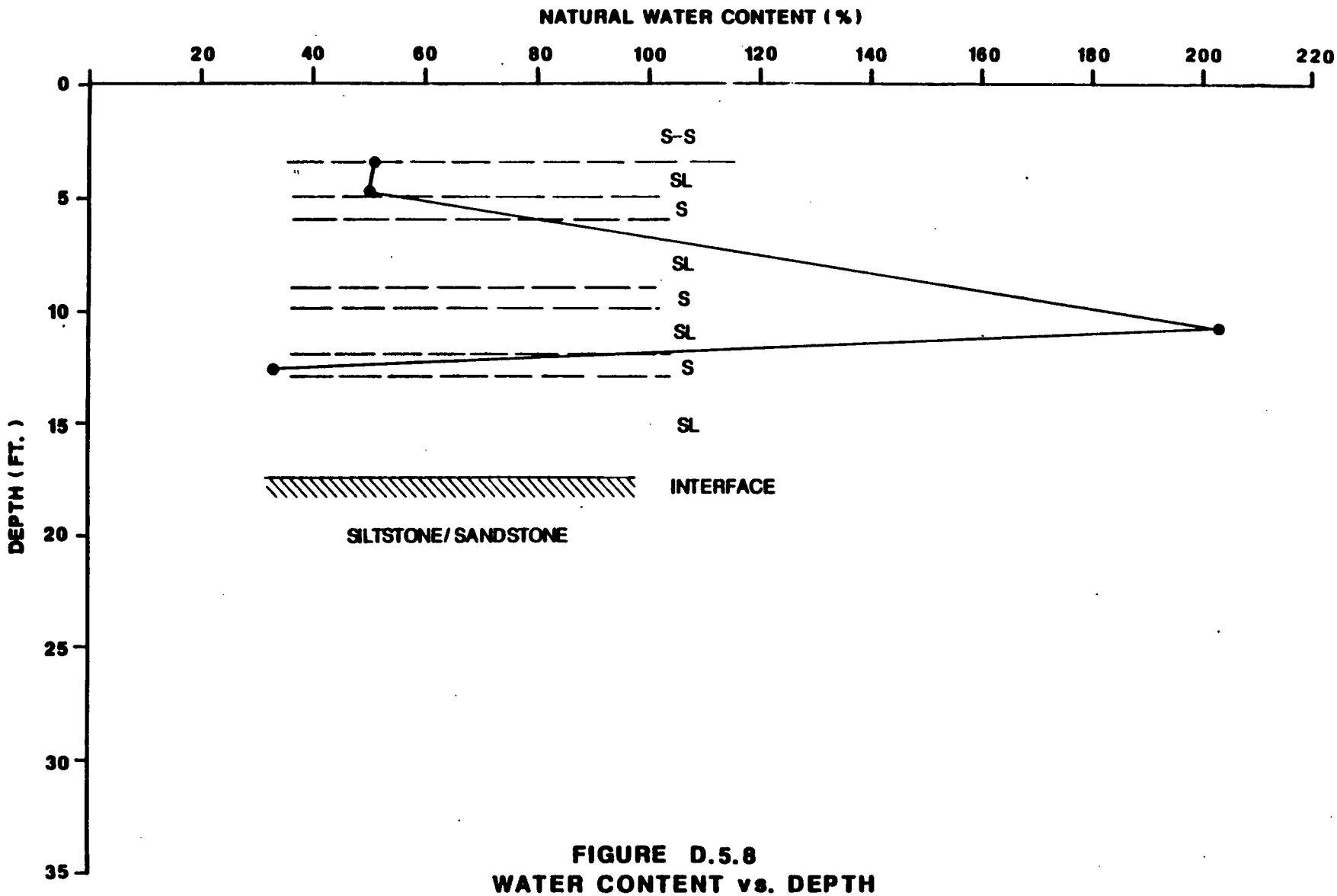


FIGURE D.5.8
WATER CONTENT vs. DEPTH
HAT01-130

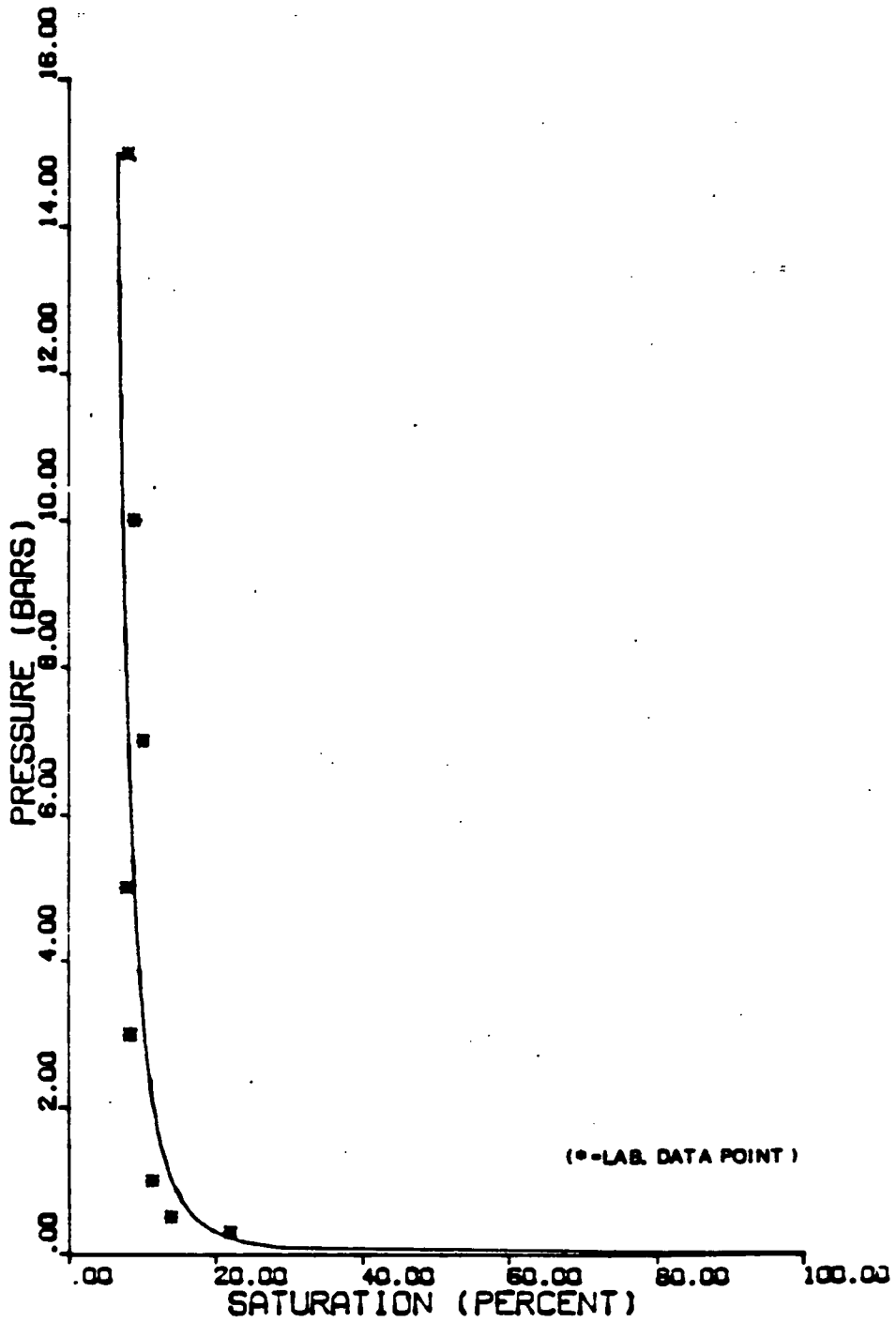


FIGURE D.5.17
CAPILLARY MOISTURE CURVE
HAT01-131 10 - 12.5 (SAMPLE 1)

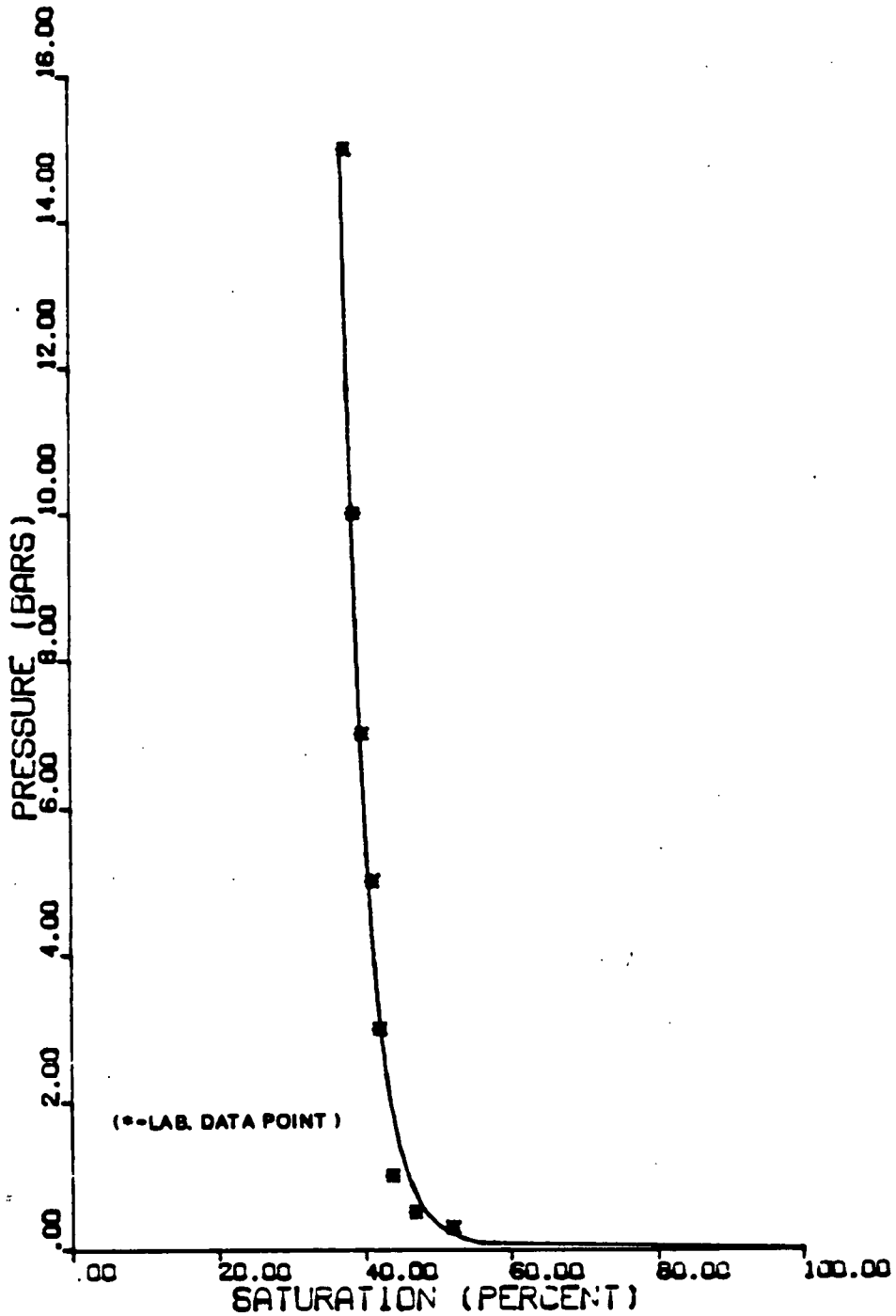
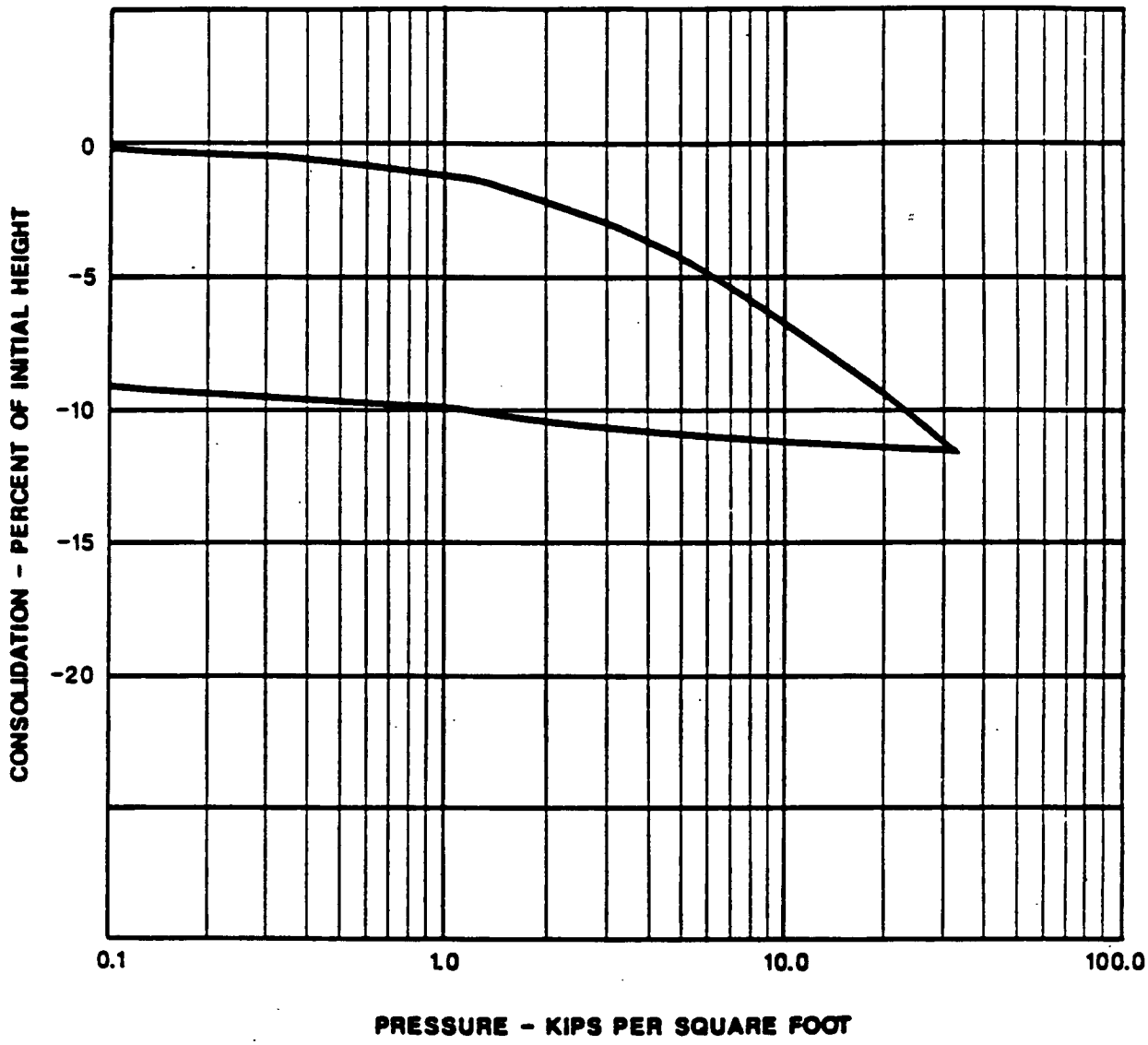


FIGURE D.5.18
CAPILLARY MOISTURE CURVE
HAT01-131 10 - 12.5 FT. (SAMPLE 2)



LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT01-131	10.0-12.5	84.0	92.5	29.2	26.4	CL

TESTED SUBMERGED

FIGURE D.5.25

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT01-131 10.0 - 12.5 FT.

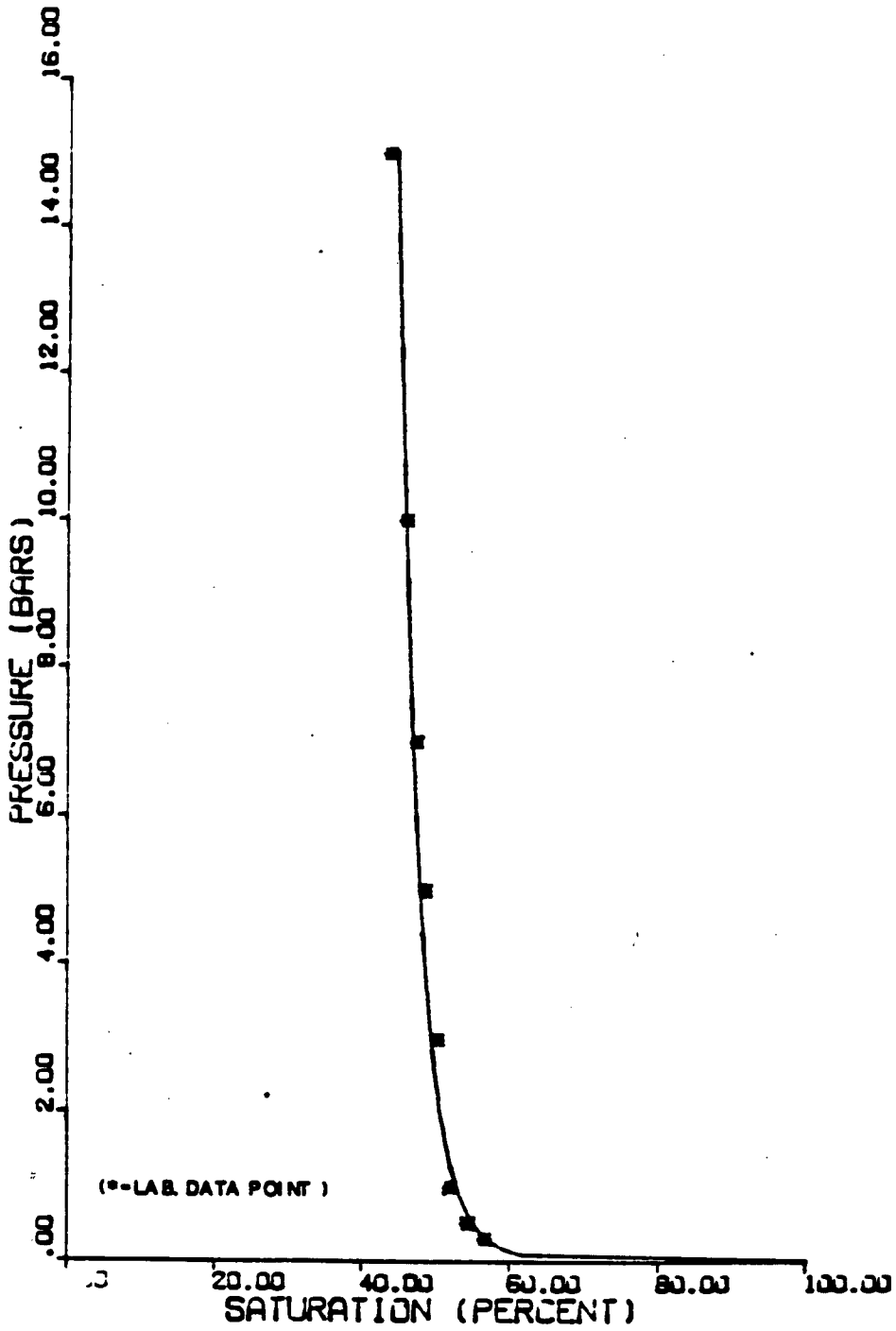
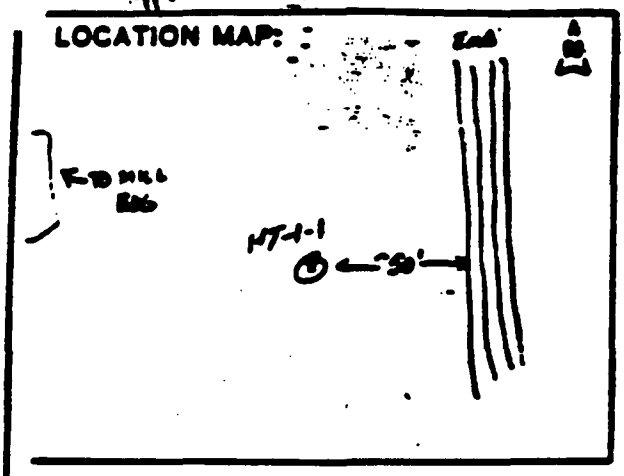


FIGURE D.5.41
CAPILLARY MOISTURE CURVE
HAT01-004 2.5-6 FT. (TEST PIT)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: HT-1-1
APPROX. SITE COORDINATES (ft.):
N 9110 E 9645
GROUND ELEVATION (ft. MSL): 4330
DRILLING METHOD: HSA CONTINUOUS
DRILLER: TEAM
DATE STARTED: 10-11-89
DATE COMPLETED: 10-11-89
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: WEST SIDE TOWARDS FAN
SITE CONDITION: SUNNY DAY - PROBABLY SURFACE

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
				S	1	1,1,1	2	SM	SAND F G WHITE D-L V. SILTY SLIGHTLY TRANSITION INTO CLAY
5				S	2	1,2,2	4	CH	CLAY V MOIST DARK BROWN SOFT LAYERED - WHITE & LT BROWN
				T	3	<2000			
5.5-6				S	4	2 SY	7	SP/CL	SAND F G SL CLAY GREY
7 7.5				S	5	3,2,4	6		OCAS. CLAY LAYERS GREY - DARK GREY
8.5 9				S	6	3,2,2	4		
10 10.5				S	7	3,2,4	6		OCAS CLAY OR V. SILTY LAYERS
11.5 12				S	8	3,3,4	7	CL	CLAY LAYERS SOFT
13 13.5				S	9	3,2,4	6		
15				T	10				
17.5				S	11	1,2,3	5		CLAY VAR FST GREY BROWN LAYER
19				S	12	3,4,5	9	SP	SAND SOME SILTY GRAVELLY
20.5				S	13	4,4,4	8		F G SILTY OCAS CLAY LAYER - GREY
22.5				T	14	<2000		CH	CLAY V MOIST GREY TO LIGHT BROWN
									See next pg.

COMMENTS: @ 8' @ 18' SUCC BY END OF PIPE @ (3-6) ENTER BUCH DEPTH B/C SLOUGH

SAMPLE TYPE
A = Auger cuttings
S = 2" O.D. 1.38" I.D. split spoon
S = 3" O.D. 2.42" I.D. split spoon
T = 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: HT-1-A
APPROX. SITE COORDINATES (ft.):
N 910 E [illegible]
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA CONTINUOUS
DRILLER: TCATT
DATE STARTED: 10-11-84
DATE COMPLETED:
FIELD REP.: [illegible]

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE METHOD	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
				S	[illegible]	1,3,4	7	CL-AL	CLAY-SANDY SILTY GREEN DIST [illegible] CL-AL
15				S	[illegible]	2,2,4	6	CL	SOME SANDY LAYERS
20									CLAY V MOIST SOFT
24.5				S	[illegible]	3,5,7	12	SP SA	SAND FG SILTY GREY MOIST MD
31				S	[illegible]	7,5,5	10		
				S	[illegible]	3,4,4	8	CL	CLAY MOIST SLSANDY MPlGRY SOFT
32.5		NO RECOVERY			[illegible]				
34	34.5							SP	TRANSITION INTO BEDRAIN SCH.PS BEDRAIN ON SANDSTONE @ 34' = TD
									TD = 34'
									SAMPLE C.E. PAGE @ 34 ON LOCK-BOXING SAMPLE A/E

COMMENTS:

SAMPLE TYPE
S = [illegible]
S = 2" O.D. 1.38" I.D. [illegible]
S = 3" O.D. 2.42" I.D. [illegible]
T = 3" O.D. [illegible]

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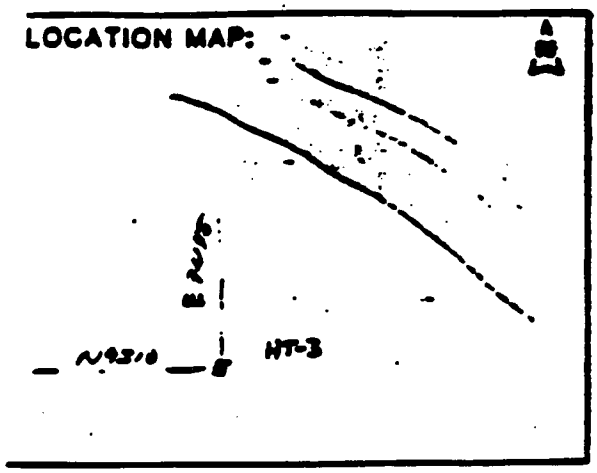
BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: HT-1-3
APPROX. SITE COORDINATES (ft.):
N 9210 E [illegible]
GROUND ELEVATION (ft. MSL): 4330
DRILLING METHOD: HSA - CONTINUOUS
DRILLER: TCATT
DATE STARTED: 10-11-90
DATE COMPLETED:
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION: NORTH PART OF UNKER PIT
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
	X	X	X	T	1	EASY		CL	CLAY - MPI LGHT TO WHITE SOFT
3.5	X	X	X	S	2	2,2,3	5	SM-SP	SAND F.G. SILTY-LOOSE, SLIGHTLY BROWN GREY
4	X	X	X	S	3	3,2,3	5		1/4" LAYERS OF GREY & BROWN CL CLAY WITH 1/16" LAYERS OF FINE SAND-SP
5.5	X	X	X	S	4	3,3,3	6		
7	X	X	X	S	5	3,2,3	5		
8.5	X	X	X	S	6	3,3,3	6	SP	SAND. F.G. GREY SLIGHTLY
10	X	X	X	S	7	3,3,4	7	HLD	CLAY LAYERS
11.5	X	X	X	S	8	3,3,2	5		
13	X	X	X	S	9	2,2,3	5		
14.5	X	X	X	S	10	3,2,2	4		
16	X	X	X	T	11	EASY PUSH		SP	SAND @ 18.5
18.5	X	X	X	S	12	3,3,4	7		
20.5	X	X	X	S	13	6,5,2	7		CLAYEY - SOFT WET TO MOIST BROWN
22	X	X	X	S	14	3,4,4	8		GROUND CLAY LAYER @ 24'
23.5	X	X	X	S	15	3,3,2	6		
25	X	X	X	S	16	3,3,9	11		26.5 SAND OVER SANDY CLAY
27.5								SS	SAMPLING @ 27 = TD

COMMENTS: CAVED 15'

SAMPLE TYPE
S - [illegible]
S - 3" O.D. 1.50" I.D. [illegible]
S - 3" O.D. 2.47" I.D. [illegible]
T - 3" O.D. [illegible]

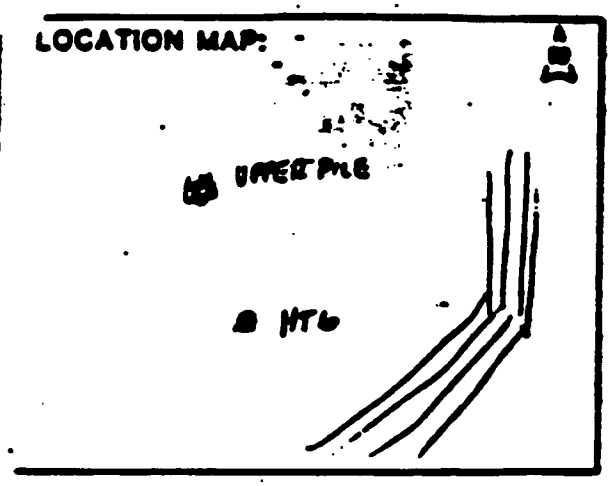
JEG-AL-ENG-23 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT6
APPROX. SITE COORDINATES (ft.):
N 8710 E 7445
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TEAFTLINE SS
DATE STARTED: 10-11-92
DATE COMPLETED: 10-11-92
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: SOUTH SIDE UPPER PILE
SITE CONDITION: WINDY SUNNY

DEPTH	SAMPLE REQUIRED	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0				S	1	1,4,1	2	SM	SAND F.to [illegible] COARSE WHITE
1.5				S	2	1,2,1	3		[illegible] SILTY LAYERS
3				U	3	6/12	6		BROWN YELLOW WHITE YELLOW CLAY
4				S	4	4/10" 2 2	4	SP-SM	90% FOREIGN SAND CLAY SILTY SAND
				S	5	2 2 3	5		
7.5				S	7	1 2 2	4		
9				S	8	1,1,2	3		
10.5				S	9	2,2,3	5		SILTY CLAY LAYER @ 11
12				S	10	3,3,3	6		YELLOW BROWN SAND & CLAY SEAMS
13.5				S	11	2,1 1/12"	3		CLAY SOFT MOIST @ 14 LAYERED
15		NR		U	12	4/12" NR	10	CH	COLORS GREY - BROWN CLAY THIN SAND LAYERS MOIST - SOFT
16.5				S	13	1,1,1	2		
18				S	14	1,1,1	2		
19.5				S	15	? 1,1,50/3	~	SS	MILES AND SANDSTONE RED BROWN SAND F.G. GRAVELLY TO BROKEN SANDSTONE SEAMS IN - JOINTED & [illegible] SS ROCK
20									TD=20'

COMMENTS:

SAMPLE TYPE
A = Auger cuttings
B = 3" O.D. 1.25" I.D. thin wall sampler
C = 3" O.D. 2.42" I.D. thick wall sampler
T = 3" O.D. [illegible] shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

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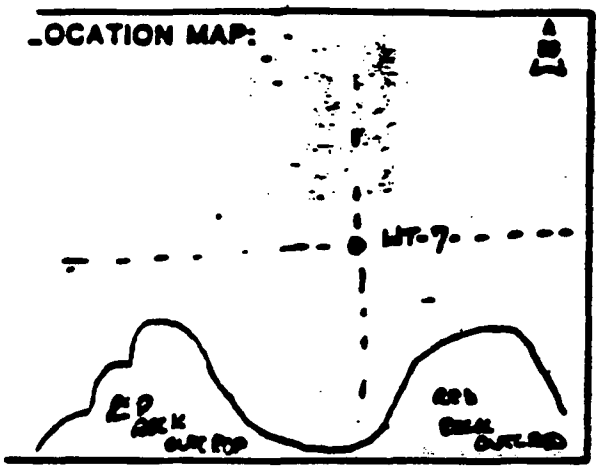
LOCATION MAP:



SITE ID: HAT (2) LOCATION ID: HT-7
APPROX. SITE COORDINATES (ft.):
N 8510 E 9215
GROUND ELEVATION (ft. MSL): 4583.2
DRILLING METHOD: HSA - CONTINUOUS SPT-SSR
DRILLER: T CART
DATE STARTED: 10-11-94
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: SOUTH SIDE UPPER MC
SITE CONDITION: [illegible]

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE REMARKS	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X		S	1	1,2,1	3	SM	SAND F. & SILTY BROWN TO BR - DRY WHITE
1.5	X	X		S	2	1,1,1	2		
	X	X		U	RING 3	12/12	17	SM	SAND F & SILTY WHITE DAY MD
4	X	X		S	4	1,2,1	3	CL	CLAY - SL SANDY - SLIMEY
5.5	X	X		S	5	2/18"	1	ML	ORN BROWN - SILTY
7.0	X	X		S	6	1,1,1	2		SL CREAM SHEEPFAT
8.5	X			U	RING 7	2/18"	1	SM-CL	SANDY CLAY WITH LENTS OF SILT & CLAYEY GREY SLIMEY BROWN SANDS "FRUTICE"
9.5	X	X		S	8	2,1,1	2		SLIMEY CONT SOFT WET BROWN - ½ GRAVEL
11	X	X		S	9	1,1,1	2	ML	GRY TRANSITIONAL ½" BROWN - GRAY BROWN SLIMEY CLAY WET SOFT "FRUTICE"
12.5	X	X		S					
14	X	X		S	10	11,13,17	30		WET - SOFT SANDSTONE 12.8
				S	11		80	SS	SANDSTONE BROWN SANDS
									TD = 14'
									SPONGY PILE OF MESSY STUFF LEFT AFTER FALLING IN HOLE CAVED @ 12.5'

COMMENTS:

SAMPLE TYPE
A = Auger cuttings
B = 2" O.D. 1.38" I.D. drive sampler
C = 3" O.D. 2.42" I.D. tube sampler
T = 3" O.D. thin-walled shelby tube

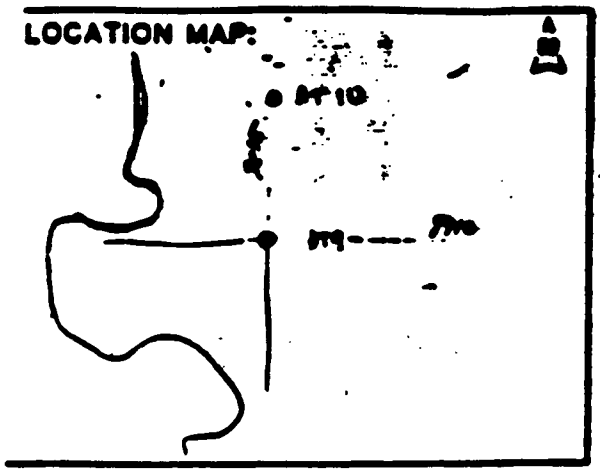
JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page ___ of ___

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT9
APPROX. SITE COORDINATES (ft.):
N 8910 E 9245
GROUND ELEVATION (ft. MSL): 4530
DRILLING METHOD: USA-CONTINUOUS
DRILLER: TLAFF
DATE STARTED: 10-11-84
DATE COMPLETED: "
FIELD REP.: SWM

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: UPPER PILE WESTSIDE
SITE CONDITION: DRY WINDY - DUSTY

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE STORAGE	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									U MILL TAILINGS
0				S	1	1,1,1	2	SM	SAND FG SILTY LIGHT WHITE DRY LOOSE
1.5									
3				S	2	2,2,1	3	SM-SC	SAND TRANSITION
4				U	3	17/12	17	CL-SC	SAND SLIMY-CLAYEY ORANGE-BROWN @ 3.5 FG SOFT M PL
				S	4	3,4,6	10		
5.3				U	5	9,3,2	5		LAYERED SILTY ORANGE BROWN 2½" SILTY CLAY SLIMES MOIST SOFT
7				U	6	2,2,3	5		
8.5				S		1,1,1	2	SP	OPEN SAND LAYER 1"
10				S	7	1,1,1	2	CL-CH	AS ABOVE CLAY M PL SLIMEY BROWN
11.5				S	8	1,1,2	3	SP	SAND LAYER - LOOSE
12.5				S	9	0,1,2	3	CL-CH	CLAY A.B. LAYERED BROWN-OR BR SL SANDY LAYERS
13.5				S	10	1,2,2	4		
15.5				S	11	1,1,2	4	SC	18' SANDSTONE RED B-BR. SL CLAYEY
17.5				S	12				18' SANDY FG. PEA GRAVEL CHIPS

TOP LAYER OF SANDSTONE IS WEATHERED LAYERED - SANDY GRAVELLY MAY HAVE BEEN PUSHED BY CAT PRIOR TO REMOVAL

COMMENTS: LAST 2 SAMPLES DRIVEN 2' W/ SINKING. 1ST SOFT SLIMES. NO OF SAMPLER OR 1 HIT & SAMPLER WOULD SINK

SAMPLE TYPE
A = Auger cuttings
B = 2" O.D. 1.50" I.D. drive sampler
C = 3" O.D. 2.42" I.D. thin wall
T = 3" O.D. thin-walled Shelby tube

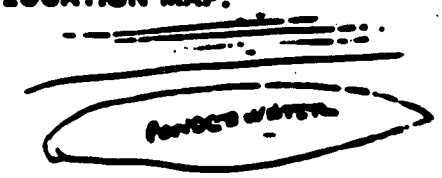
JEG-AL-ENG-28 (3/84)

0-5 SPT

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HATOI LOCATION ID: HT-11
APPROX. SITE COORDINATES (ft.):
N 9570 E 9845
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: [illegible]
DATE STARTED: 11-12-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: N SIDE UPGRADIENT AT SERVICE PARK
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									FILL TAILINGS
0				S	1	1,6,8	14	SM-SC	LOOSE SILTY BROWN WHITE LPM - TRACE YELLOW - SOFT DRY
1.5									
3				S	2	7,7,7	14	..	SAND & SILTS LAYERS 60% LPM GREY TRACE GRAVEL MEDIUM MOIST
4.5				S	3	3,3,5,6	11		
5									SANDS & SILT LAYERS
				T	4	HARD			
				S	5				
10				T				CL	
				T	6			CL	CLAY FIRM SOFT MOIST - BROWN TO GREY
12.5				T	7	222	4		
				T	8	322	4	SC	LAYER SAND - SILTY & MOIST GREY SOFT
15				T	9	3.2.2	4	CL	CLAY - V. MOIST SOFT GREY
16.5					10	2,27,50/6			
19					11	15-19.5		SS	SANDSTONE PIECES @ 16.5 MOIST ANALYSIS WB LAYER LAYER 17-19.5
									TD=17'

COMMENTS:

SAMPLE TYPE
A = Auger cuttings
S = 2" O.D. 1.38" I.D. split spoon
U = 3" O.D. 2.87" I.D. tube sampler
T = 3" O.D. thin-walled shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: TP-4
APPROX. SITE COORDINATES (ft)
N 9112.0 E 9445.0
GROUND ELEV. (FT. MSL)
DATE EXCAVATED: 10-25-84
BACKHOE TYPE: CASE 580
CONTRACTOR: BLAKE ENTERPRISES
FIELD REP: P.S. OAGA
REHAB. DATE: Not applicable

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)
		None	

LOCATION DESCRIPTION Upper Tailings Pile
SITE CONDITION

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
2.5		D*		ML	Silt with thin sand stringer, non-plastic, fine sand, white.
6.0		D	001	ML	Silt, non plastic (?), wet to very wet (?), yellowish brown with lenses of dark brown.
7.5		D	002	CL-SP	Silty Clay with thin sand stringers, low plastic (?), fine sand, wet, gray.

D* - small bag sample taken for miscellaneous testing.

COMMENTS: Collected 4-5gal. soil sample. 2-5gal samples shipped to Chem & Assoc and 2-5gal samples shipped to Vera Rogers. Stopped backhoe at 7.5 ft.

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: TP 5
APPROX. SITE COORDINATES (ft)
N 9310 E 9445
GROUND ELEV. (FT. MSL)
DATE EXCAVATED: 10-23-84
BACKHOLE TYPE: CASE 580
CONTRACTOR: BLAKE ENTERPRISES
FIELD REP: P.S. DARR
REHAB. DATE: Not Applicable

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)
		None	

LOCATION DESCRIPTION Upper Tailings Pile
SITE CONDITION

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
				ML	Silt, non-plastic, dry, white
3.0 4.5		X	001	SP	Sand, fine, moist, gray.

COMMENTS: Stopped backhoe at 4.5 ft. Collected 2-1.5 gal soil samples, 1-1.5 gal to Chem & Assoc & 1-5 gal to Vera Riggins

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

GJ-27

RADIOLOGIC CHARACTERIZATION OF THE MEXICAN HAT, UTAH, URANIUM MILL TAILINGS REMEDIAL ACTION SITE

John R. Ludlam

Bendix Field Engineering Corporation
Grand Junction Operations

January 1985

Prepared for
U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
Albuquerque Operations Office

Under Contract No. DE-AC07-76GJ01664
U.S. Department of Energy
Grand Junction Projects Office
Grand Junction, Colorado

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PLATES
(in pocket, back inside cover)

Plate 1. Base Map for the Mexican Hat, Utah, Site

1.0 INTRODUCTION

This radiologic characterization of the inactive uranium millsite at Mexican Hat, Utah, was conducted by Bendix Field Engineering Corporation (Bendix) for the U.S. Department of Energy (DOE), Grand Junction Projects Office, in response to and in accord with a Statement of Work prepared by the DOE Uranium Mill Tailings Remedial Action Project (UMTRAP) Technical Assistance Contractor, Jacobs Engineering Group, Inc. (JEG). The objective of this project was to determine the horizontal and vertical extent of contamination that exceeds the U.S. Environmental Protection Agency (EPA) standards at the Mexican Hat site. The data presented in this report are required for characterization of the areas adjacent to the Mexican Hat tailings piles and for the subsequent design of cleanup activities. Some on-pile sampling was required to determine the depth of the 15-pCi/g Ra-226 interface in an area where wind and water erosion has taken place.

An orientation visit to the site was conducted on 4-8 June 1984, in conjunction with Jacobs Engineering Group, to determine the approximate extent of contamination that exceeds EPA standards surrounding the piles, to establish survey control points and baselines for later establishment of grid lines, to assess drilling requirements, and to gather background radiologic and geochemical data to be used to determine exposure rates, disequilibrium between radium and its radon daughters, moisture content in soils, and concentrations of radium, thorium, and potassium in soils. The information gained from this visit was used in determining the scope of work required for the radiologic site characterization.

Fieldwork at Mexican Hat was conducted on 10-24 September 1984. Radiometric measurements, soil samples, and building surveys were completed on 20 September and drilling was completed on 24 September 1984.

2.0 BACKGROUND

2.1 LOCATION

The inactive uranium millsite is located on the Navajo Nation (Indian Reservation) approximately 1.5 miles southwest of the town of Mexican Hat, Utah (see Figure 1). The mill housing area, now the community of Halchita, is located 0.5 mile southwest of the millsite. The millsite is within Section 13, Township 42 South, Range 18 East, Salt Lake Base and Meridian, San Juan County, Utah.

2.2 GEOLOGIC AND HYDROLOGIC SETTING

The Mexican Hat site is located within the southern Monument Upwarp region of the Colorado Plateau. This portion of the north-south elongated uplift contains several small plunging anticlines. The millsite is in the Mexican Hat syncline which is a sharp downfold between the Raplee Anticline to the east and the Cedar Mesa-Halgaito Anticlines to the west. The site is on the gently east-dipping (3 to 6 degrees) west limb of the syncline.

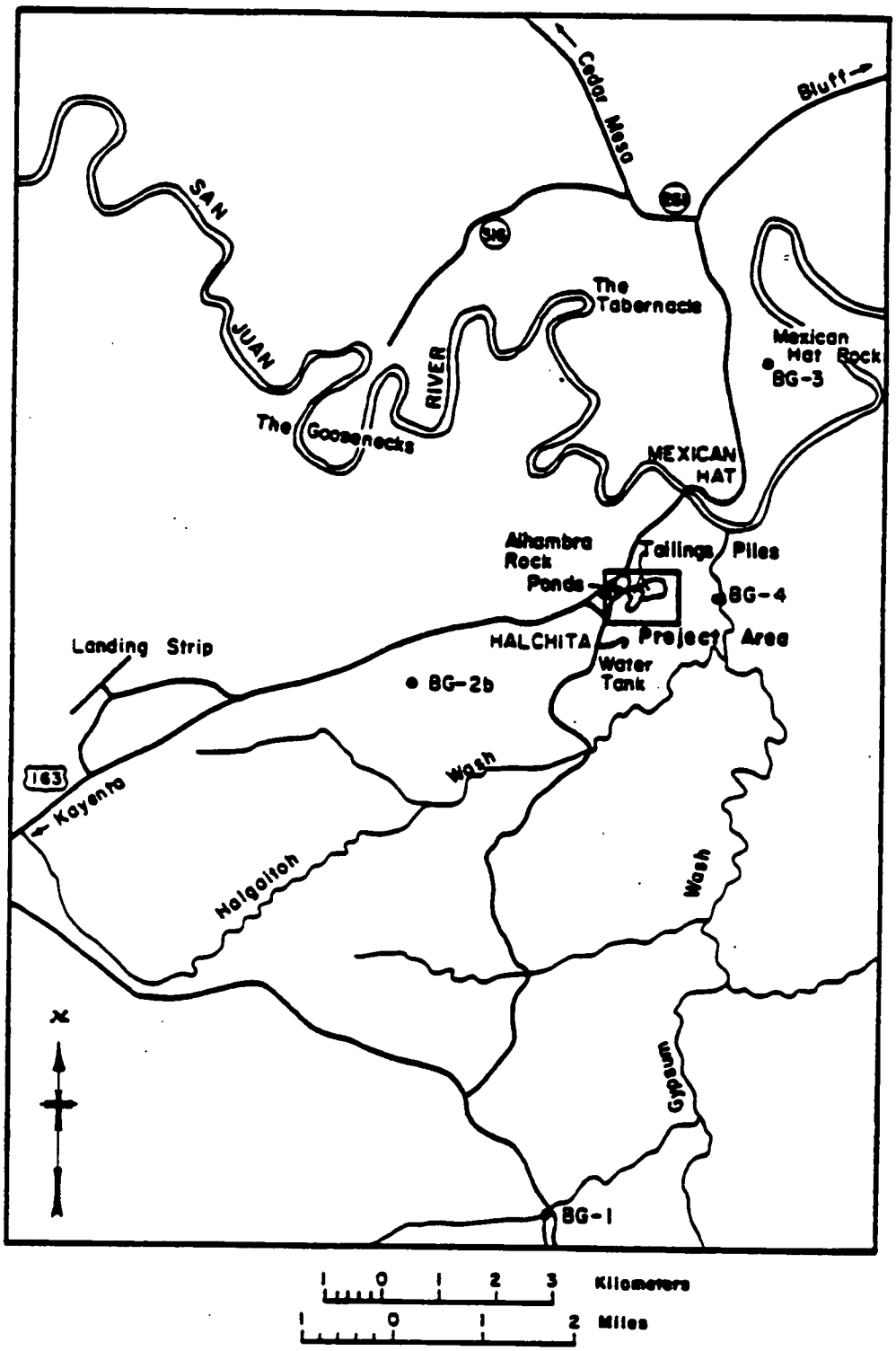


Figure 1. Location Map of the Mexican Hat Site Showing Background-Measurement Locations

Sedimentary rocks of the millsite area consist of fine-grained silty sandstones and shales of the Halgaito Tongue, a member of the Cutler Formation of Pennsylvanian age. These beds are a distinctive red to chocolate-brown in color and range in thickness from approximately 50 to 100 ft. The mill area and tailings piles are underlain by Halgaito redbeds. To the east of the tailings piles in the bottoms of the major arroyos draining the site are resistant limestone beds, probably part of the Rico Formation (or facies of the Cutler Formation), which underlie rocks of the Halgaito Tongue.

Unlike many other millsites, the Mexican Hat site does not contain a developed soil horizon or alluvial cover. Most of the site is located on bedrock or weathered bedrock. Accumulations of unconsolidated material greater than 2 ft thick are mainly restricted to man-made mixtures of bedrock, tailings, ore, and debris. Due to the color contrast between the Halgaito redbeds and contaminated materials (often white to gray), it is generally not difficult to identify contaminated materials.

Surface drainage at the millsite is to the east-northeast via tributary arroyos which drain into Gypsum Wash less than one mile from where it empties into the San Juan River. These arroyos are usually dry, with water flow restricted to infrequent periods of heavy rainfall.

Due to the fine-grained nature of the Halgaito sandstones and shales and to the arid climate at the millsite, no major near-surface groundwater aquifers exist. The major source of domestic water in the area is the San Juan River.

2.3 SITE HISTORY

The mill at Mexican Hat was built and operated by Texas-Zinc Minerals Corporation from 1957 to 1963. The mill was acquired by the Atlas Corporation in 1963 and was operated by them until operations ceased in 1965. A sulfuric acid plant continued to operate at the site until 1970. After the mill closure, control of the site reverted to the Navajo Nation. The site was used for a short period as a trade school (carpentry, welding, electrical, etc.) operated by the Utah Trades Commission. Presently the only continuously occupied portion of the site is the former mill office building which is now the Halchita Health Center.

Much of the ore processed at the mill came from the White Canyon district of Utah. This ore contained, along with uranium, a considerable amount of copper sulfides from which copper was also recovered. Brown and others (1974) described the process of recovery as a froth-flotation process followed by acid leaching. The leached flotation concentrates were filtered to recover a final copper product and the filtrate was combined with main-circuit leach slurry from the flotation tailings. A five-stage counter-current thickener circuit was used to separate leached solids and pregnant liquor, which was then clarified before solvent extraction. The loaded organic solvent was stripped with an ammonium nitrate solution, which was then neutralized with magnesium hydroxide to precipitate the final uranium product.

The tailings were distributed to two piles (referred to as the upper and lower piles) by a cyclone separator which built up the dams with coarse sand and

allowed the slimes to flow toward the center and southwestern portions of the piles.

The mill processed a total of 2.2 million tons of ore which assayed at an average of 0.28 percent U_3O_8 and produced 5700 tons of U_3O_8 concentrate for sale to the U.S. Atomic Energy Commission.

2.4 PREVIOUS WORK

Prior to the start of fieldwork for this characterization project, a thorough literature search was performed to identify published information pertaining to remedial action at the Mexican Hat site. The results of this search are presented in the bibliography at the end of this report (Section 7.0).

Previous studies at Mexican Hat include the following: an environmental survey of the uranium mill tailings piles at Mexican Hat by the U.S. Environmental Protection Agency conducted in May 1968; a cooperative site visit to assess site conditions by the U.S. Atomic Energy Commission, Environmental Protection Agency, and the State of Utah in May 1974; an engineering assessment of the site by Ford, Bacon and Davis Utah, Inc. under contract to the U.S. Energy Research and Development Administration in 1974; a radiologic impact assessment of the site by Oak Ridge National Laboratory for the U.S. Department of Energy in March 1980; and an aerial radiologic survey of the area surrounding the site by EG&G Energy Measurement Group for the U.S. Department of Energy Office of Operational Safety in September 1980.

2.5 SITE CONDITIONS

The remains of eight mill buildings exist at the site. Of the eight buildings only two are still in use. The former mill office building has been converted to a health center and is in good condition. A metal building once used as a chemistry lab and later as a sheet metal shop is now used for storage and remains locked. The long building once used for a trade school is abandoned but appears to contain a large amount of salvageable materials. An empty metal storage shed, in good condition, also appears to be salvageable. Other buildings including the scale house, ore-crushing building, and generator building are either contaminated or do not lend themselves to salvage.

Other remains of the milling operations include foundations of buildings that have been removed, tanks used for holding crushed ore, tanks used in the manufacture of sulfuric acid, and miscellaneous buried junk materials. A sewage pond, water line, and electrical transformer are also present and in use at the site.

The tailings piles, although crusted, are not covered or stabilized and access to the piles, as well as the entire site, is not restricted. Both wind and water erosion have occurred on the piles. The piles occupy a natural drainage area and although berms and dikes were built to reduce the amount of tailings being washed or blown off of the piles, arroyos downstream from the pile contain tailings for a considerable distance. The prevailing wind direction and drainage direction are both to the northeast. Therefore an area surrounding the northeast corner of the lower pile contains both visible windblown and

water-transported tailings contamination. Outward from the pile to the east and northeast, contamination is confined to a thin (generally less than 1-in. thick) blanket of windblown tailings over a broad area and to scattered sand bars (generally less than 1-ft thick) containing tailings, located along the bottoms of arroyos draining the pile area.

Due to the variable topography at the site (rolling hills, narrow ridges, and deep arroyos), much of the access to sampling, measurement, and drilling sites was accomplished by the use of three-wheeled, all-terrain cycles (ATCs). A portion of the drilling at the site was accomplished using a portable hand-held gas-powered auger.

3.0 PROCEDURES

The measurement techniques, instrumentation, and procedures used for the Mexican Hat radiologic characterization were based primarily on protocols developed by the DOE Division of Remedial Action Projects (DRAP) Technical Measurements Center (TMC) and on field-implementation experience gained during radiologic characterizations of other UMTRAP sites (Allen, Showalter, and others, 1983; Allen, Steele, and others, 1983; Allen and Strong, 1984; Marutzky and others, 1983; Shay and others, 1984; Shay and Rush, 1984; and Goodknight and Walker, 1984).

All activities at or in support of the project were performed in compliance with the provisions set forth in an approved Quality Assurance Program Plan (QAPP). To ensure the health and safety of personnel assigned to the project, a comprehensive health and safety plan was followed during the fieldwork phase of the project. This plan included monitoring of external radiologic exposure, potential for internal radiologic exposure (i.e., inhalation of airborne radioactive dust), personnel contamination, site access, and equipment contamination.

For purposes of this study, radiometric measurements made indirectly by measurement of radiation from sources other than the decay of the nuclide of interest are reported as 'equivalent' concentrations, denoted by an 'e' prefix, e.g., pCi(eRa-226)/g. Similarly, 'e' is used to report equivalent elemental concentrations (e.g., eK, eTh) calculated from the natural abundance of the nuclide (K-40 for eK) or a daughter in equilibrium with the parent (Tl-208 for eTh). Equivalent concentration is that concentration of nuclide/element of interest in equilibrium with its daughter products that yields the same measurement as the sample.

All instruments used for radiologic characterization were calibrated at the DOE calibration facilities in Grand Junction, Colorado, both before and after the fieldwork session. Instrument-response field checks were made before use each day, and the results were monitored for compliance with quality-control limits established on the statistical basis of previous response checks. The methods used for instrument-response field checks are described in Appendix A.

3.1 AREA DESIGNATIONS

The Mexican Hat site was divided into six areas (Areas A through F, Plate 1) as described in the Statement of Work, delineated on the basis of differing contamination patterns. These areas are the following: (A) windblown contamination north, northeast, and east of the tailings piles and arroyos containing both wind- and water-transported contamination; (B) windblown contamination south of the piles; (C) mill yard and ore-storage area; (D) ponds and contaminated arroyo in the northwest portion of the site; and (E) and (F) wind and water erosion adjacent to retaining dikes ringing the upper and lower tailings piles respectively. The type and amount of work required to characterize each area are discussed later in this report.

3.2 PHYSICAL SURVEY

The physical survey was conducted by a Bendix surveyor using a Theodolite and Geodimeter to establish baselines from horizontal control stations as shown on the Horizontal and Vertical Control map supplied by Jacobs Engineering Group. The millsite at Mexican Hat differed from previous sites in that the property boundary lines coincide with the baselines used to establish the grid network. A distance check was made between boundary points before baselines were established.

Once the baselines were established, several auxiliary lines were established with the instruments at right angles to the baselines to aid in gridding the different areas. All other gridpoints were set by steel tape and line of sight from established points. These gridpoints were located to the nearest 0.5 ft.

The borehole locations in Areas C and D were staked in the same manner as the gridpoints, using steel tape and existing points as line of sight. The boreholes located in Areas E and F were staked at approximate locations based on the work statement sample-design map provided by Jacobs Engineering Group. Many of the planned boreholes were moved to locations of easier access. After drilling, all holes in Areas E and F were surveyed from existing control stations. Elevations of all boreholes were established by differential leveling between control stations.

Many of these holes were moved and restaked by the Bendix Site Manager and the Technical Assistance Contractor to more accessible locations or to locations that would yield the best subsurface information (e.g., boreholes Hat-124, Hat-125, and Hat-158 in Area A).

3.3 SOIL SAMPLING AND DELTA-GAMMA RADIUM MEASUREMENTS AT GRIDPOINTS

A total of 145 gridpoints were established in Areas A through D for soil samples and delta-gamma measurements. Each grid point had a 0-to-6-in. soil sample taken for laboratory gamma-ray spectroscopic analysis. Delta-gamma measurements were made at a depth of 6 in. at specified gridpoints for field guidance in sampling. The purpose of the 0-to-6-in. soil sample was to determine the extent of surface contamination exceeding the EPA standard of 5 pCi/g Ra-226 above background. Subsequent subsurface delta-gamma measurements and soil samples were taken to define areas where the EPA standard of 15 pCi/g Ra-

226 was exceeded. The higher limit only applies to areas that will be excavated and then backfilled; the lower limit must be applied to areas that may be excavated but are not backfilled with at least 15 cm of soil. The procedure used for gridpoints in Areas A and B was (1) a 0-to-6-in. soil sample taken at each gridpoint, (2) a 6-in. delta-gamma measurement taken at one half of the gridpoints, and (3) a 6-to-12-in. soil sample where a 6-in. delta-gamma measurement indicates Ra-226 activity greater than 5 pCi/g, followed by a 12-in. delta-gamma measurement. This alternating procedure was continued until the delta measurement indicated less than 5 pCi/g or until an 18-to-24-in. soil sample was taken. In Areas C and D at every specified gridpoint this alternating soil sample/delta-gamma measurement protocol was also used.

3.3.1 Soil Sampling

Several steps were taken to ensure the integrity of the soil samples during the soil-sampling process. The samples were excavated using specially constructed shovels designed to produce samples of equal size. Care was taken to collect a uniform vertical cross section of the 6-in. layer sampled. Care was also taken to clean the sample-gathering equipment to prevent cross-contamination. Sample ticket books with the prefix MHD were used for samples collected in the field during this project. Pertinent information such as sample type, grid location, sample depth, project code, sampler's name, and soil conditions were placed on each sample ticket. A paper record of the sample-ticket number was placed inside the plastic bag holding the sample and the top of the bag was then folded twice and stapled shut to retain moisture. Using a permanent ink marker, the sample number, location, and depth were written on the plastic bag. The plastic bag was then placed in a duck-cloth bag which was also labeled with the sample number and depth. The samples were then boxed and returned to Grand Junction for analysis by the Bendix Analytical Chemistry Laboratory.

Following transport to Grand Junction, the soil samples were weighed, dried, reweighed, crushed and ground to -28 mesh, blended, and sealed in sample cans. The difference in weight after drying, or loss on drying (LOD), in percent, was recorded for about 10 percent of the samples submitted for analysis. These values were used later to calculate moisture correction factors. The samples were stored for at least 21 days to allow the radon and radon daughters to reach equilibrium with any radium present. The samples were analyzed for radium, potassium, and thorium using high-resolution germanium gamma-ray spectroscopy systems. The systems were calibrated against the New Brunswick Laboratory (NBL) Series 100-A certified gamma-ray standards. All samples were positioned on a detector by means of an automatic sample changer to maintain consistent sample/detector geometry. The laboratory procedures used are described in detail in the Handbook of Analytical and Sample-Preparation Methods (Bendix Field Engineering Corporation, 1984c).

Amplifier gain and baseline were manually checked daily, using a Th-232 source. Two known control samples were analyzed each day; acceptance of the data set thus generated required that at least one control be within one standard deviation and that both controls be within two standard deviations of the statistically established individual ranges. In addition to analysis of known controls, 10 percent of the blended samples were split and analyzed for radium concentration as blind duplicates. The duplicates are identified with an MBG sample prefix.

3.3.2 Delta-Gamma Radium Measurements

In-situ measurements of equivalent radium at gridpoints were made using a Bendix delta-gamma system containing internal collimation and prefilters. The Bendix system was operated on counting plateau using a delta (difference) technique. The detector was placed on the surface to be assayed and an UP count was collected for 120 seconds; a high-density shield was then placed between the detector and the surface being assayed and a DOWN count of 120 seconds was collected. The UP/DOWN counter automatically registered the difference or delta count.

The statistical validity of the delta-gamma measurements was monitored in the field by taking two or more sets of measurements at each location. The procedures used in determining the statistical validity of the measurements and for data reduction are described in Section 6.3 of the Radiologic Field Measurements Procedures Manual (Bendix Field Engineering Corporation, 1984a). The mean of the count sets was determined arithmetically, and the standard deviation of each count set was calculated using the equation

$$\sigma_{N_d} = \sqrt{2N_u - N_d} \qquad (1)$$

where σ is the standard deviation and where N_g and N_d are the unshielded (UP) gross counts and the shielded (DOWN) difference or delta counts, respectively. A statistical check was made to determine if the second set of measurements was within 2σ of the first. If not, a third set of measurements was made. The data were summed and σ was calculated for the total measurement. A check was made to determine whether σ is less than 15 percent of the difference count using the equation

$$U_d = \frac{\sigma_{N_d}}{N_d}(100) \qquad (2)$$

where U_d is the percent uncertainty of the difference count. If this criterion could not be met after three 120-second measurements, the data were flagged as being semiquantitative.

A calibration factor and three major corrections were applied to the raw delta-gamma readings to obtain radium concentrations in picoCuries of equivalent radium per gram [pCi(eRa-226)/g]. Calibration of the instruments was performed at the Department of Energy (DOE) Walker Field calibration pads in Grand Junction, Colorado. The stripping factors necessary to calculate raw equivalent-radium concentrations from the delta-gamma readings were obtained from the calibration data.

A correction for contributions from radioelements other than Ra-226 was made to compensate for the fact that the raw data collected in the delta-gamma measurements are the result of all gamma radiation reaching the detector. The correction factor used in the field was derived from potassium and thorium concentrations determined from in-situ gamma-ray-spectrometer measurements and laboratory gamma-ray-spectroscopic analysis of soil samples obtained during the orientation visit to the site. The correction factor used in this report was obtained from gamma-ray-spectroscopic analysis of soil samples collected during the fieldwork phase of the project.

A correction factor was also applied for soil-moisture content since soil moisture reduces the total gamma-ray flux at the surface and because concentrations are conventionally based on dry sample weight. This correction factor was obtained through laboratory loss-on-drying (LOD) measurements performed on selected soil samples taken during the fieldwork phase of the project. Due to the small variability in soil conditions at the site, an average soil-moisture value, together with the moisture-content values for the calibration pads, was converted to a single correction factor to be applied to all of the delta-gamma measurements.

A disequilibrium factor was applied to the data to correct for the disequilibrium between radium and its gamma-emitting daughter products. This disequilibrium is due to loss of radon gas, radium's first daughter, from the soil. In-situ delta-gamma measurements include these gamma-ray-emitting radon daughters. When the correction for radon loss is applied, the apparent concentration of radium measured in situ increases. The disequilibrium factor was derived from laboratory analysis of selected soil samples. Equivalent-radium concentrations were measured at 2 to 12 hours after canning, and again after 6 days. Estimates of the radon disequilibrium ratio were made by calculating the radium concentration at disequilibrium and at equilibrium, using the standard equations for ingrowth and decay of the various isotopes involved (Marutzky and others, 1984; Scott and Dodd, 1960).

3.4 ARROYO DELTA-GAMMA MEASUREMENTS

To semiquantitatively characterize the extent of contamination in arroyos draining the site in Areas A and D, delta-gamma measurements were made at 200-ft intervals until three successive surface delta-gamma measurements indicated radium concentrations less than 5 pCi/g or until physical access became impossible.

Starting at surveyed gridpoints established during the physical survey, a ROLLATAPE bicycle wheel distance-measuring device was used to establish delta-gamma measurement locations at approximately 200-ft intervals along the bottoms of the arroyos.

At each location a surface delta-gamma measurement was made. Where surface measurements indicated Ra-226 concentrations greater than 5 pCi/g, an additional measurement was made at a depth of 6 in. This procedure was followed until (1) a measurement indicated Ra-226 concentrations were less than 5 pCi/g, (2) a measurement was made at a depth of 18 in. or (3) competent bedrock was reached.

The same statistical checks and corrections that were applied to delta-gamma measurements at grid points (cf. Section 3.3.2) were used for measurements taken in the arroyos. No soil samples were taken in the arroyos with the exception of surveyed grid points used as starting points for the arroyo delta-gamma survey.

3.5 BOREHOLE SAMPLING, DRILLING, AND LOGGING

3.5.1 Sampling

For each borehole location, a 0-to-6-in. surface soil sample was taken prior to drilling. The samples were collected in the same manner as those at grid points described in Section 3.3.1. No further subsurface sampling was required at borehole locations for this study.

3.5.2 Drilling

Borehole drilling was accomplished, using standard geotechnical techniques, with a CME 550 auger rig where access permitted. Hollow-stem augers (6-5/8 in. O.D. by 3-1/4 in. I.D.) were used to drill to total depth in each hole. Augers were left in place in the hole during radiometric logging operations to prevent hole collapse and to minimize smearing of any downhole contamination. A retrievable center bit was used for drilling to avoid contamination within the auger itself; the center bit was removed for radiometric logging. The driller furnished three auger heads so that two holes could be left open for geophysical logging while the third hole was being drilled.

The boreholes were drilled to either the total estimated depth as specified in the Statement of Work or until the driller reached a point of refusal (stopped downward penetration) due to conditions such as shallow bedrock, buried concrete, large rocks, or other material that would stop penetration.

Borehole locations which were inaccessible by a truck-mounted auger rig were drilled using a portable gas-powered 'Little Beaver' drill with a 4-in.-diameter auger. The boreholes were drilled and then immediately logged with the auger removed. Equipment transport to these holes was accomplished using three-wheeled ATCs.

Once geophysical logging operations were completed, hole abandonment was accomplished by filling the hole with auger cuttings or with other nearby natural material found on the ground surface. Holes that exceeded 8 ft or more in depth and that encountered groundwater were filled with a bentonite slurry having at least a 55-second viscosity.

A Bendix drilling supervisor monitored the drilling operations and maintained a record of footage drilled and materials used. The drilling supervisor also checked the augers and drill bits for contamination after removal from each borehole, using an Eberline PAC-6 Alpha Meter. Tools measuring greater than 200 counts per minute (cpm) were cleaned to remove the apparent source of contamination. The tools were then rechecked and recleaned if necessary, until measurements were less than 60 cpm.

3.5.3 Geophysical Logging

Boreholes accessible by two-wheel-drive truck and that were at least 5 feet in depth were logged using a Bendix computer-based geophysical-borehole-logging (Compulogger) system. The probe, which contains a 2-in.-diameter-by 6-in.-long sodium iodide detector, was raised from the bottom to the top of the borehole

at an approximate rate of 1.5 ft per minute; data were recorded at each 0.5-ft interval. Repeat logs were made of the entire borehole to confirm the measurements obtained during the main logging phase.

The gamma-ray detection system was operated in a linear (energy-proportional) mode. Uphole electronics provided system-gain stabilization by monitoring the 835-keV gamma-ray peak from a manganese-54 source contained in the probe. Pulse-height data were collected from single-channel-analyzer (SCA) windows corresponding to the principal energy peaks from the decays of potassium, radium, and thorium. Data from a fourth SCA window, the total-count window (1050 to 3000 keV), were collected to provide statistically improved radium concentrations.

After returning to Grand Junction, the data from the Bendix computer-based logging system were electronically transferred from a nine-track tape on the CDC-815 computer to a disk on the Zenith Z-100 portable computer and verified according to approved quality-assurance procedures. Data from the total count channel were corrected to reflect an average subsurface moisture content of 6.3 percent.

Data from the total-count channel were also corrected for gamma-ray attenuation caused by the auger casing and auger joints. The correction factor was determined in the calibration models at Grand Junction, using sections of casing identical to the casing used at the field site. This factor is an equation which corrects all counts to the observed count rate in the constant-thickness casing. At positions far from the auger joint, the function has a value of 1.0, but as the depth measured approaches the center of the joint, the value of the correction factor increases to a maximum value. Three coefficients determine the correction, one for the maximum value at the center, one for the distance from the center at which the correction reaches one-half of the maximum, and one which controls the speed at which the exponential curves approach the maximum and minimum values.

The depth of auger joints was determined by measuring the height of the auger above the ground surface for each borehole. Since the total auger length was known, the depth of the auger joints could be calculated. The auger joint correction was applied once the joint depth was known.

The data were then spatially deconvolved (George and Price, 1982) to produce logs of apparent-radium concentration versus depth. Corrections were applied for contributions from potassium and thorium. Contributions from potassium and thorium to the apparent radium analysis for the truck-mounted system are 1 pCi(eRa-226)/g for 1 percent potassium and 0.133 pCi(eRa-226)/g for 1 ppm thorium-232, respectively. The average concentrations of potassium and thorium, based on soil samples taken at the site, are 1.3 percent and 6.6 ppm, respectively.

In those areas not accessible by two-wheel drive truck or at shallow boreholes less than 5 feet in depth, logging was performed using a portable gross-count system. This system consists of an Eberline Model PRS-1 field survey meter (RASCAL) connected by 20 ft of cable to a waterproof Eberline Model SPA-3, 2-in.-by-2-in. sodium iodide detector. The system is operated on counting plateau in a gross-count mode, which counts all gamma rays whose energies exceed approximately 30 keV.

The probe was manually lowered to the bottom of the borehole in 6-in. increments, with 30-second measurements recorded manually at each step. The data measurements recorded while lowering the detector were identified as 'Phase 1'. The probe was then raised to the top of the borehole in 6-in. increments, with 30-second measurements again recorded at each step. Data recorded while the detector was being raised were identified as 'Phase 2'.

Most of the data were manually entered into the data base of a Zenith Z-100 portable computer and verified in the field according to approved quality-assurance procedures. Data taken during the last two days of fieldwork were entered and verified upon returning to Grand Junction. The data were then corrected for average moisture content and for gamma-ray attenuation caused by the auger-stem casing, as described for the truck-mounted logging system. These data were also corrected for auger-joint effects.

The borehole-logging systems were field-checked prior to logging each day, using a special monazite sand for the truck-mounted system and a radium check source for the portable system. The resulting data were recorded and compared with previous field-check data and with the two-standard-deviation limits for quality control. Repeat logging phases were run for each hole and the results of both the main and repeat phases were checked for agreement. Additional repeat logs were collected where disagreements in the data were observed. When possible, the apparent cause of the disagreement was noted.

The logging systems were calibrated, both before and after the fieldwork, using the DOE borehole-calibration models at Grand Junction, Colorado, and with the computer program LOGCAL (Showalter and others, 1984). Pre-fieldwork calibration was performed to process the data, while post-fieldwork calibration permitted detection of any equipment malfunctions. The resulting data were then archived in a permanent calibration data base.

3.6 BUILDING SURVEYS AND MEASUREMENTS

3.6.1 Exposure-Rate Measurements

Two indoor exposure-rate measurements were made at the same location in the approximate center of each building using a Reuter-Stokes Model RSS-111 Pressurized Ionization Chamber (PIC). This instrument, widely used for exposure rate measurements, produces a nearly flat response to gamma rays ranging in energy from 100 keV to 3 MeV and is also designed to respond linearly in gamma fields up to 100 mR/h.

A daily instrument check was made using a 1-μCi radium check source placed in the source-holding fixture at the top of the ion chamber. First, with the source removed, a background reading was obtained using a Bendix-modified readout to determine the average exposure rate over a time interval of 90 seconds. Following the background exposure-rate determination, the 1-μCi source was placed in the source holder and the same procedure was used to determine the average exposure rate. The background exposure rate was subtracted from the second exposure rate to determine net exposure rate from the source. The resulting value was recorded and checked for compliance with quality-control limits. To monitor PIC performance at higher exposure-rate levels, the procedure was repeated using a 10-μCi check source.

Two exposure-rate measurements were taken at the approximate center of each building at a height of 3 feet using a counting time of 180 seconds (3 minutes). The exposure-rate readings in μR/h were then entered into a field data book.

3.6.2 Alpha Measurements

An Eberline Air Proportional Alpha Detector was used to obtain gross-alpha measurements inside the site buildings. These measurements, recorded in counts per minute (cpm), were made to determine surface contamination levels. The overall objective of the measurements was to determine the extent of decontamination needed in the buildings.

A daily instrument-response check was made using a set of plutonium check sources. The detector was placed over the source and a reading was recorded. The detector was rotated 180 degrees and a second reading was recorded. The two readings were averaged and the result was checked to determine if the reading was within 2σ of the value (in cpm) stated on the reference check source. If the readings were not within 2σ, the procedure was repeated.

If the second test failed, the instrument was tagged 'DO NOT USE' and returned to Grand Junction for repair.

Two alpha measurements were made at each delineated location within the abandoned buildings. Four measurement locations were delineated for every 1000 square feet of floor space, with a minimum of four locations per building. The first reading was a direct surface reading. The location was then wiped or brushed clean and a second reading was taken. A marked decrease in count rate provided an indication that the contamination is removable. For the two buildings still in use, the Halchita Health Center and the locked storage building, both direct readings and smears were collected. The smears were taken at the same location as the direct reading. The smears were counted using a Ludlum Model 2000 Scaler with a Ludlum Model 43-17 detector for a period of 3 minutes. A sketch of each building showing the approximate alpha-measurement location was provided with the data.

3.7 BACKGROUND MEASUREMENTS

The four areas selected for background measurements near the site include an area approximately 3 miles northeast of the site near the Mexican Hat Rock, an area 5 miles to the south, an area 2 miles to the west-southwest, and an area 0.5 mile to the east. The background site to the east was located just west of Gypsum Wash, since there are no access roads across Gypsum Wash to allow establishment of a background site at least 3 miles east of the site. Three miles to the east of the site is the crest of the Raplee Anticline which is in a different geologic setting. All of the background sites were located in silty sandstones and shales of the Halgaito Tongue of the Cutler Formation, similar to the geologic setting at the millsite.

At each background site, PIC gamma exposure-rate measurements, delta-gamma measurements, and soil samples were taken. Soil samples taken during the

orientation visit were analyzed for Ra-226, Th, K, and moisture (LOD). One sample was analyzed for U-234, U-238, and Th-230. Soil samples taken at background sites during the fieldwork phase were analyzed for Ra-226, Th, and K.

4.0 RESULTS

Data obtained during the fieldwork phase of the project are presented in Appendices B through G. Discussion of the results of each task performed both during and after fieldwork is presented in subsequent sections of this report.

4.1 PHYSICAL-SURVEY RESULTS

Before establishing the baselines used in gridding the site, the Theodolite and Geodimeter were set up over two separate brass-capped control points, and the distance between the two points was measured. The measured distance was compared to the calculated distance and results indicated that the difference between the measured and the calculated distances was insignificant (less than 0.30 ft). Following this check, the baselines were established.

From the baselines, several auxiliary lines were established with the Theodolite and Geodimeter at right angles to the baselines. From these lines, gridpoints were set by tape and line of sight. A total of 145 gridpoints for sampling and measurements were established.

Boreholes in Areas C and D were located using a steel tape and existing points as line of sight prior to drilling. Several boreholes in Areas C and D were moved by the Bendix Site Manager to avoid powerlines, concrete foundations, surface bedrock, or other obstructions. These holes were usually moved only a few feet using a measuring tape and line of sight. Boreholes in Areas E and F were staked at approximate locations, based on the sample design map provided by Jacobs Engineering Group. Many of these holes were moved and restaked by the Bendix Site Manager and the Technical Assistance Contractor to more accessible locations or to locations that would yield the best subsurface information. After drilling, all holes in Areas E and F were surveyed from existing control stations to the nearest 0.5 ft.

Elevations of all boreholes were established by differential leveling between control stations. In the mill yard and ore-storage area, traverses were made from Station 5 to Station 7 to Station 6 and back to Station 5, and from Station 7 to Station 8. The differences in elevation survey closures noted at Stations 7, 6, and 5 were -0.04, -0.01, and 0.03 ft, respectively, and the difference in elevation noted at Station 8 was -0.03 ft. Around the upper tailings pile a traverse was made from Station 3 to Station 7 and back to Station 3. No difference in elevation closure was noted within this traverse. Around the lower tailings pile a traverse was made from Station 2 to Station 7 to Station 3 and back to Station 2. The differences in elevation closures noted at Stations 7, 3, and 2 were -0.17, +0.01, and +0.10 ft, respectively. The overall closure difference noted at Station 2 was -0.07 ft. All borehole elevations were determined to the nearest 0.1 ft.

The location of survey control stations, established gridpoints, and borehole locations are shown on Plate 1.

4.2 SOIL SAMPLING RESULTS

A total of 293 soil samples were collected and analyzed for radium, thorium, and potassium; results are presented in Appendix B, Table B-1. Duplicate analyses were performed on 27 samples for all three radionuclides; the results are presented in Appendix C, Table C-1. Duplicate samples are identified by the prefix MBG. Appendix C, Table C-2, presents the radium data for the original and duplicate analyses to permit comparison of the results.

The differing contamination patterns described in Section 3.1 of this report, with the exception of arroyo contamination where soil samples were not taken, are indicated in the results of soil-sample analyses. Figure 2 shows the distribution of radium concentrations for soil samples collected at 0-to-6-in. depths. Figure 3 shows the location of soil samples having greater than 5 pCi(eRa-226)/g radium concentrations in soil samples taken at 0-to-6-in. depths.

Windblown contamination (Area A) exceeding 5 pCi/g radium-226 in surface (0 to 6 in.) soil samples is present in a broad area to the northeast and east of the lower tailings pile. Soil samples taken at grid points N10152 and E9290, N10000 and E9200, N9960 and E9246, and N10600 and E10400 contain radium concentrations of 369, 535, 676, and 100 pCi/g, respectively. The first three samples are related to small piles of material containing uranium ore and the fourth was taken from the bottom of an arroyo containing water-transported tailings. All of the remaining soil samples in Area A containing greater than 5 pCi/g Ra-226 are related to windblown contamination. As shown by the delta-gamma data taken at a depth of 6 in., the windblown contamination is restricted to the upper 6 in. of material except for an area along the eastern edge of the lower pile. Only one surface soil sample in Area B has a concentration of radium-226 exceeding 5 pCi/g. This indicates that windblown contamination is insignificant south of the pile.

Contamination in soil samples taken from the mill and ore-storage areas (Area C) is highly variable. West of approximately E7600, the radium-226 concentrations in soil samples are at or near background concentrations (1 to 4 pCi/g). East of approximately E7600 to the upper tailings pile, the radium concentrations vary greatly ranging from 3 to 363 pCi/g, reflecting the scattered ore, tailings, and contaminated debris found in this area. Many of the soil samples taken in Area C correspond to borehole locations.

Soil samples taken in Area D have concentrations of Ra-226 at or near background levels, except those taken in the wash or arroyo which drains Area D to the north. The samples from the wash have Ra-226 concentrations ranging from 2 to 482 pCi/g, which represent spotty contamination by tailings and slimes being transported downstream during periods of heavy rainfall.

Equivalent-thorium concentrations in soil samples are highly variable, ranging from 0 to 1384 ppm. The highest concentrations of thorium are related to soil

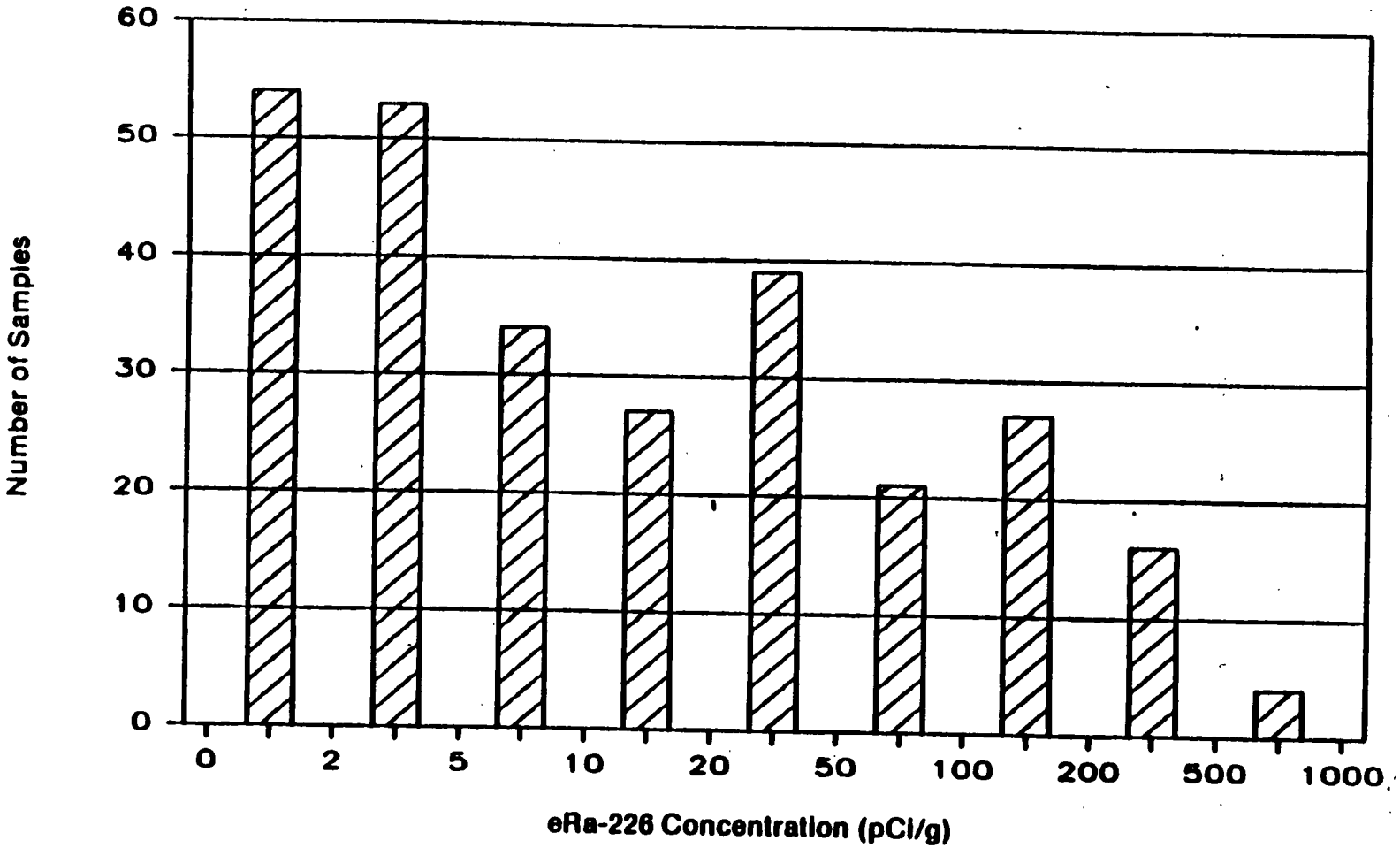


Figure 2. Histogram of Analytical Results for eRa-226 in Soils

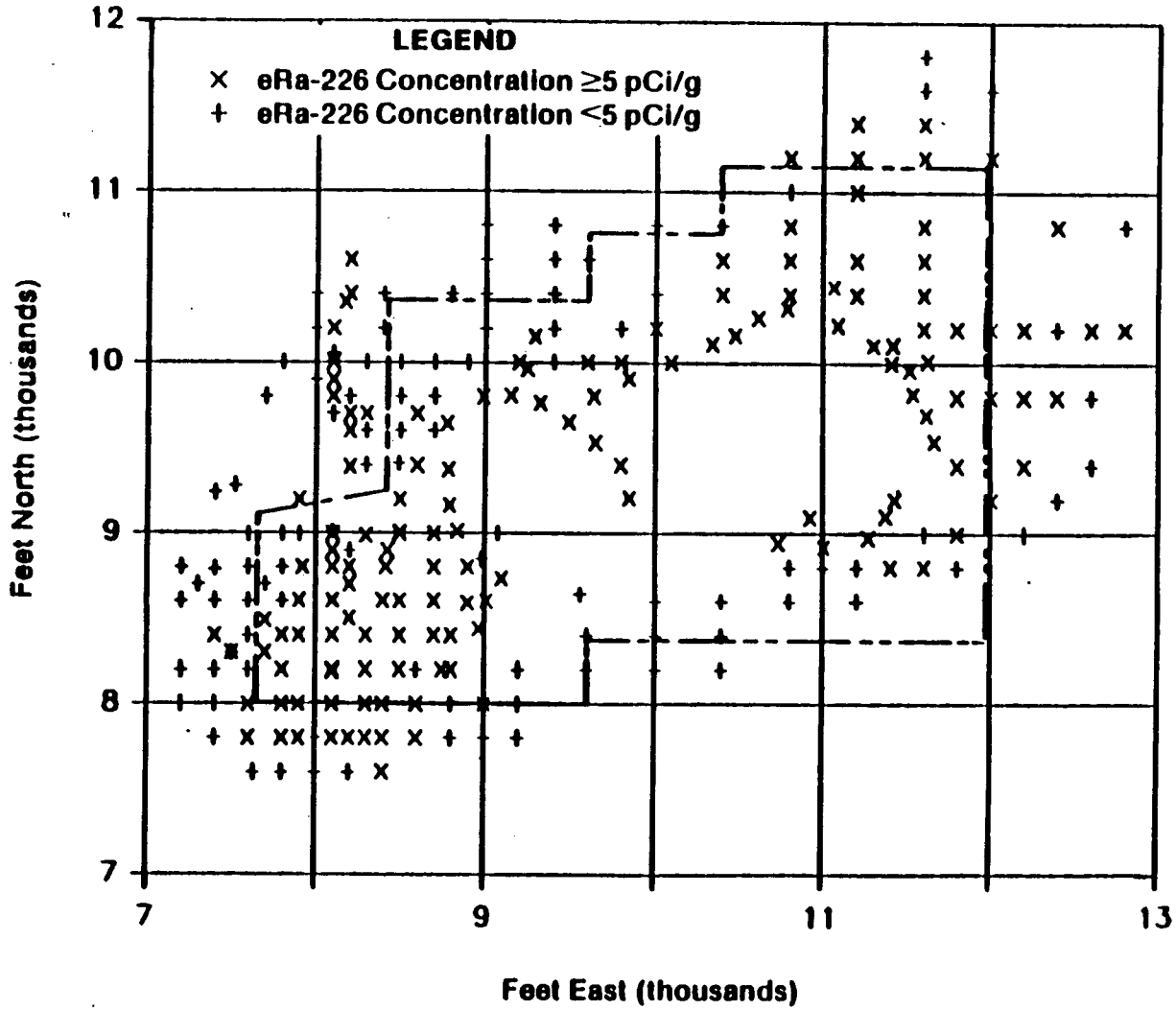


Figure 3. Locations of Soil Samples Having eRa-226 Concentrations Greater Than 5 pCi/g at Depths of 0 to 6 Inches

samples containing uranium ore and tailings. The locations of soil samples containing thorium in concentrations greater than 15 ppm are shown in Figure 4. A discussion on correction factors used to correct radiologic measurements for thorium contributions is presented in Section 4.3 of this report.

Potassium concentrations in soil samples are generally low but are also variable and range from below detection limit (<0.5 percent) to 3.2 percent. A discussion on correction factors used to correct radiologic measurements for potassium contributions is presented in the following section.

4.3 DELTA-GAMMA MEASUREMENTS

4.3.1 Soil-Moisture Correction Factors

Loss-on-drying (LOD) measurements were performed on ten percent (28) of the soil samples collected during the fieldwork phase of the study and on 16 samples collected during the site-orientation visit, to derive an average soil-moisture-content value for the site (Appendix B, Table B-2). Based on 25 soil samples taken at a depth of 0 to 6 in., the average moisture is 1.6 percent. Two samples taken at a depth of 6 to 12 in. and one sample taken at a depth of 12 to 18 in. had moisture contents of 1.13 percent, 2.65 percent, and 6.26 percent, respectively.

Soil-moisture corrections were applied to in-situ radium measurements to convert the measurements to dry-weight radium concentrations. The corrections were calculated, using the moisture content of the soil, from the equation

$$F_m = 1 + 1.11\ [M/(1-M)] \qquad (3)$$

where M is the fraction of the total weight accounted for by water (Marutzky and others, 1984).

Because calibration-pad moisture must also be taken into account, the ratio of the soil-moisture correction to the calibration-pad-moisture correction is applied to the data as follows:

$$F'_m = \frac{1 + 1.11\ [M_f/(1-M_f)]}{1 + 1.11\ [M_p/(1-M_p)]} \qquad (4)$$

where M_f is the soil-moisture content determined for each sampling depth interval in the study area and M_p is the calibration-pad moisture content (approximately 11 percent). Since the moisture content for the 6-to-12-in. depths was not significantly different from those of the 0-to-6-in. samples, the same correction factor ($F'_m = 0.89$) was applied for data in these depth ranges. For the seven soil samples taken below a depth of 12 in., a correction factor of $F'_m = 0.94$ was applied.

4.3.2 Disequilibrium Correction Factor

Radon escaping from the soil decreases the apparent concentration of radium measured in situ because the in-situ measurement technique actually measures gamma-ray-emitting radon daughters. The amount of this decrease is the fraction of radon that escapes from the soil.

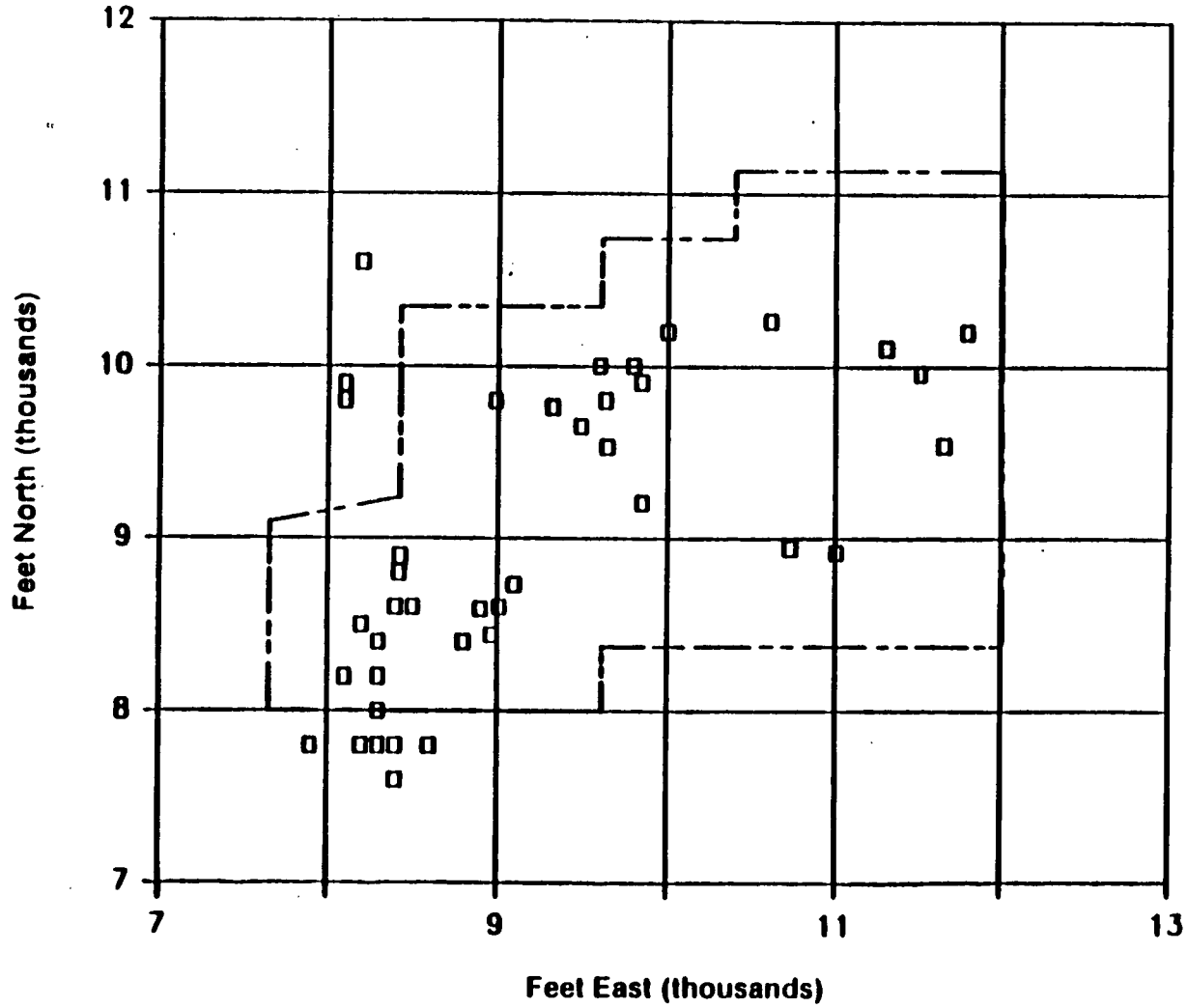


Figure 4. Locations of Soil Samples Having Thorium Concentrations Greater Than 15 ppm at Depths of 0 to 6 Inches

Results of laboratory measurements of disequilibrium between radium and its radon daughters for 2 samples taken during the site orientation visit were 17.8 ± 1.0 percent and 18.6 ± 1.0 percent. The average of the two values is 18.2 ± 1.0 percent. This value is lower than previous site disequilibrium values probably due to the low moisture content of the soils (1.6 percent for depths 0 to 6 in.).

The equation used for disequilibrium correction is

$$F_e = 1/(1-E) \tag{5}$$

where F_e is the disequilibrium correction and E is the fraction of radon escaping from the soil. The apparent-radium concentration calculated from in-situ data is multiplied by the disequilibrium factor to determine actual radium concentration. Because the calibration pads also emanate radon (approximately 10 percent), the final correction applied to the field data is the ratio between the field disequilibrium correction and the calibration-pad disequilibrium correction, or

$$F'_e = \frac{1/(1-E_f)}{1/(1-E_p)} = 1.10 \tag{6}$$

where E_p is the fraction of radon escaping from the pads (10 percent) and E_f is the fraction of radon escaping from the soil (18.2 percent).

4.3.3 Delta-Gamma Measurement Results

The raw data collected during the field survey were converted to equivalent-radium concentrations using correction factors for moisture, disequilibrium, and thorium and potassium concentrations, as well as the necessary calibration factors obtained from calibrations performed on the DOE Walker Field calibration pads.

The equation for data reduction is

$$C_{Ra} = [(k_{Ra})RF'_m - (S_K C_K) - (S_{Th} C_{Th})]\ F'_e \tag{7}$$

where C_{Ra} is radium concentration in pCi(eRa-226)/g, k_{Ra} is the delta-count calibration factor in pCi(eRa-226)/g per cps, R is average net count rate in cps, F'_m is the moisture correction factor (average per area), S_K is the stripping factor in pCi(eRa-226)/g per percent K, C_K is percent K (average per area), S_{Th} is the stripping factor in pCi(eRa-226)/g per ppm Th, C_{Th} is ppm Th (average per area), and F'_e is the disequilibrium correction factor (average per area).

The disequilibrium correction factor (F'_e) determined for this study is 1.10 (cf. Section 4.3.2). The moisture correction factor (F'_m) for this study area is 0.89 for measurements less than or equal to 12 in. in depth and 0.94 for measurements greater than 12 in. in depth. Mean thorium and potassium concentrations for the millsite were determined from laboratory analysis of a group of soil samples containing very high concentrations of thorium. The statistical mean for thorium is 38 ppm. To compensate for these high values, all thorium values greater than 15 ppm were, for the purpose of data reduction, placed in a separate file where the locations of the high thorium samples were

checked against locations of delta-gamma measurements. Delta measurements taken at the same location as soil samples containing high thorium were corrected individually for thorium. The remaining delta-gamma measurements were corrected for thorium using a mean concentration of 6.6 ppm. A mean potassium concentration (C_K) of 1.3 percent was used to reduce the delta-gamma data.

Uncertainties in radium-concentration values were calculated using the equation

$$\sigma = k_{Ra}[(2N_u - N_d)^{1/2}/t](F_e')(F_m') \qquad (8)$$

where σ is the uncertainty in radium concentration, N_u and N_d are the unshielded (UP) counts and delta or difference counts, respectively, t is the counting interval (time in seconds for the UP count), and the other parameters are as defined above. These uncertainties reflect counting errors only. Not included are the uncertainties in the equivalent-radium concentration introduced by the errors associated with each correction and calibration factor. At low radium concentrations, the counting uncertainty is, most likely, the largest source of error in the measurement. At high concentrations, however, the reported counting uncertainty is likely to be overshadowed by errors introduced by the correction- and calibration-factor uncertainties.

Equivalent-radium concentrations determined using the delta-gamma method and their associated two-standard-deviation counting uncertainties are reported in Appendix D, Table D-1. Figure 5 shows locations where the equivalent-radium content of the soil exceeds 5 pCi/g as determined by the delta-gamma method. Figure 6 illustrates the distribution of the delta-gamma measurements over the range of equivalent-radium concentrations determined for the site.

With the exception of delta-gamma measurements in arroyos, nearly all of the delta-gamma measurements were made at a depth of 6 in. as specified in the Statement of Work. The measurements were made at approximately half of the gridpoints in Areas A and B, and at all of the gridpoints (excluding borehole locations) in Areas C and D following the collection of a 0-to-6-in. soil sample. The alternating soil sample/delta-gamma measurement method described in Section 3.3 was used to determine the depth of contamination exceeding EPA standards.

The results of delta-gamma measurements taken in areas containing windblown contamination (Areas A and B) indicate that equivalent Ra-226 concentrations below a depth of 6 in. are at or near background concentrations. By comparing the 0-to-6-in. soil-sample data and the 6-in. delta-gamma measurement data, it appears that windblown contamination exceeding 5 pCi/g Ra-226 is confined to near-surface (0 to 6 in.) materials.

Delta-gamma measurements in arroyos of Area A indicate that extensive contamination consisting of a mixture of water- and wind-transported tailings is present in scattered sand bars along each of four arroyos surveyed. The extent of the contamination usually extends outside of available site maps. Therefore, in Appendix D, Table D-2, location values of 99999 are given for measurements taken outside the site map. However, in the remarks section of the data-entry sheets, the measurements are referenced to a known point (e.g., 400 ft downstream from N10600, E8200). The depths of contamination exceeding EPA standards generally correspond to depths needed to reach bedrock. The arroyo bottoms at the site are floored by bedrock and in many cases bedrock is reached

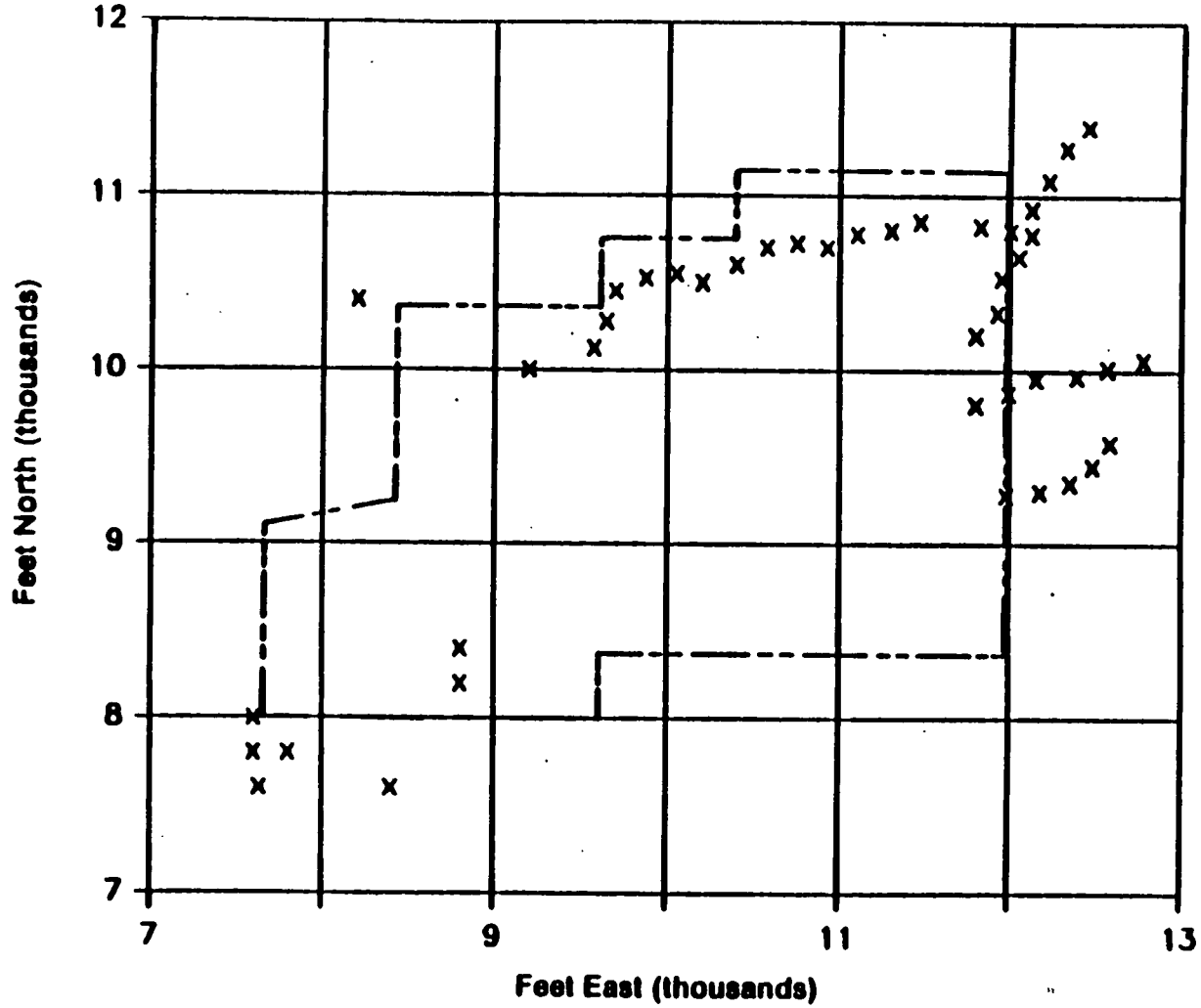


Figure 5. Locations of Delta-Gamma Measurements Greater Than 5 pCi(eRa-226)/g

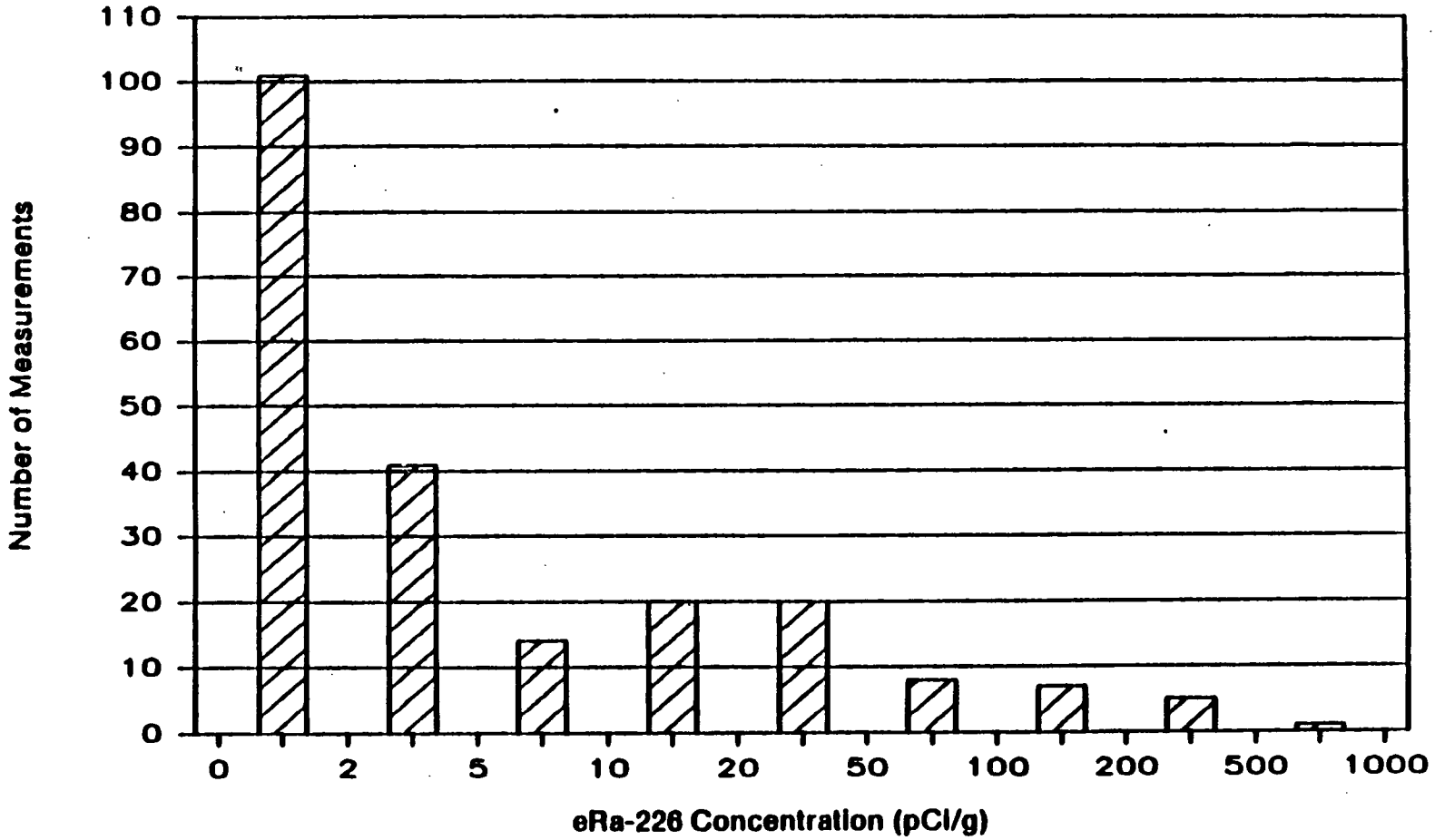


Figure 6. Histogram of Delta-Gamma Measurement Results for eRa-226

at a depth of 3 to 4 in. Once bedrock is reached, the equivalent-radium concentration falls below the EPA standard of 5 pCi/g above background. The arroyo in Area D contains the same type of concentration, but due to a greater thickness of material in the bottom of the arroyo south of U.S. Highway 163, the arroyo was characterized by drilling. North of the highway, surface delta-gamma measurements indicate the contamination extends only approximately 300 ft downstream from the highway.

The delta-gamma measurements from the mill yard and ore-storage area (Area C) indicate that with the exception of six gridpoints (N8200, E7600; N8000, E7600; N7800, E7600; N7600, E7635; N7800, E8200; and N7600, E8400) the eRa-226 concentrations at a depth of 6 in. are less than 5 pCi/g. Of the six measurement locations that contain concentrations greater than 5 pCi/g, four are located in a borrow-pit area between the gravel road on the west edge of the millsite and ore-storage area and the paved road to Ralchita. The remaining two locations are located adjacent to small ore piles still present in the ore-storage area. Delta-gamma measurements at two of the above gridpoints (N7800, E8200 and N7600, E8400) yielded negative eRa-226 concentrations due to corrections for high thorium concentrations. Soil samples taken at a depth of 0 to 6 in. at these locations contain 138 and 857 ppm eTh, respectively. Other soil samples in Area C also contain high concentrations of thorium. These samples, however, corresponded to borehole locations and will be discussed in Section 4.4.2.

4.4 BOREHOLE DRILLING, SAMPLING, AND LOGGING RESULTS

4.4.1 Drilling and Sampling Results

A total of 117 boreholes were drilled, of which 47 were located in the mill yard and ore-storage area (Area C), 17 were located in the sewage pond and arroyo area in the northwest portion of the site (Area D), 23 were located along the periphery of the upper pile (Area E), 28 were located along the periphery of the lower pile (Area F), and 2 holes were added to test piles of contaminated material in Area A. The borehole numbers, coordinates, and elevations are included in Appendix E.

Boreholes in Area C were drilled by truck-mounted auger according to the locations specified in the Statement of Work, with the exception of 8 boreholes (HAT-013, 017, 022, 023, 026, 037, 048, and 051) that were moved to avoid utilities, existing structures, and other obstructions. Borehole HAT-057 was deleted since it was located directly on bedrock. Borehole depths were generally shallower than originally estimated depths due to the shallow depth to bedrock.

Boreholes in Area D were drilled with a truck-mounted auger according to the Statement of Work with the exception of boreholes HAT-071, 073, 078, 086, and 088 which were moved due to difficult access or shallow depth to bedrock. Borehole HAT-084 was abandoned due to both the lack of access and to shallow depth to bedrock. Borehole HAT-085 was drilled using a portable auger.

Boreholes in Areas E and F, which had approximate locations specified in the Statement of Work, were drilled with both truck-mounted auger in easily accessible locations and portable auger in difficult-access areas. Boreholes were located by the Technical Assistance Contractor and the Bendix site manager to

accommodate drilling and to provide the best subsurface information. Boreholes originally located along the southern periphery of both piles were moved inward to the edge of the tailings because the original approximate locations were 10 to 12 ft in elevation above the tailings piles, which would have required drilling approximately 10 ft of bedrock to reach the desired depth. These holes were drilled to determine the amount of leaching of contamination below the tailings/bedrock interface.

In Area A two small areas contained thick accumulations of contaminated materials (tailings, uranium ore, sulfur, and other debris) which could not be fully evaluated using the delta-gamma measurements. One borehole was placed in the approximate center of each pile of contaminated material.

A soil sample was taken from a depth of 0 to 6 in. at each borehole location prior to drilling. Appendix B, Table B-1 contains the results of analysis of the samples.

4.4.2 Geophysical Borehole-Logging Results

4.4.2.1 Borehole Logging with the Truck-Mounted System. The truck-mounted spectral gamma-ray logging system was used to log 32 boreholes of which 10 were in Area C, 9 were in Area D, 6 were in Area E, and 7 were in Area F. The radiometric logs are provided on microfiche in Appendix E; borehole-logging and equipment data are presented in Table E-1.

The logs of boreholes located in the ore-storage area (Area C) indicate that contamination exceeding the EPA standard of 5 pCi(eRa-226)/g above background is spotty and ranges from no contamination (HAT-021, 023, 029, and 045) to contamination at a depth of 5 ft (HAT-022). The deepest and most extensive contamination is found in boreholes surrounding the foundation of the old mill (HAT-022, 026, 031, and 035). The borehole drilled next to the truck scale also contains contamination from the surface to 4 ft in depth.

Logs of boreholes located in Area D also indicate that contamination exceeding EPA standards is spotty. In general the contamination is shallow (0 to 6 in. in HAT-073, 074, 080, 084, and 088) with the exception of boreholes HAT-071, 075, 081, 083, and 086, which have spotty contamination to a depth of 4 ft, 7.5 ft, 10.5 ft, 6.5 ft, and 2 ft, respectively. These holes are located in the arroyo containing water-transported tailings.

The logs of boreholes using the truck-mounted system located in Areas E and F are confined to boreholes located along the northern periphery of the upper and lower piles with the exception of boreholes HAT-120 and 121, located on the west edge of the upper pile and HAT-110 located on the south portion of the berm road between the upper and lower pile. Contamination, with the exception of boreholes HAT-102 and 103, is deep, often extending to the total depth of the hole.

4.4.2.2 Borehole Logging with the RASCAL Portable System. The RASCAL system was used to log boreholes that were generally not accessible by the truck-mounted logging system or that were shallow (<5 ft). The radiometric logs are provided on microfiche in Appendix E; borehole-logging and equipment data are presented in Table E-2.

Uncertainties in the final eRa-226 concentrations were calculated at the 95 percent confidence level (two standard deviations) and include terms for the following parameters:

- Statistics of the observed count rate.
- The deconvolution algorithm.
- Correction factors for casing, auger joints, and moisture, as well as background contributions of potassium and thorium concentrations.
- The k-factor (conversion factor for total gamma-ray count rate to radium concentration) for the system.

These calculated uncertainties may be used, together with calculated concentration values, to quantify radium concentrations as being definitely below specific limits with 95 percent confidence.

Radium concentrations at or near the surface, as indicated by borehole radiometric logs, do not agree with concentrations determined from gamma-ray spectroscopic analysis of 0-to-6-in.-deep soil samples, because the calibration procedure does not simulate the air/earth interface at the top of the borehole. The borehole-logging systems are calibrated in the middle of a zone of radioactive material assumed to appear infinitely thick and homogenous for gamma-ray generation and propagation. This same assumption is then made for the borehole when processing the log data, with appropriate deconvolution to correct for adjacent bed effects, but not near-surface and surface measurements for the air/earth interface effects.

A total of 82 boreholes were logged using the RASCAL system. Fourteen of these boreholes were drilled with a portable auger and were logged without casing. The remaining boreholes were logged through hollow-stem augers.

RASCAL borehole logs in Area C indicate that contamination, as with the truck-mounted logging, is spotty as was also indicated by the Compulogger system. Of 37 holes logged using the RASCAL system in this area, 27 of the boreholes did not contain contamination exceeding EPA standards below a depth of 6 in. Of the 10 that did contain greater than 5 pCi(eRa-226)/g below a depth of 6 in., only 4 had contamination below a depth of 1 ft.

RASCAL logs from boreholes in Area D indicated no contamination exceeding EPA standards below a depth of 6 in.

Logs of boreholes in Areas E and F indicate that contamination along the northern periphery of the upper and lower piles (HAT-101, 152, 154, 155, 156, and 158) is shallow, with depths to 6 in. or less. Contamination along the eastern periphery of the lower pile (windblown-tailings area) is more extensive, with depths to 12 ft. Boreholes on the southern periphery were drilled to bedrock on the edge of the tailings with a portable auger. In most cases the contamination exceeds 5 pCi(eRa-226)/g at the bottom of the hole. To fully test the amount of leaching below the tailings/Halgaito shale interface requires truck-mounted rotary drilling. Logs of boreholes along the west edge of the upper pile indicate that contamination is shallow, with depths generally less than 1 ft.

Logs of the two boreholes in Area A (HAT-124 and 125), which were drilled to test small piles of contamination, indicate that in HAT-124 approximately 7 ft of contaminated material exists from surface to bedrock; HAT-125 appears to contain a 5-ft-thick zone of contaminated material.

4.5 BUILDING SURVEY RESULTS

The eight buildings at the Mexican Hat site stand in relatively high gamma fields (often referred to as 'pile shine') due to their proximity to the tailings piles and the ore-storage area, and consequently only one indoor gamma exposure-rate measurement was made in the approximate center of each building at a height of one meter. Surface alpha measurements were made at approximately four locations per 1000 square feet of floor space. In abandoned buildings a surface reading was taken, the surface was brushed and wiped with a disposable wipe, and then a second reading was taken. This procedure gave a general indication of removable versus nonremovable contamination levels. In the two occupied buildings (the Halchita Health Clinic and the sheet metal shop, which is now used as a storage shed) direct measurements were taken, followed by smears on Rad-wipe filter paper which were then counted. Appendix F provides building diagrams showing measurement locations (Figures F-1 through F-8) and alpha contamination and exposure-rate measurement data (Tables F-1 through F-8).

The Halchita Health Clinic (building number 8) and the sheet metal shop storage building (building number 2) show little sign of alpha contamination. Alpha measurements in the former trade school building (building number 5) also indicate that little alpha contamination is present, ranging from 10 to a maximum of 130 cpm. Much of the alpha activity appears to be removable. Building 5 appears to contain a large amount of salvageable materials (e.g. structural steel). Another small metal building (building number 3) has higher alpha activity on the floor (135-220 cpm), but most of the alpha contamination appears to be removable and the building itself appears to be in good condition. The remaining buildings, the scale house building (number 7), ore-crushing building (number 1), generator building (number 4), and the small brick building (number 6), were either highly contaminated (number 7 and number 1) or had little salvage value (number 4 and number 6).

4.6 BACKGROUND CHARACTERIZATION RESULTS

Four locations were chosen for background measurements in the area of the Mexican Hat site (cf. Figure 1). Three of five background locations established during the site orientation visit were chosen as final background locations for the site. A fourth location was established during the fieldwork phase of the project. Background measurement areas were to be, according to the Statement of Work, at least 3 miles east or northeast of the site and at least 1 mile from the site in other directions. Background locations BG-1, 2b, 3, and 4 are located approximately 5 miles south, 2 miles west-southwest, 3 miles northeast, and 0.5 mile east of the Mexican Hat site, respectively. The background location BG-4 is located just west of Gypsum Wash; the lack of access to areas east of Gypsum Wash prevented the establishment of a background site 3 miles east as stated in the Statement of Work. All of the background

sites were located on weathered, red silty sandstones and shales of the Halgaito Tongue, a member of the Cutler Formation, similar to the geologic setting at the Mexican Hat site.

Gamma exposure-rate measurements, delta measurements, and soil samples were taken at each background location. Results of measurements and laboratory analyses of soil samples are presented in Appendix G, Table G-1.

The PIC exposure-rate measurements yield a mean background exposure rate of 11.6 ± 0.7 μR/h for the Mexican Hat area which is consistent with values reported by previous studies.

Delta-gamma measurements at each background location indicate that background eRa-226 concentrations range from 1.1 to 2.5 pCi/g with a mean of 1.6 ± 0.4 pCi/g.

Analyses of soil samples taken from the background locations had Ra-226 concentrations ranging from 0.7 to 2 pCi/g and a mean of 1.2 ± 0.4 pCi/g, Th concentrations ranging from 1 to 9.9 ppm and a mean of 5.4 ± 2.8 ppm, and K concentrations ranging from 1.3 to 1.8 percent and a mean of 1.4 ± 0.3 percent. For purposes of determining areas containing 5 pCi (eRa-226)/g above background, a background concentration of 1 pCi (eRa-226)/g can be used.

5.0 SUMMARY

Arroyo contamination consisting of windblown and water-transported tailings is the most widespread and problematic contamination at the Mexican Hat site. Spotty contamination is present in the bottom of arroyos from the north, northeast, and east edges of the tailings piles to their confluence with Gypsum Wash, approximately 2200 ft downstream from the lower pile. The contamination consists of elongated sand bars ranging in thickness from 6 in. to approximately 2 ft. This material contains eRa-226 concentrations greater than the EPA standard of 5 pCi/g above background.

Surface windblown contamination is widespread to the northeast and east of the tailings piles; contamination exceeds 5 pCi(eRa-226)/g approximately 1000 ft north and approximately 800 ft east of the lower pile. Results show that most of this contamination does not extend below a depth of 6 in. To the south and west no windblown contamination exceeding 5 pCi(eRa-226)/g was found.

Contamination in the ore-storage and mill areas is spotty and, due to the shallow depth to bedrock, is generally shallow as well. This contamination consists of a variety of materials including tailings, uranium ore, and other buried debris. The deepest contamination occurs in an area surrounding the large concrete foundation of the old mill.

The sewage pond and arroyo area in the northwest portion of the site do not appear to contain contamination exceeding 5 pCi(eRa-226)/g except in and along the banks of the small arroyo draining to the north. Results of drilling indicate that near the head of the arroyo (near the upper pile) water-transported tailings contamination exceeding EPA standards is present to as much as 10.5 ft in depth. Farther to the north near U.S. Highway 163, the contamina-

tion is shallow (less than 1 ft), except for dozed material on the east bank of the arroyo where contaminated material has been piled to a thickness of approximately 4 ft.

Several buildings at the Mexican Hat site are salvageable or contain large amounts of salvageable materials which are not contaminated. The Halchita Health Clinic was found to be free of contamination and in good condition. The sheet metal shop (former lab building), which is now used for storage of insulation and building supplies, was also found to be uncontaminated and in good condition. An empty metal shed was found to contain minor contamination but it appears that most of this contamination is in the form of removable radioactive dust, and the building is in good condition. The long building formerly used as a trade school also appears to contain minor removable contamination. Although missing large areas of metal siding and roofing, this building contains a large amount of salvageable materials. The remaining buildings are either contaminated or have little salvage value.

Appendix A

INSTRUMENT-PERFORMANCE FIELD CHECKS

Instrument-response field checks were performed on each instrument before use each day. These checks were performed in an area near the motel in Mexican Hat at which the radiologic-characterization field crew was housed.

Readings were recorded in the appropriate data book and plotted on a graph that displayed a history of previous field-check results and specified quality-control limits, which were established as two standard deviations (2σ) from the mean of the previous readings. Readings which fell outside these limits were repeated to determine if they were the result of an instrumentation problem or of the statistical probability that approximately 5 percent could be expected to fall outside these specified limits. Values used for the mean and standard deviation were based on field-check data accumulated during the previous site characterizations.

For field-checking the Bendix delta-gamma units, a field-check source fixture held both the detector and a uranium-button source in a fixed geometry while a 100-second UP count was collected. The source was then removed to a point beyond its range of influence, and a 100-second DOWN count was collected. The resulting delta count was recorded in the appropriate data book, plotted on the graph, and checked for compliance with the 2-sigma quality-control limits.

A calibration jig was used for field-checking the portable spectrometers. A 240-second background count was followed by successive 240-second counts with a uranium-button source and a thorium-button source. The uranium source provided test counts in the K and gross-count channels as well as in the U channel, and the thorium source provided a test of the Th channel. Background counts in each channel were subtracted from the source counts, and net counts were recorded in the appropriate data book. Again, the counts were plotted and checked for compliance with quality-control limits.

For field-checking the Reuter-Stokes pressurized ionization chamber (PIC), a small source-holding fixture mounted permanently to the detector housing was used. A background reading was obtained using a built-in integrator to determine the average exposure-rate in μR/h over a 90-second interval. Following determination of background exposure rate, a radium button source was placed in the source-holding fixture and the average exposure rate over a 90-second interval was again determined. The background rate was subtracted from this second rate to determine the net exposure rate from the source. The rate was recorded in the appropriate data book and checked for compliance with quality-control limits. To monitor PIC performance at two different exposure levels, the procedure was repeated using 1-μCi and 10-μCi check sources.

Appendix B

ANALYTICAL DATA FOR SOIL SAMPLES

Table B-1 presents gamma-ray-spectroscopy data for the soil samples collected. The analytical uncertainties are reported at the two-standard-deviation (2σ) level. Radium, thorium, and potassium values represent equivalent concentrations. The MHD numbers in the table are sample numbers. The depth indicated refers to the top of a 6-inch sample interval. The borehole number is included for those samples taken from borehole locations. A less-than sign (<) indicates the value is below the detection limits of the analytical instrument being used.

Table B-1

Gamma-Ray-Spectroscopy Data for Soil Samples

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
11800	11600	0		198	2 ± 1	5 ± 1	2.1 ± 0.5
11600	11600	0		197	3 ± 1	< 2 ± 0	0.9 ± 0.2
11600	12000	0		200	4 ± 1	4 ± 1	1.1 ± 0.3
11400	11200	0		192	8 ± 1	11 ± 2	1.4 ± 0.3
11400	11600	0		196	6 ± 1	< 2 ± 0	1.0 ± 0.2
11202	11600	0		195	6 ± 1	< 2 ± 0	0.8 ± 0.2
11200	10800	0		189	7 ± 1	9 ± 2	1.1 ± 0.3
11200	11200	0		193	6 ± 1	6 ± 2	1.5 ± 0.3
11200	12000	0		199	10 ± 1	< 2 ± 0	1.2 ± 0.3
11000	10400	0		188	5 ± 1	6 ± 2	0.9 ± 0.2
11000	10802	0		190	5 ± 1	6 ± 2	1.1 ± 0.2
11000	11200	0		194	8 ± 1	8 ± 2	2.1 ± 0.5
10800	9000	0		131	1 ± 1	9 ± 2	1.7 ± 0.4
10800	9400	0		132	2 ± 1	4 ± 1	1.4 ± 0.4
10800	10000	0		184	2 ± 1	4 ± 1	1.0 ± 0.2
10800	10400	0		187	3 ± 1	7 ± 2	1.3 ± 0.3
10800	10800	0		191	6 ± 1	7 ± 2	1.0 ± 0.2
10800	11600	0		144	35 ± 2	15 ± 4	1.1 ± 0.3
10800	12400	0		152	7 ± 1	4 ± 2	1.1 ± 0.3
10800	12800	0		153	4 ± 1	6 ± 2	1.5 ± 0.3
10600	8200	0		311	15 ± 1	19 ± 3	1.0 ± 0.2
10600	9000	0		130	2 ± 1	6 ± 1	1.0 ± 0.3
10600	9400	0		183	2 ± 1	7 ± 2	1.3 ± 0.3
10600	9600	0		133	2 ± 1	10 ± 2	1.8 ± 0.4
10600	10400	0		185	100 ± 5	< 3 ± 0	1.0 ± 0.3
10600	10400	6		186	64 ± 4	< 3 ± 0	0.8 ± 0.2
10600	10800	0		141	16 ± 1	< 2 ± 0	1.1 ± 0.3
10600	11200	0		142	31 ± 2	< 2 ± 0	0.9 ± 0.3
10600	11600	0		143	16 ± 1	< 2 ± 0	1.3 ± 0.3
10446	11063	0	158	591	139 ± 9	< 4 ± 0	< 0.6 ± 0.0

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
10400	8000	0		576	3 ± 1	5 ± 1	2.1 ± 0.2
10400	8200	0		307	24 ± 1	< 3 ± 0	0.9 ± 0.2
10400	8200	6		308	53 ± 3	< 3 ± 0	1.1 ± 0.3
10400	8200	12		309	39 ± 2	< 3 ± 0	0.9 ± 0.2
10400	8200	18		310	34 ± 2	< 3 ± 0	0.8 ± 0.2
10400	8400	0		306	2 ± 1	< 2 ± 0	1.0 ± 0.3
10400	8800	0		128	2 ± 1	9 ± 2	1.4 ± 0.4
10400	9000	0		129	3 ± 1	7 ± 1	1.3 ± 0.4
10400	9400	0		182	2 ± 1	6 ± 2	1.2 ± 0.3
10400	10000	0		138	3 ± 1	7 ± 2	1.1 ± 0.3
10400	10400	0		139	12 ± 1	9 ± 2	1.4 ± 0.3
10400	10800	0		140	28 ± 2	< 2 ± 0	1.1 ± 0.3
10400	11200	0		145	132 ± 6	< 4 ± 0	0.6 ± 0.2
10400	11600	0		147	37 ± 2	14 ± 4	1.4 ± 0.4
10350	8173	0	71	560	18 ± 1	9 ± 3	1.5 ± 0.3
10320	10788	0	157	590	81 ± 5	< 3 ± 0	< 0.6 ± 0.0
10263	10614	0	156	589	79 ± 5	22 ± 3	1.5 ± 0.2
10223	11088	0	159	592	226 ± 15	< 5 ± 0	< 0.6 ± 0.0
10200	8000	0		283	5 ± 1	< 1 ± 0	1.4 ± 0.3
10200	8100	0	72	562	8 ± 1	< 1 ± 0	0.8 ± 0.2
10200	8400	0		305	2 ± 1	9 ± 2	2.3 ± 0.5
10200	9000	0		126	3 ± 1	4 ± 1	1.3 ± 0.4
10200	9400	0		181	3 ± 1	5 ± 2	1.3 ± 0.3
10200	9800	0		136	4 ± 1	10 ± 2	1.7 ± 0.4
10200	10000	0		137	11 ± 1	18 ± 3	0.9 ± 0.4
10200	11600	0		149	38 ± 2	< 2 ± 0	1.2 ± 0.3
10200	11800	0		146	110 ± 6	< 3 ± 0	0.9 ± 0.3
10200	11800	6		148	166 ± 8	45 ± 9	0.9 ± 0.3
10200	11800	12		150	171 ± 8	< 4 ± 0	0.9 ± 0.3
10200	12000	0		154	12 ± 1	12 ± 3	1.8 ± 0.4
10200	12200	0		155	9 ± 1	< 2 ± 0	1.5 ± 0.4
10200	12400	0		156	4 ± 1	< 2 ± 0	1.2 ± 0.3
10200	12600	0		157	6 ± 1	< 2 ± 0	1.3 ± 0.3
10200	12800	0		158	8 ± 1	9 ± 2	0.6 ± 0.2
10159	10478	0	155	586	20 ± 1	8 ± 2	1.6 ± 0.2
10152	9290	0	125	605	369 ± 18	< 6 ± 0	0.8 ± 0.3
10109	10340	0	154	588	41 ± 1	13 ± 2	2.3 ± 0.2
10108	11416	0	161	594	22 ± 2	< 2 ± 0	1.3 ± 0.3
10107	11416	0	160	593	164 ± 8	< 5 ± 0	< 0.7 ± 0.0
10105	11302	0	177	613	167 ± 8	45 ± 9	< 0.3 ± 0.0
10050	8100	0	73	561	2 ± 1	5 ± 2	1.3 ± 0.3
10012	11622	0	179	597	168 ± 8	< 5 ± 0	< 0.7 ± 0.0
10000	7800	0		282	1 ± 1	3 ± 1	1.2 ± 0.3
10000	8100	0	73	559	19 ± 1	< 2 ± 0	1.2 ± 0.3
10000	8300	0		284	2 ± 1	7 ± 2	1.1 ± 0.3
10000	8500	0		281	3 ± 1	6 ± 1	1.2 ± 0.3
10000	8700	0		280	1 ± 1	4 ± 2	1.0 ± 0.3

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
10000	8900	0		127	3 ± 1	4 ± 1	1.1 ± 0.4
10000	9200	0		176	535 ± 21	< 5 ± 0	1.2 ± 0.2
10000	9200	6		177	437 ± 17	< 5 ± 0	1.0 ± 0.2
10000	9200	12		178	504 ± 18	< 5 ± 0	0.7 ± 0.1
10000	9200	18		179	458 ± 18	< 11 ± 0	0.9 ± 0.5
10000	9400	0		180	4 ± 1	8 ± 2	1.8 ± 0.4
10000	9600	0		134	11 ± 1	17 ± 3	1.5 ± 0.4
10000	9800	0		135	9 ± 1	22 ± 3	2.6 ± 0.5
9999	10095	0	153	585	7 ± 1	12 ± 2	3.2 ± 0.3
9998	11407	0	178	610	239 ± 12	< 5 ± 0	0.8 ± 0.3
9960	9246	0	124	604	676 ± 33	< 7 ± 0	< 0.4 ± 0.0
9957	11511	0	180	611	217 ± 10	52 ± 11	< 0.3 ± 0.0
9907	9847	0	152	587	15 ± 1	19 ± 2	2.3 ± 0.2
9900	8000	0	74	563	3 ± 1	4 ± 1	1.4 ± 0.4
9900	8100	0	75	558	31 ± 2	69 ± 7	1.3 ± 0.3
9818	11533	0	163	612	198 ± 9	< 5 ± 0	0.7 ± 0.3
9807	9149	0	102	550	50 ± 3	< 3 ± 0	1.4 ± 0.4
9801	9638	0	151	570	39 ± 3	17 ± 3	1.4 ± 0.5
9800	7700	0	76	609	1 ± 1	5 ± 1	1.0 ± 0.2
9800	8100	0	77	557	153 ± 7	51 ± 10	< 0.3 ± 0.0
9800	8198	0	78	564	3 ± 1	6 ± 2	1.8 ± 0.4
9800	8500	0		304	3 ± 1	8 ± 2	1.3 ± 0.3
9800	8700	0		303	1 ± 1	5 ± 1	1.4 ± 0.3
9800	8990	0	101	549	88 ± 5	324 ± 19	0.8 ± 0.2
9800	11800	0		201	34 ± 3	< 3 ± 0	0.8 ± 0.2
9800	12000	0		163	23 ± 1	12 ± 2	1.4 ± 0.2
9800	12200	0		161	22 ± 1	< 3 ± 0	1.0 ± 0.2
9800	12400	0		160	7 ± 1	10 ± 2	1.3 ± 0.3
9800	12600	0		159	3 ± 1	8 ± 2	1.3 ± 0.3
9762	9322	0	103	566	194 ± 11	47 ± 8	1.1 ± 0.4
9700	8100	0	79	565	3 ± 1	7 ± 1	1.1 ± 0.4
9700	8200	0	80	556	13 ± 1	10 ± 3	0.9 ± 0.2
9700	8300	0	81	555	37 ± 2	< 2 ± 0	1.1 ± 0.3
9700	8600	0	82	554	15 ± 1	11 ± 3	1.2 ± 0.3
9697	11614	0	164	595	21 ± 1	< 3 ± 0	1.9 ± 0.4
9652	9489	0	104	567	303 ± 17	85 ± 12	1.3 ± 0.5
9642	8775	0	123	572	12 ± 1	6 ± 2	1.5 ± 0.4
9600	8200	0	83	553	277 ± 13	< 5 ± 0	1.0 ± 0.4
9600	8300	0		577	3 ± 1	5 ± 1	1.5 ± 0.1
9600	8500	0		225	2 ± 1	5 ± 1	1.4 ± 0.1
9600	8700	0		302	3 ± 1	4 ± 2	1.4 ± 0.3
9538	11662	0	165	596	64 ± 5	38 ± 6	0.9 ± 0.3
9530	9648	0	105	568	300 ± 18	168 ± 17	0.6 ± 0.4
9410	8490	0	111	607	4 ± 1	6 ± 2	1.3 ± 0.3
9400	8300	0	87	551	3 ± 1	6 ± 2	1.0 ± 0.2
9400	8600	0		224	6 ± 1	6 ± 1	1.8 ± 0.2
9400	9799	0	106	569	49 ± 3	9 ± 3	1.7 ± 0.4

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
9400	11800	0		165	9 ± 1	10 ± 2	1.9 ± 0.2
9400	12200	0		167	7 ± 1	10 ± 2	2.7 ± 0.2
9400	12600	0		171	5 ± 1	8 ± 1	1.5 ± 0.2
9390	8200	0	86	552	482 ± 24	< 7 ± 0	< 0.4 ± 0.0
9373	8783	0	122	573	789 ± 29	< 13 ± 0	1.7 ± 0.6
9280	7520	0	88	548	1 ± 1	< 2 ± 0	0.7 ± 0.2
9240	7400	0		270	1 ± 1	5 ± 1	1.5 ± 0.4
9208	9849	0	107	571	199 ± 10	88 ± 11	1.4 ± 0.4
9200	7900	0	11	501	32 ± 2	< 3 ± 0	1.2 ± 0.3
9200	8500	0	14	504	29 ± 2	< 2 ± 0	0.6 ± 0.2
9200	12000	0		169	6 ± 1	7 ± 1	1.6 ± 0.2
9200	12400	0		170	5 ± 1	9 ± 1	2.2 ± 0.2
9199	11424	0	166	598	59 ± 4	15 ± 4	0.5 ± 0.2
9163	8790	0	121	574	9 ± 1	7 ± 2	2.9 ± 0.5
9104	11372	0	167	599	198 ± 11	< 5 ± 0	< 0.7 ± 0.0
9095	10924	0	170	602	241 ± 14	< 5 ± 0	< 0.7 ± 0.0
9014	8836	0	120	575	302 ± 17	< 9 ± 0	1.6 ± 0.5
9010	8100	0	12	502	5 ± 1	< 2 ± 0	1.0 ± 0.3
9008	8500	0	17	507	11 ± 1	< 2 ± 0	0.6 ± 0.2
9004	9074	0	119	580	5 ± 1	13 ± 2	1.8 ± 0.2
9000	7600	0		268	3 ± 1	5 ± 1	1.3 ± 0.4
9000	7800	0		221	4 ± 1	4 ± 1	0.9 ± 0.2
9000	7900	0	15	509	2 ± 1	4 ± 1	1.5 ± 0.4
9000	8100	0	16	508	16 ± 2	< 2 ± 0	0.9 ± 0.2
9000	8500	0	18	506	75 ± 5	< 3 ± 0	0.5 ± 0.2
9000	8700	0	19	505	87 ± 5	< 4 ± 0	< 0.6 ± 0.0
9000	11600	0		168	3 ± 1	9 ± 1	1.8 ± 0.2
9000	11800	0		266	11 ± 1	10 ± 2	1.1 ± 0.3
9000	12200	0		173	5 ± 1	8 ± 1	1.9 ± 0.2
8990	8300	0	13	503	15 ± 2	< 2 ± 0	0.5 ± 0.2
8978	11269	0	168	600	155 ± 8	< 5 ± 0	0.2 ± 0.1
8945	10732	0	171	603	321 ± 16	316 ± 21	< 0.7 ± 0.0
8922	11004	0	169	601	111 ± 5	223 ± 15	< 0.7 ± 0.0
8900	8100	0	20	510	11 ± 1	4 ± 1	1.0 ± 0.4
8900	8200	0	21	511	3 ± 1	6 ± 1	1.6 ± 0.4
8900	8425	0	22	512	30 ± 2	24 ± 4	1.7 ± 0.4
8852	8980	0	118	581	3 ± 1	10 ± 1	2.8 ± 0.3
8800	7200	0		222	1 ± 1	5 ± 1	1.1 ± 0.3
8800	7600	0		267	2 ± 1	7 ± 2	2.0 ± 0.4
8800	7800	0		220	2 ± 1	8 ± 2	1.6 ± 0.4
8800	7920	0	23	514	7 ± 1	6 ± 2	1.5 ± 0.4
8800	8100	0	24	513	11 ± 1	5 ± 1	1.5 ± 0.4
8800	8200	0	25	515	7 ± 1	8 ± 2	1.3 ± 0.4
8800	8420	0	26	516	126 ± 6	42 ± 7	2.0 ± 0.5
8800	8700	0	27	543	114 ± 8	< 4 ± 0	< 0.6 ± 0.0
8800	8900	0	28	542	10 ± 1	< 2 ± 0	1.7 ± 0.4
8800	10800	0		276	2 ± 1	8 ± 2	0.9 ± 0.2

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
8800	11000	0		230	2 ± 1	10 ± 2	2.1 ± 0.5
8800	11200	0		229	3 ± 1	7 ± 2	1.9 ± 0.4
8800	11400	0		226	7 ± 1	10 ± 1	1.3 ± 0.1
8800	11600	0		175	6 ± 1	7 ± 1	1.9 ± 0.2
8800	11800	0		265	5 ± 1	7 ± 2	0.9 ± 0.2
8790	7400	0		271	4 ± 1	8 ± 2	1.8 ± 0.4
8734	9097	0	117	582	7 ± 1	17 ± 2	2.3 ± 0.2
8700	7300	0	29	547	2 ± 1	< 2 ± 0	0.6 ± 0.2
8700	7700	0	30	608	1 ± 1	4 ± 1	0.8 ± 0.2
8700	8200	0	31	520	22 ± 2	6 ± 2	1.3 ± 0.4
8642	9559	0	110	606	3 ± 1	9 ± 2	1.1 ± 0.3
8600	7200	0		223	1 ± 1	4 ± 1	1.0 ± 0.1
8600	7400	0		272	1 ± 1	6 ± 1	1.5 ± 0.4
8600	7600	0		269	3 ± 1	6 ± 1	1.4 ± 0.4
8600	7800	0		219	2 ± 1	6 ± 2	1.3 ± 0.3
8600	7900	0	32	522	132 ± 10	< 7 ± 0	1.4 ± 0.4
8600	8100	0	33	521	127 ± 9	< 8 ± 0	1.3 ± 0.4
8600	8400	0	34	519	192 ± 15	32 ± 7	1.5 ± 0.5
8600	8500	0	35	518	76 ± 4	35 ± 6	1.6 ± 0.4
8600	8700	0	36	517	38 ± 2	8 ± 2	1.7 ± 0.4
8600	9008	0	116	583	20 ± 1	317 ± 16	1.9 ± 0.2
8600	10000	0		238	4 ± 1	5 ± 2	1.0 ± 0.2
8600	10400	0		239	5 ± 1	9 ± 2	< 0.5 ± 0.0
8600	10800	0		228	2 ± 1	14 ± 2	2.5 ± 0.5
8600	11200	0		227	4 ± 1	9 ± 2	1.9 ± 0.4
8590	8900	0	37	544	58 ± 4	194 ± 15	1.1 ± 0.3
8500	8200	0	39	523	103 ± 8	22 ± 3	1.7 ± 0.2
8490	7700	0	38	524	6 ± 1	7 ± 1	2.4 ± 0.2
8442	8964	0	115	584	50 ± 5	1384 ± 135	< 1.5 ± 0.0
8400	7400	0		273	43 ± 3	14 ± 3	1.2 ± 0.4
8400	7600	0		264	2 ± 1	5 ± 2	0.9 ± 0.2
8400	7800	0		218	37 ± 3	< 3 ± 0	< 0.6 ± 0.0
8400	7900	0	40	525	73 ± 5	< 3 ± 0	1.9 ± 0.2
8400	8100	0	41	526	120 ± 9	13 ± 3	1.7 ± 0.2
8400	8300	0	42	527	89 ± 6	109 ± 9	1.5 ± 0.2
8400	8500	0	43	528	40 ± 2	7 ± 2	1.6 ± 0.2
8400	8700	0	44	529	28 ± 1	10 ± 2	1.6 ± 0.2
8400	8800	0		210	112 ± 7	35 ± 7	1.3 ± 0.5
8400	8800	6		211	40 ± 3	10 ± 3	1.1 ± 0.4
8400	9600	0		241	3 ± 1	13 ± 2	1.3 ± 0.3
8400	10000	0		237	1 ± 1	6 ± 2	1.5 ± 0.4
8400	10400	0		234	2 ± 1	8 ± 2	1.6 ± 0.4
8300	7500	0	45	540	6 ± 1	< 2 ± 0	0.9 ± 0.2
8300	7500	0	45	541	2 ± 1	3 ± 1	1.3 ± 0.3
8300	7700	0	46	539	19 ± 1	< 2 ± 0	1.1 ± 0.3
8200	7200	0		278	1 ± 1	8 ± 2	1.3 ± 0.3
8200	7400	0		274	3 ± 1	8 ± 2	1.5 ± 0.4

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
8200	7600	0		263	2 ± 1	7 ± 2	1.1 ± 0.3
8200	7800	0		217	7 ± 1	< 2 ± 0	1.0 ± 0.2
8200	8100	0	47	533	363 ± 29	171 ± 16	1.2 ± 0.2
8200	8300	0	49	531	53 ± 3	37 ± 4	1.6 ± 0.2
8200	8500	0	50	530	127 ± 12	14 ± 3	0.9 ± 0.1
8200	8600	0		215	5 ± 1	6 ± 2	0.7 ± 0.2
8200	8750	0	51	545	70 ± 4	< 3 ± 0	0.7 ± 0.2
8200	8800	0		249	13 ± 1	< 2 ± 0	1.0 ± 0.3
8200	8800	6		212	13 ± 1	8 ± 1	1.4 ± 0.2
8200	8800	12		214	17 ± 1	6 ± 1	1.5 ± 0.2
8200	9200	0		243	1 ± 1	< 2 ± 0	0.8 ± 0.2
8200	9600	0		240	2 ± 1	< 2 ± 0	0.7 ± 0.2
8200	10000	0		236	1 ± 1	9 ± 2	1.5 ± 0.3
8200	10400	0		235	2 ± 1	11 ± 2	1.8 ± 0.4
8185	8100	0	48	532	47 ± 4	11 ± 2	1.8 ± 0.2
8000	7200	0		277	1 ± 1	5 ± 2	1.5 ± 0.3
8000	7400	0		275	2 ± 1	4 ± 1	1.1 ± 0.3
8000	7600	0		261	42 ± 3	< 2 ± 0	1.1 ± 0.3
8000	7600	6		262	49 ± 3	< 3 ± 0	1.2 ± 0.3
8000	7800	0		216	11 ± 1	11 ± 3	1.0 ± 0.3
8000	7900	0	52	534	75 ± 4	13 ± 3	1.6 ± 0.2
8000	8100	0	53	535	33 ± 2	< 3 ± 0	0.5 ± 0.1
8000	8300	0	54	536	47 ± 3	46 ± 6	1.4 ± 0.3
8000	8400	0		279	122 ± 6	< 4 ± 0	1.1 ± 0.3
8000	8600	0		202	17 ± 1	9 ± 2	1.2 ± 0.3
8000	8800	0		248	3 ± 1	8 ± 2	1.0 ± 0.3
8000	9000	0		247	6 ± 1	9 ± 2	1.2 ± 0.3
8000	9200	0		242	5 ± 1	7 ± 2	1.2 ± 0.3
7800	7400	0		258	1 ± 1	6 ± 2	1.1 ± 0.3
7800	7600	0		259	75 ± 4	< 3 ± 0	1.0 ± 0.3
7800	7600	6		260	27 ± 2	< 2 ± 0	1.2 ± 0.3
7800	7800	0		256	54 ± 3	< 3 ± 0	1.4 ± 0.3
7800	7800	6		257	8 ± 1	7 ± 2	1.6 ± 0.4
7800	7900	0	55	546	29 ± 2	31 ± 5	1.1 ± 0.3
7800	8000	0		255	3 ± 1	3 ± 1	1.0 ± 0.2
7800	8100	0	56	538	54 ± 4	< 3 ± 0	0.8 ± 0.2
7800	8200	0		252	106 ± 6	138 ± 11	< 0.7 ± 0.0
7800	8200	6		254	8 ± 1	< 2 ± 0	1.7 ± 0.4
7800	8300	0	57	537	252 ± 16	476 ± 33	< 0.7 ± 0.0
7800	8400	0		251	26 ± 2	16 ± 3	0.6 ± 0.2
7800	8600	0		253	71 ± 6	39 ± 6	1.7 ± 0.4
7800	8800	0		246	2 ± 1	< 2 ± 0	1.3 ± 0.3
7800	9000	0		245	1 ± 1	7 ± 2	0.8 ± 0.2
7800	9200	0		244	5 ± 1	7 ± 2	1.3 ± 0.3
7600	7635	0		207	3 ± 1	< 2 ± 0	1.2 ± 0.3
7600	7635	6		208	21 ± 2	< 6 ± 0	1.4 ± 0.4
7600	7635	12		209	10 ± 1	5 ± 1	1.5 ± 0.2

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
7600	7800	0		206	2 ± 1	< 2 ± 0	1.3 ± 0.3
7600	8000	0		205	2 ± 1	4 ± 1	1.1 ± 0.3
7600	8200	0		204	5 ± 1	12 ± 2	< 0.6 ± 0.0
7600	8400	0		250	285 ± 16	857 ± 51	< 0.7 ± 0.0
7600	8400	6		203	129 ± 10	399 ± 32	1.6 ± 0.4

Table B-2

Loss-On-Drying Results

Sample Number	LOD (%)	Sample Number	LOD (%)
MHD 101	1.21	MHD 191	0.62
MHD 102	0.57	MHD 199	0.63
MHD 103	1.21	MHD 212	1.13
MHD 104	1.71	MHD 227	1.38
MHD 105	2.52	MHD 238	0.84
MHD 106	5.08	MHD 249	1.23
MHD 107	4.21	MHD 260	2.65
MHD 108	3.66	MHD 268	1.24
MHD 109	4.15	MHD 277	0.68
MHD 110	3.47	MHD 304	1.61
MHD 111	2.33	MHD 504	2.46
MHD 112	3.06	MHD 512	5.04
MHD 113	6.96	MHD 524	2.08
MHD 114	3.06	MHD 535	1.48
MHD 115	2.34	MHD 538	1.33
MHD 117	2.48	MHD 552	3.27
MHD 126	2.01	MHD 560	1.24
MHD 129	0.52	MHD 574	2.43
MHD 143	1.12	MHD 583	5.09
MHD 155	0.80	MHD 589	0.89
MHD 178	6.26	MHD 599	0.68
MHD 183	0.95	MHD 608	1.91

APPENDIX C

DUPLICATE ANALYTICAL RESULTS

Table C-1 presents duplicate gamma-ray-spectroscopic analytical results for splits of approximately 10 percent of the soil samples collected. Radium, thorium, and potassium values represent equivalent concentrations. Table C-2 presents a comparison of the Ra-226 content in the soil sample (MHD) and the corresponding split (MBG). A less-than sign (<) indicates that the minimum detection limit based on Compton background was reached. A question mark (?) indicates that the analysis is semiquantitative due to a low count rate.

Table C-1

Duplicate Gamma-Ray-Spectroscopy Analytical Results

Sample Number	Ra-226 (pCi/g)		Error	Th (ppm)		Error	K (%)		Error
MBG-601	2.3	±	1.0	4.4	±	1.8	1.2	±	0.3
MBG-602	2.3	±	1.0	5.9	±	1.6	1.0	±	0.2
MBG-603	27.2	±	1.6	8.8	±	2.9	1.1	±	0.3
MBG-604	6.6	±	1.0	10.4	±	2.4	1.5	±	0.3
MBG-605	4.6	±	1.0	8.7	±	2.2	1.5	±	0.3
MBG-606	7.6	±	1.0	10.9	±	2.5	1.2	±	0.3
MBG-607	10.3	±	1.0	5.2	±	2.2	1.3	±	0.3
MBG-608	11.0	±	1.0	< 1.5	±	0.0	1.2	±	0.3
MBG-609	1.7	±	1.0	7.6	±	2.0	1.4	±	0.3
MBG-610	2.5	±	1.0	7.7	±	2.2	1.3	±	0.3
MBG-611	1.2	±	1.0	8.5	±	2.0	1.1	±	0.3
MBG-612	2.2	±	1.0	11.5	±	2.0	1.8	±	0.4
MBG-613	8.7	±	1.0	? 5.9	±	1.6	2.2	±	0.5
MBG-614	2.0	±	1.0	? 7.3	±	1.6	1.2	±	0.4
MBG-615	2.0	±	1.0	? 5.7	±	1.4	1.2	±	0.4
MBG-616	18.4	±	1.8	? 6.3	±	1.8	1.3	±	0.4
MBG-617	74.5	±	3.1	35.0	±	5.7	1.7	±	0.4
MBG-618	41.6	±	2.4	? 7.8	±	2.4	1.5	±	0.4
MBG-619	4.6	±	1.0	? 4.0	±	1.0	1.7	±	0.4
MBG-620	39.7	±	2.2	< 7.2	±	0.0	1.5	±	0.4
MBG-621	67.6	±	4.3	< 7.1	±	0.0	1.5	±	0.4
MBG-622	? 1.0	±	1.0	? 7.4	±	1.6	1.2	±	0.4
MBG-623	31.8	±	1.6	59.5	±	6.3	? 0.8	±	0.2
MBG-624	297.3	±	14.9	110.4	±	12.3	< 0.7	±	0.0
MBG-625	1.0	±	1.0	? 3.0	±	1.4	? 1.0	±	0.2
MBG-626	38.1	±	2.5	< 2.7	±	0.0	1.2	±	0.3
MBG-627	179.8	±	9.8	< 4.6	±	0.0	< 0.7	±	0.0

All errors reported in Table C-2 are expected analytical errors at 2σ. One sample showed a difference greater than expected. Re-analysis of this data set showed no significant change in either value. This difference is attributed to sample preparation.

Table C-2

Comparison of Radium Results Between Samples and Corresponding Splits

Sample Number	Ra-226 (pCi/g)			Duplicate Sample Number	Ra-226 (pCi/g)		
MHD-126	2.5	±	1.0	MBG-601	2.3	±	1.0
MHD-132	2.2	±	1.0	MBG-602	2.3	±	1.0
MHD-140	28.3	±	1.6	MBG-603	27.2	±	1.6
MHD-160	6.5	±	1.0	MBG-604	6.6	±	1.0
MHD-173	4.8	±	1.0	MBG-605	4.6	±	1.0
MHD-189	7.4	±	1.0	MBG-606	7.6	±	1.0
MHD-199	9.6	±	1.0	MBG-607	10.3	±	1.0
MHD-209	10.1	±	1.0	MBG-608	11.0	±	1.0
MHD-219	1.9	±	1.0	MBG-609	1.7	±	1.0
MHD-229	2.8	±	1.0	MBG-610	2.5	±	1.0
MHD-245	.9	±	1.0	MBG-611	1.2	±	1.0
MHD-235	2.2	±	1.0	MBG-612	2.2	±	1.0
MHD-257	8.0	±	1.0	MBG-613	8.7	±	1.0
MHD-264	2.2	±	1.0	MBG-614	2.0	±	1.0
MHD-275	2.0	±	1.0	MBG-615	2.0	±	1.0
MHD-508	16.0	±	1.6	MBG-616	18.4	±	1.8
MHD-518	75.7	±	3.7	MBG-617	74.5	±	3.1
MHD-528	39.3	±	2.2	MBG-618	41.6	±	2.4
MHD-283	4.9	±	1.0	MBG-619	4.6	±	1.0
MHD-309	39.0	±	1.0	MBG-620	39.7	±	2.2
MHD-538	54.4	±	3.7	MBG-621	67.6	±	4.3
MHD-548	1.0	±	1.0	MBG-622	1.0	±	1.0
MHD-558	30.6	±	1.0	MBG-623	31.8	±	1.6
MHD-568	299.9	±	18.4	MBG-624	297.3	±	14.6
MHD-578	1.1	±	1.0	MBG-625	1.0	±	1.0
MHD-588	40.7	±	1.4	MBG-626	38.1	±	2.5
MHD-613	167.0	±	7.8	MBG-627	179.8	±	9.8

Appendix D

DELTA-GAMMA RADIUM MEASUREMENT DATA

Table D-1 presents results of the in-situ delta-gamma radium measurements. The two-standard-deviation (2σ) error reported in this table reflects only the uncertainty in the counting statistics; it does not include errors introduced through the use of a calibration factor and three correction factors. These data were generated using the computer program DELTCALC.BAS, Version 1.1. Radium values represent equivalent concentrations.

Table D-1

In-Situ Delta-Gamma Radium Measurement Results

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)	Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
11600	11600	0	2.3 ± 0.8	10800	12000	0	10.8 ± 1.5
11600	11600	6	0.3 ± 0.6	10800	12000	6	* 0.6
11600	12000	6	0.9 ± 0.8	10800	12400	6	0.4 ± 0.7
11400	12450	0	95.8 ± 3.0	10800	12800	6	0.6 ± 0.7
11400	12450	6	131.5 ± 4.0	10775	11100	0	45.3 ± 1.9
11400	12450	12	65.8 ± 3.6	10775	11100	6	41.3 ± 2.7
11400	12450	15	28.1 ± 4.5	10775	11100	12	5.4 ± 1.9
11275	12325	0	39.3 ± 1.8	10775	11100	14	1.8 ± 2.1
11275	12325	6	2.4 ± 1.4	10775	12125	0	69.7 ± 3.0
11202	11600	6	1.7 ± 0.7	10775	12125	6	4.6 ± 2.2
11200	10800	6	0.6 ± 0.7	10725	10750	0	59.6 ± 2.3
11200	11200	6	0.4 ± 0.7	10725	10750	6	38.8 ± 2.9
11200	12000	6	2.3 ± 1.0	10725	10750	12	2.1 ± 1.7
11090	12225	0	6.1 ± 1.4	10700	10575	0	55.4 ± 2.5
11090	12225	6	1.1 ± 0.9	10700	10575	6	4.5 ± 1.9
11000	10400	0	3.7 ± 0.8	10700	10575	12	2.2 ± 1.2
11000	10400	6	0.7 ± 0.8	10700	10925	0	20.1 ± 1.5
10925	12125	0	37.1 ± 2.4	10700	10925	6	1.5 ± 0.9
10925	12125	6	4.2 ± 1.8	10650	12050	0	68.4 ± 3.1
10900	11650	0	3.8 ± 1.2	10650	12050	6	32.0 ± 3.1
10850	11475	0	31.4 ± 2.2	10600	8200	2	3.1 ± 0.9
10850	11475	6	4.0 ± 1.7	10600	9000	6	2.6 ± 0.8
10825	11825	0	22.8 ± 1.4	10600	9600	6	1.6 ± 0.9
10825	11825	6	31.0 ± 1.9	10600	10400	6	15.8 ± 3.5
10825	11825	12	39.8 ± 2.4	10600	10400	8	11.1 ± 3.3
10825	11825	18	11.1 ± 2.3	10600	11200	6	0.7 ± 1.3
10800	9400	6	0.5 ± 0.6	10550	10050	0	41.4 ± 2.1
10800	10000	6	0.9 ± 0.8	10550	10050	4	6.7 ± 1.8
10800	10800	6	0.3 ± 0.7	10525	9875	0	35.6 ± 2.2
10800	11300	0	41.3 ± 2.7	10525	9875	6	16.0 ± 2.1
10800	11300	6	2.9 ± 1.6	10525	9875	12	* 1.5
10800	11600	6	2.4 ± 1.3	10525	11950	0	135.1 ± 3.9
				10525	11950	6	78.4 ± 3.1

*There is at least 95 percent confidence that the true value is less than the measurement reported.

Table D-1 (continued)

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
10525	11950	10	10.8 ± 2.7
10500	10200	0	240.2 ± 4.5
10500	10200	6	278.1 ± 6.0
10500	10200	12	2.2 ± 4.1
10450	9700	0	12.8 ± 1.6
10450	9700	4	1.1 ± 1.2
10400	8000	6	0.7 ± 0.6
10400	8200	6	45.4 ± 2.1
10400	8200	12	24.1 ± 2.5
10400	8200	18	15.9 ± 2.6
10400	8200	24	4.1 ± 1.9
10400	8400	6	0.9 ± 0.8
10400	8800	6	0.7 ± 0.8
10400	9400	6	0.9 ± 0.7
10400	10400	6	1.5 ± 0.9
10400	10800	6	2.3 ± 1.3
10400	11600	6	3.6 ± 1.4
10325	11925	0	44.2 ± 2.5
10325	11925	6	59.0 ± 2.0
10325	11925	10	9.4 ± 2.3
10275	9650	0	143.6 ± 3.5
10275	9650	4	19.1 ± 2.5
10200	8000	6	0.8 ± 0.7
10200	8400	6	1.8 ± 0.9
10200	9000	6	1.0 ± 0.8
10200	10000	6	0.9 ± 1.0
10200	11600	6	2.3 ± 1.5
10200	11800	0	124.8 ± 3.8
10200	11800	6	224.1 ± 4.2
10200	11800	12	194.4 ± 5.4
10200	11800	15	115.8 ± 5.7
10200	12200	6	1.9 ± 1.0
10200	12600	4	* 0.3
10125	9575	0	155.9 ± 3.8
10125	9575	6	8.2 ± 2.4
10125	9575	10	5.4 ± 1.9
10059	12775	0	5.9 ± 1.1
10059	12775	6	0.7 ± 0.7
10010	12565	0	5.5 ± 1.2
10010	12565	3	0.6 ± 0.8
10000	7800	6	0.9 ± 0.7
10000	8300	6	2.2 ± 0.7
10000	8500	6	1.3 ± 0.8
10000	8700	6	1.1 ± 0.9
10000	8900	6	1.7 ± 0.9
10000	9200	6	510.8 ± 8.2
10000	9200	12	491.0 ± 7.2
10000	9200	18	493.3 ± 9.7
10000	9400	6	2.4 ± 0.8
10000	9600	6	2.7 ± 1.3
10000	9800	6	3.7 ± 1.4
9967	12390	0	16.6 ± 1.7
9967	12390	1	1.3 ± 1.3
9950	12150	0	13.5 ± 2.0
9950	12150	4	2.1 ± 1.2
9866	11994	0	19.1 ± 1.7
9866	11994	3	3.9 ± 1.5
9800	8500	6	1.8 ± 0.9
9800	8700	6	1.7 ± 0.9
9800	11800	0	11.2 ± 1.9
9800	11800	5	1.5 ± 1.1
9800	12200	5	0.5 ± 1.0
9800	12200	6	1.2 ± 1.0
9600	8300	2	1.2 ± 0.9
9600	8500	6	0.7 ± 0.7
9600	8700	6	0.4 ± 0.8
9600	12000	6	2.2 ± 1.2
9580	12580	0	23.3 ± 1.8
9580	12580	6	5.6 ± 1.4
9580	12580	8	2.0 ± 1.3
9450	12480	0	9.5 ± 1.3
9450	12480	6	1.8 ± 0.9
9400	8600	6	1.0 ± 0.9
9400	12000	6	1.0 ± 1.0
9400	12600	4	2.5 ± 0.8
9350	12350	0	6.3 ± 1.3
9350	12350	6	1.4 ± 0.8
9300	12175	0	13.7 ± 1.4
9300	12175	6	2.3 ± 1.2
9280	11980	0	20.4 ± 1.9
9280	11980	5	5.7 ± 1.3
9275	11800	0	4.0 ± 1.5
9240	7400	6	0.6 ± 0.7
9200	12000	6	* 0.2
9200	12400	6	3.0 ± 1.0
9000	7600	6	0.8 ± 0.7
9000	7800	6	0.7 ± 0.8
9000	11600	6	1.2 ± 0.8
9000	12200	6	0.3 ± 0.7
8800	7200	6	1.3 ± 0.7
8800	7600	6	2.0 ± 0.7
8800	7800	2	1.4 ± 0.7

*There is at least 95 percent confidence that the true value is less than the measurement reported.

Table D-1 (continued)

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)	Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
8800	11000	6	1.8 ± 0.9	8200	10000	6	1.0 ± 0.8
8800	11400	6	2.4 ± 0.9	8200	10400	6	3.0 ± 0.8
8800	11800	6	1.7 ± 0.9	8000	7200	6	1.0 ± 0.7
8790	7400	6	1.4 ± 0.9	8000	7400	6	0.4 ± 0.6
8600	7200	6	1.1 ± 0.7	8000	7600	6	21.6 ± 2.1
8600	7400	6	1.0 ± 0.8	8000	7600	12	3.1 ± 1.7
8600	7600	6	1.8 ± 0.9	8000	7800	6	2.5 ± 0.9
8600	7800	6	0.7 ± 0.7	8000	8400	6	3.5 ± 2.2
8600	10400	6	2.3 ± 1.3	8000	8600	6	2.9 ± 1.3
8600	10800	6	2.9 ± 1.0	8000	9000	6	0.1 ± 0.7
8600	11200	6	0.7 ± 0.7	8000	9600	6	1.1 ± 0.8
8400	7200	6	1.0 ± 0.7	7800	7400	6	1.0 ± 0.8
8400	7200	6	1.0 ± 0.8	7800	7600	6	14.0 ± 2.1
8400	7400	6	1.8 ± 1.3	7800	7600	12	3.3 ± 1.6
8400	7600	6	1.2 ± 0.8	7800	7800	6	5.7 ± 1.8
8400	7800	6	1.8 ± 0.9	7800	7800	12	1.3 ± 1.5
8400	8800	6	8.3 ± 1.7	7800	8000	6	0.2 ± 0.7
8400	8800	8	1.9 ± 1.5	7800	8200	6	4.2 ± 1.7
8400	9600	6	2.1 ± 1.0	7800	8200	12	2.7 ± 1.2
8400	10000	6	4.2 ± 0.9	7800	8400	6	2.7 ± 1.3
8400	10400	6	1.9 ± 0.7	7800	8800	6	1.7 ± 0.8
8200	7200	6	2.0 ± 0.8	7800	9200	6	3.1 ± 0.8
8200	7400	6	1.5 ± 0.9	7600	7635	6	13.7 ± 1.1
8200	7600	6	* 0.1	7600	7635	12	5.0 ± 1.4
8200	7800	6	1.3 ± 0.9	7600	7635	18	2.8 ± 1.4
8200	8600	4	1.4 ± 0.8	7600	7800	6	0.7 ± 0.6
8200	8800	6	14.3 ± 1.6	7600	8000	6	0.9 ± 0.8
8200	8800	12	13.2 ± 1.6	7600	8200	6	0.5 ± 0.7
8200	8800	18	1.6 ± 1.2	7600	8400	6	16.4 ± 4.2
8200	9200	6	2.2 ± 1.0	7600	8400	12	* 0.1

*There is at least 95 percent confidence that the true value is less than the measurement reported.

Table D-2

In-Situ Delta-Gamma Radium Measurement Results for Approximate Locations (N99999)

North	East	Depth (in.)	eRa-226(pCi/g)	Remarks
99999	1	0	2.2 ± 0.7	Background location BG-1
99999	2	0	1.6 ± 0.7	Background location BG-1
99999	3	0	1.0 ± 0.7	Background location BG-2b
99999	4	0	1.5 ± 0.7	Background location BG-2b
99999	5	0	1.3 ± 0.7	Background location BG-3
99999	6	0	1.1 ± 0.7	Background location BG-3
99999	7	0	1.1 ± 0.7	Background location BG-4
99999	8	0	1.2 ± 0.7	Background location BG-4
99999	9	0	11.7 ± 1.4	Arroyo- 200 ft downstream from N11400, E12450
99999	10	6	1.4 ± 0.9	Arroyo- 200 ft downstream from N11400, E12450
99999	11	0	13.2 ± 1.4	Arroyo- 400 ft downstream from N11400, E12450
99999	12	6	0.2 ± 0.9	Arroyo- 400 ft downstream from N11400, E12450
99999	13	0	14.7 ± 1.8	Arroyo- 600 ft downstream from N11400, E12450
99999	14	6	0.5 ± 0.9	Arroyo- 600 ft downstream from N11400, E12450
99999	15	0	8.6 ± 1.2	Arroyo- 800 ft downstream from N11400, E12450
99999	16	6	1.4 ± 0.9	Arroyo- 800 ft downstream from N11400, E12450
99999	17	0	0.6 ± 0.7	Arroyo-1000 ft downstream from N11400, E12450
99999	18	0	1.3 ± 0.7	Arroyo-1200 ft downstream from N11400, E12450
99999	19	0	10.0 ± 1.2	Arroyo-1400 ft downstream from N11400, E12450
99999	20	2	1.9 ± 0.9	Arroyo-1400 ft downstream from N11400, E12450
99999	21	0	2.9 ± 0.9	Arroyo-1600 ft downstream from N11400, E12450
99999	22	0	1.6 ± 0.8	Arroyo-1800 ft downstream from N11400, E12450
99999	23	0	51.7 ± 2.1	Arroyo- 200 ft downstream from N10600, E8200
99999	24	6	2.9 ± 1.6	Arroyo- 200 ft downstream from N10600, E8200
99999	25	0	2.9 ± 0.8	Arroyo- 400 ft downstream from N10600, E8200
99999	26	0	0.5 ± 0.6	Arroyo- 600 ft downstream from N10600, E8200
99999	27	0	0.8 ± 0.7	Arroyo- 800 ft downstream from N10600, E8200
99999	28	0	10.5 ± 1.3	Arroyo- 400 ft downstream from N10059, E12775
99999	29	6	4.8 ± 1.1	Arroyo- 400 ft downstream from N10059, E12775
99999	30	12	2.2 ± 1.0	Arroyo- 400 ft downstream from N10059, E12775
99999	31	0	4.4 ± 0.9	Arroyo- 600 ft downstream from N10059, E12775
99999	32	0	15.9 ± 1.3	Arroyo- 200 ft downstream from N9967, E12390
99999	33	5	2.1 ± 1.1	Arroyo- 200 ft downstream from N9967, E12390
99999	34	0	9.2 ± 1.0	Arroyo- 800 ft downstream from N9967, E12390
99999	35	6	3.3 ± 1.1	Arroyo- 800 ft downstream from N9967, E12390
99999	36	0	8.9 ± 1.4	Arroyo- 200 ft downstream from N9580, E12580
99999	37	6	1.1 ± 0.8	Arroyo- 200 ft downstream from N9580, E12580
99999	38	0	7.1 ± 1.2	Arroyo- 400 ft downstream from N9580, E12580
99999	39	6	0.5 ± 0.7	Arroyo- 400 ft downstream from N9580, E12580
99999	40	0	3.2 ± 1.0	Arroyo- 600 ft downstream from N9580, E12580
99999	41	0	2.9 ± 0.8	Arroyo- 800 ft downstream from N9580, E12580
99999	42	0	1.2 ± 0.8	Arroyo- 925 ft downstream from N9580, E12580
99999	43	0	39.2 ± 1.6	Arroyo- 43 ft north of U.S. Highway 163 (Area D)
99999	44	6	13.8 ± 1.6	Arroyo- 43 ft north of U.S. Highway 163 (Area D)
99999	45	8	15.8 ± 1.6	Arroyo- 43 ft north of U.S. Highway 163 (Area D)

Appendix E

BOREHOLE GEOPHYSICAL LOGS AND DATA

Two logging systems were used at the Mexican Hat, Utah, site, a spectral system (Compulogger) and a total-count system (PRS-1 RASCAL). Borehole data from each system are presented in Tables E-1 and E-2, respectively. Equipment characteristics and calibration information are included to document the parameters used in data reduction.

Uncertainties for the total-count system were calculated at a 95 percent confidence level (2σ). Water was encountered in only two boreholes. Logs for all other boreholes have an indicated fluid-level depth of 99.0 ft which is a default value. The auger height shown on each log indicates the distance measured from the top of the auger to the ground surface.

Radiometric logs for each of the boreholes are presented on microfiche in the pocket below. The percent sign (%) preceding data entries signifies an overflow in the data field which occurs after an apparent radium-226 concentration greater than 999.9 is reached.

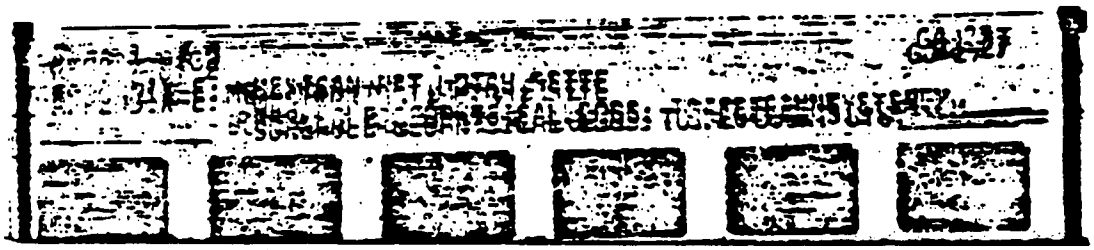


Table E-1

Borehole Data from Spectral System

EQUIPMENT DATA

INSTRUMENT	COMPULOGGER	CASING THICKNESS	0.1875 in.
GJO NUMBER	1815	CASING FACTOR	1.238 ± 0.012
SERIAL NUMBER	231-03	FLUID FACTOR	1.220 ± 0.154
DETECTOR	NaI(Tl)	MOISTURE FACTOR	1.069 ± 0.007
DETECTOR SIZE	2 in. x 6 in.	K FACTOR	7.00 ± 0.18 g-cps/pCi(eRa-226)
PROBE DIAMETER	2.5 in.	BACKGROUND	21.04 ± 3.24 cps
HOLE DIAMETER	6.87 in.	ALPHA FACTOR	3.0 ± 0.3
		CALIBRATION DATE	4 September 1984

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
HAT-014	9200	8500	4335.1	7.5
HAT-021	8900	8200	4345.5	3.5
HAT-022	8900	8400	4339.7	6.0
HAT-023	8800	7900	4347.6	3.5
HAT-026	8800	8500	4340.4	4.0
HAT-029	8700	7300	4332.8	3.5
HAT-031	8700	8200	4342.1	3.5
HAT-035	8600	8500	4350.3	4.0
HAT-045	8300	7500	4340.1	5.5
HAT-047	8200	7900	4353.4	4.0
HAT-071	10350	8150	4313.8	4.0
HAT-073	10000	8100	4315.0	3.0
HAT-074	9900	8000	4316.8	8.0
HAT-075	9900	8100	4318.4	9.5
HAT-080	9700	8200	4321.0	7.5
HAT-081	9700	8300	4323.6	11.0
HAT-083	9600	8200	4322.4	8.0
HAT-086	9400	8200	4328.3	18.5
HAT-088	9300	7500	4330.8	4.5
HAT-102	9807	9148	4312.1	5.0
HAT-103	9762	9321	4305.1	4.0
HAT-105	9530	9647	4315.6	8.5
HAT-110	8642	9559	4336.0	27.5
HAT-120	9014	8836	4331.3	8.5
HAT-121	9163	8789	4331.2	14.0
HAT-151	9801	9637	4305.6	5.5
HAT-153	9999	10095	4292.2	8.0
HAT-157	10320	10788	4268.3	9.0
HAT-159	10223	11088	4267.7	7.0
HAT-161	10108	11630	4233.5	12.5
HAT-166	9199	11424	4300.7	9.0
HAT-169	8922	11004	4295.6	9.0

Table E-2

Borehole Data from Total-Count System

EQUIPMENT DATA

INSTRUMENT	PRS-1 RASCAL	CASING THICKNESS	0.1875 in.
GJO NUMBER	C-3572S	CASING FACTOR	1.555 ± 0.095
SERIAL NUMBER	753	FLUID FACTOR	1.112 ± 0.078
DETECTOR	NaI(Tl)	MOISTURE FACTOR	1.069 ± 0.007
DETECTOR SIZE	2 in. x 2 in.	K FACTOR	77.14 ± 2.24 g-cps/pCi(eRa-226)
PROBE DIAMETER	2.5 in.	BACKGROUND	135.51 ± 94.20 cps
HOLE DIAMETER	6.87 in.	ALPHA FACTOR	3.0 ± 0.3
		CALIBRATION DATE	04 September 1984

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
HAT-011	9200	7900	4331.6	1.5
HAT-012	9200	8100	4343.6	1.3
HAT-013	9200	8300	4337.6	2.9
HAT-015	9000	7900	4342.1	3.8
HAT-016	9000	8100	4348.9	4.4
HAT-017	9000	8300	4342.1	2.8
HAT-018	9000	8500	4335.2	4.2
HAT-019	9000	8700	4330.3	2.5
HAT-020	8900	8100	4348.3	3.6
HAT-021	8900	8200	4345.5	4.4
HAT-024	8800	8100	4346.1	3.6
HAT-025	8800	8200	4343.4	1.0
HAT-027	8800	8700	4344.2	1.5
HAT-028	8800	8900	4338.7	1.0
HAT-030	8700	7700	4355.0	4.1
HAT-032	8600	7900	4350.6	2.7
HAT-033	8600	8100	4344.6	1.0
HAT-034	8600	8400	4342.6	3.7
HAT-036	8600	8700	4345.1	1.6
HAT-037	8590	8900	4.41.7	3.8
HAT-038	8500	7700	4351.5	2.2
HAT-039	8500	8200	4343.8	2.0
HAT-040	8400	7900	4350.8	1.3
HAT-041	8400	8100	4348.1	3.9
HAT-042	8400	8300	4347.4	2.8
HAT-043	8400	8500	4352.1	2.4
HAT-044	8400	8700	4359.3	0.7
HAT-046	8300	7700	4351.6	3.2
HAT-048	8185	8100	4351.6	2.8
HAT-049	8200	8300	4354.9	0.8
HAT-050	8200	8500	4357.4	0.3
HAT-051	8200	8750	4352.9	1.9
HAT-052	8000	7900	4353.2	3.5

Table E-2 (continued)

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
HAT-053	8000	8100	4358.7	1.4
HAT-054	8000	8300	4357.6	3.5
HAT-055	7800	7900	4353.2	3.5
HAT-056	7800	8100	4360.1	2.0
HAT-072	10200	8100	4312.5	1.0
HAT-076	9800	7700	4328.4	4.3
HAT-078	9800	8200	4321.7	4.0
HAT-079	9700	8100	4318.6	1.4
HAT-082	9700	8600	4332.1	2.9
*HAT-085	9500	8200	4332.5	2.7
HAT-087	9400	8300	4336.8	0.8
HAT-101	9800	8990	4332.6	2.9
HAT-104	9652	9489	4315.0	4.0
HAT-106	9400	9769	4312.3	1.8
HAT-107	9208	9849	4300.0	14.5
*HAT-108	9023	9802	4315.0	2.7
*HAT-109	8825	9720	4296.8	2.0
*HAT-112	8299	9223	4329.5	2.8
*HAT-113	8388	9135	4332.2	7.5
*HAT-114	8241	8895	4329.1	3.5
HAT-115	8442	8964	4332.9	9.5
HAT-116	8600	9008	4336.4	1.9
HAT-117	8734	9097	4334.5	0.8
HAT-118	8852	8979	4338.4	0.8
HAT-119	9003	9074	4334.9	2.8
HAT-122	9373	8783	4330.1	2.0
HAT-123	9642	8775	4332.7	3.2
HAT-124	9960	9246	4313.7	7.1
HAT-125	10151	9290	4317.3	7.0
HAT-152	9907	9847	4295.7	4.7
HAT-154	10109	10340	4282.0	3.4
HAT-155	10159	10478	4287.3	0.9
HAT-156	10263	10614	4268.0	2.5
HAT-158	10446	11062	4257.3	4.5
HAT-160	10107	11416	4236.8	3.0
*HAT-163	9818	11533	4245.8	7.9
HAT-164	9697	11614	4272.7	2.7
HAT-165	9538	11662	4271.8	11.8
HAT-167	9103	11372	4304.3	3.3
HAT-168	8978	11269	4300.5	1.6
HAT-171	8944	10732	4293.5	4.5
*HAT-173	8903	10319	4284.5	1.3
*HAT-174	8898	10249	4280.2	5.3

*Boreholes logged without casing. Data were reduced for these boreholes using a hole diameter of 5.5 in., a casing thickness of 0 in., and a casing factor of 1.000 ± 0.000. All other equipment data were the same for all boreholes.

Table E-2 (continued)

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
*HAT-175	8876	10100	4281.9	1.9
*HAT-176	8728	9768	4289.7	2.1
*HAT-177	10105	11302	4242.0	2.5
*HAT-178	9998	11407	4239.9	9.5
HAT-179	10011	11622	4230.7	2.7
*HAT-180	9957	11511	4237.2	4.6

*Boreholes logged without casing. Data were reduced for these boreholes using a hole diameter of 5.5 in., a casing thickness of 0 in., and a casing factor of 1.000 ± 0.000. All other equipment data were the same for all boreholes.

Appendix F

BUILDING-SURVEY DATA

Tables F-1 through F-8 present results of exposure-rate and alpha measurements made in buildings at the Mexican Hat site. Figures F-1 through F-8 identify the approximate locations of the measurements. Locations identified by the letter X indicate locations of PIC measurements. Locations identified by a black dot followed by a number indicate locations of alpha-survey measurements.

Table F-1

Survey Data for Building 1/Ore-Crushing Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			64.0	63.1
1	Floor	370	345		
2	Floor	1000	1030		
3	Floor	625	600		
4	Floor	395	320		
5	Floor	1400	1300		
6	Floor	1100	1400		
7	Footer	1100	1100		
8	Pit	800	800		

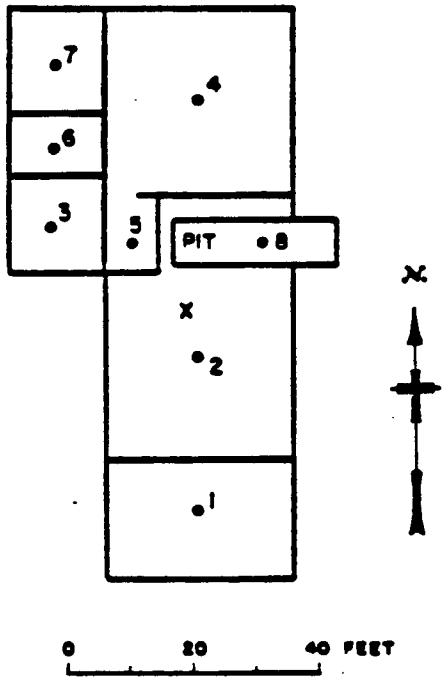


Figure F-1. Measurement Locations in Building 1/Ore-Crushing Building

Table F-2

Survey Data for Building 2/Sheet Metal Shop

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			20.7	20.7
1	Wall	20	0		
2	Floor	20	2		
3	Light Fixture	25	5		
4	Wall	40	0		
5	Floor	20	4		
6	Brick Wall	75	0		
7	Wall		2		
8	Floor		8		
9	Fuse Box		8		
10	Wall		0		

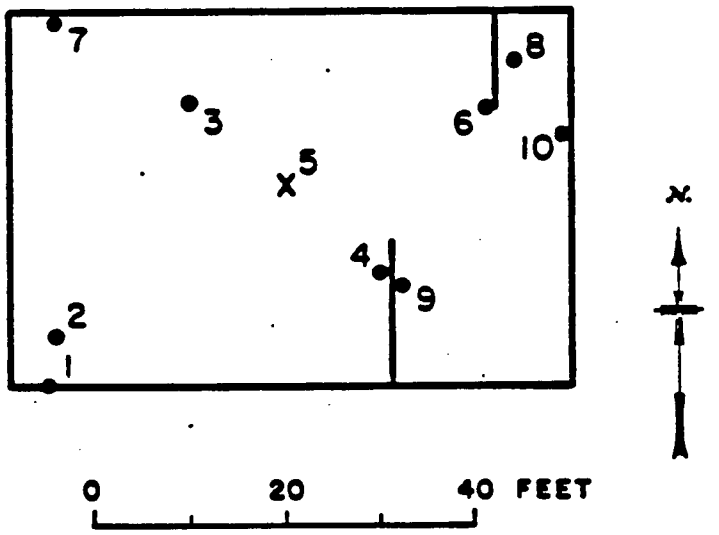


Figure F-2. Measurement Locations in Building 2/Sheet Metal Shop

Table F-3

Survey Data for Building 3/Empty Metal Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (uR/h) First Reading	PIC Exposure-Rate (uR/h) Second Reading
X	3 ft/Center of Bldg.			33.1	32.1
1	Floor	135	65		
2	Floor	220	40		
3	Floor	140	70		
4	Floor	180	90		

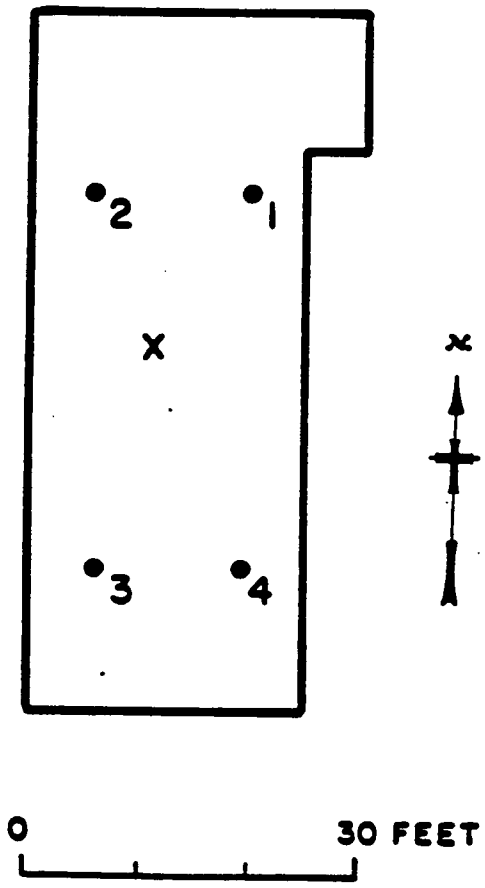


Figure F-3. Measurement Locations in Building 3/Empty Metal Building

Table F-4

Survey Data for Building 4/Generator Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			17.2	16.0
1	Floor	100	95		
2	Floor	100	95		
3	Floor	50	110		
4	Floor	160	140		
5	Generator Support	120	140		
6	Generator Support	110	80		
7	Floor	75	75		
8	Floor	100	120		

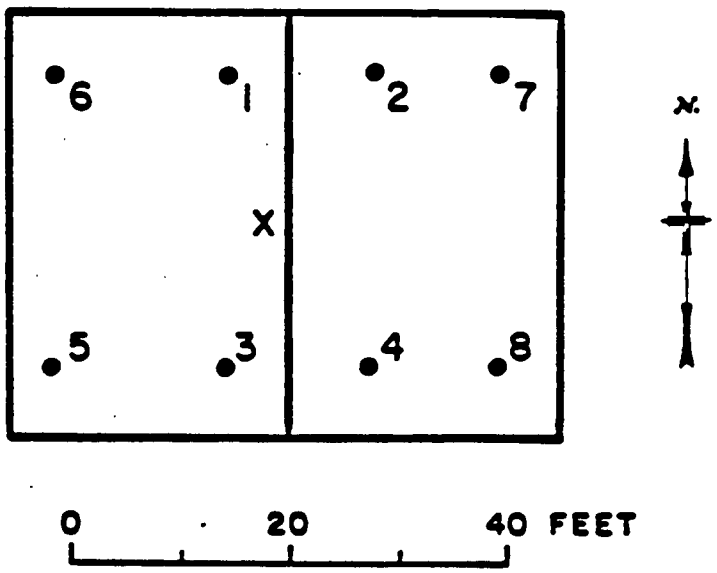


Figure F-4. Measurement Locations in Building 4/Generator Building

Table F-5

Survey Data for Building 5/Trade School Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (uR/h) First Reading	PIC Exposure-Rate (uR/h) Second Reading
X	3 ft/Center of Bldg.			18.0	17.4
1	Floor	80	60		
2	Floor	55	80		
3	Floor	130	100		
4	Floor	55	60		
5	Floor	55	55		
6	Floor	70	30		
7	Floor	60	50		
8	Floor	80	60		
9	Floor	30	80		
10	Wall	40	30		
11	Floor	55	35		
12	Wall	40	35		
13	Floor	10	10		
14	Floor	35	30		
15	Wall (Brick)	20	20		
16	Floor	40	30		
17	Floor	30	25		
18	Wall	50	20		
19	Floor	20	5		
20	Floor	50	40		
21	Floor	35	50		
22	Floor	50	25		
23	Heater Duct	90	55		
24	Floor	35	35		
25	Floor	90	70		
26	Floor	80	60		
27	Floor	90	60		
28	Floor	60	30		
29	Floor	80	40		
30	Wall	30	15		

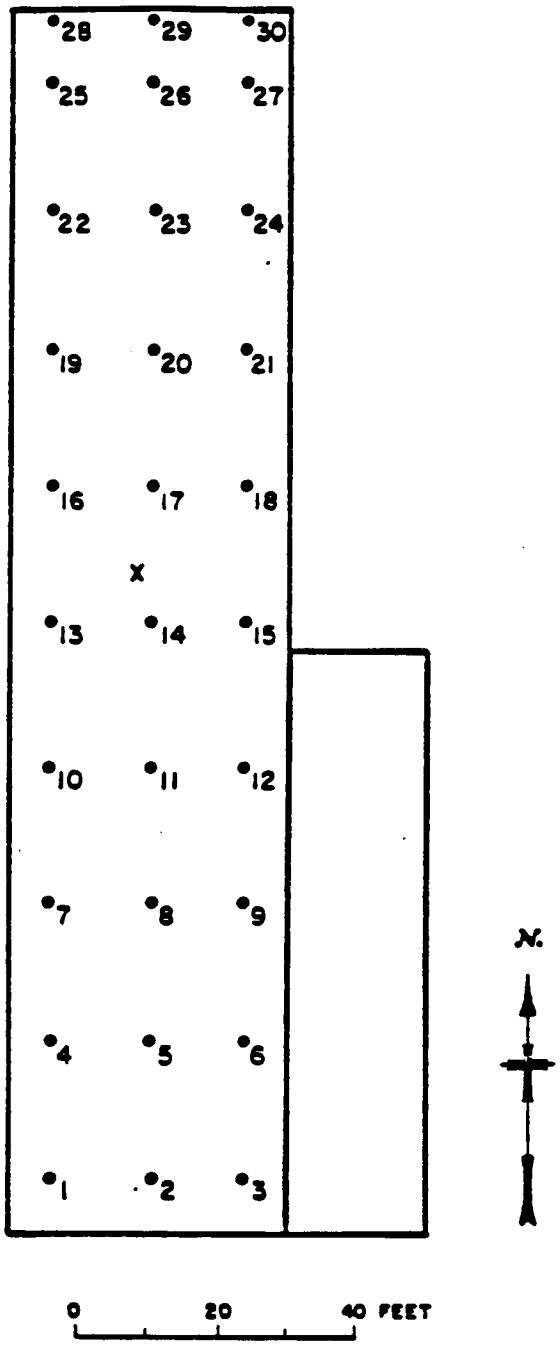


Figure F-5. Measurement Locations in Building 5/Trade School Building

Table F-6

Survey Data for Building 6/Brick Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			18.0	18.6
1	Floor	80	50		
2	Floor	35	80		
3	Wall	40	20		
4	Floor	50	20		

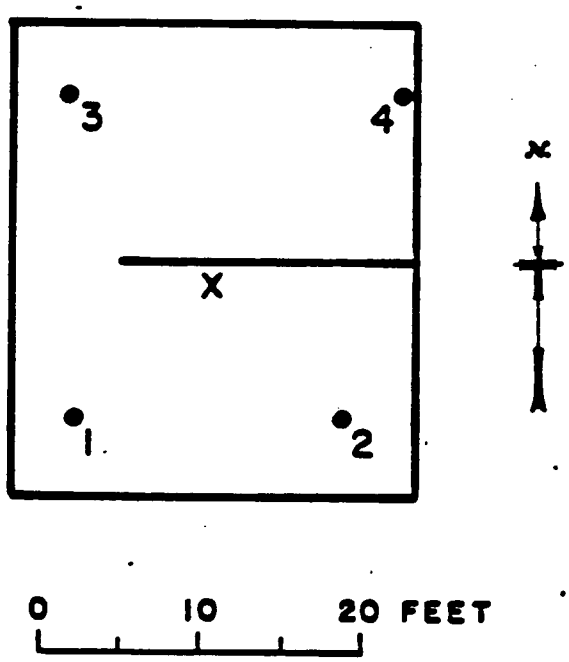


Figure F-6. Measurement Locations in Building 6/Brick Building

Table F-7

Survey Data for Building 7/Scale House

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			67.7	67.9
1	Floor	330	280		
2	Floor	260	255		
3	Floor	235	400		
4	Floor	250	310		

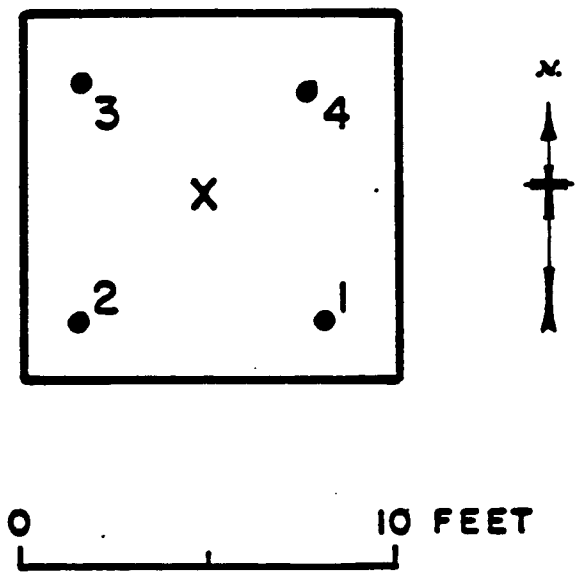


Figure F-7. Measurement Locations in Building 7/Scale House

Table F-8

Survey Data for Building 8/Health Clinic

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			13.7	13.5
1	Waiting Room	40	0		
2	Dark Room	40	1		
3	Screening Room	40	1		
4	Exam Room	30	0		
5	Lab Room	30	0		
6	Pharmacy Room	10	0		
7	CHN Room	20	1		
8	ABE Room #1	20	0		
9	ABE Room #2	10	0		
10	RD Room	30	0		
11	Adult Ed. Room	20	0		
12	Sewing Room	15	0		
13	Womens Restroom	40	0		
14	Mens Restroom	30	0		
15	ABE Room #3	30	0		
16	ER Room	20	0		
17	Storage Room	25	0		
18	Furnace Room	50	0		

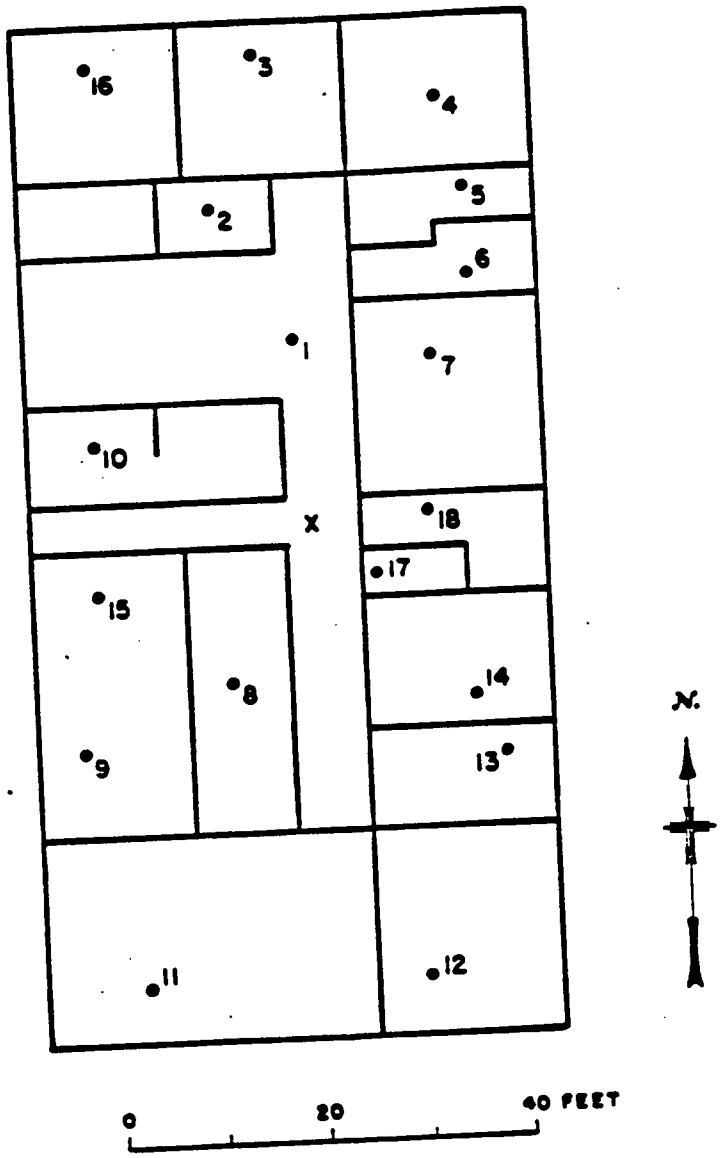


Figure F-8. Measurement Locations in Building 8/Health Clinic

Appendix G

BACKGROUND MEASUREMENT DATA

Table G-1 presents analytical and measurement data obtained at four background locations indicated in Figure 1. Radium, thorium, and potassium values represent equivalent concentrations. All measurements were surface measurements. Soil samples were collected at a depth of 0 to 6 in.

Table G-1

Background Location Analytical and Measurement Data

Area	PIC Exposure-Rate (μR/h) Reading 1/Reading 2	Delta-Gamma Results pCi(Ra-226)/g Inst. C-1114 C-1130	Soil Sample Laboratory Results Sample No.	Moisture (%)	Radium (pCi/g)	Thorium (ppm)	Potassium (%)
BG-1	11.5 / 11.4	2.0 ± 0.7	MHD 101	1.2	1.0 ± 1.0	6.0 ± 2.0	1.3 ± 0.4
		1.4 ± 0.7	MHD 301		0.9 ± 1.0	9.9 ± 2.0	1.3 ± 0.3
BG-2b	11.7 / 11.4	1.3 ± 0.7	MHD 213		1.4 ± 1.0	5.6 ± 1.4	1.8 ± 0.4
		0.8 ± 0.7	MHG 625		1.0 ± 1.0	3.0 ± 1.4	1.0 ± 0.2
			MHD 578		1.1 ± 1.0	6.3 ± 1.0	1.8 ± 0.2
BG-3	10.7 / 10.9	1.1 ± 0.7	MHD 103	1.2	1.0 ± 1.0	7.0 ± 2.0	1.3 ± 0.2
		0.9 ± 0.7	MHD 151		0.7 ± 1.0	1.7 ± 0.0	1.4 ± 0.3
BG-4	12.7 / 12.4	1.0 ± 0.7	MHD 114	3.0	2.0 ± 1.0	1.0 ± 1.0	1.3 ± 0.4
		0.9 ± 0.7	MHD 579		1.3 ± 1.0	5.6 ± 1.4	1.6 ± 0.4

APPARENT RADIUM-226 CONCENTRATION 011

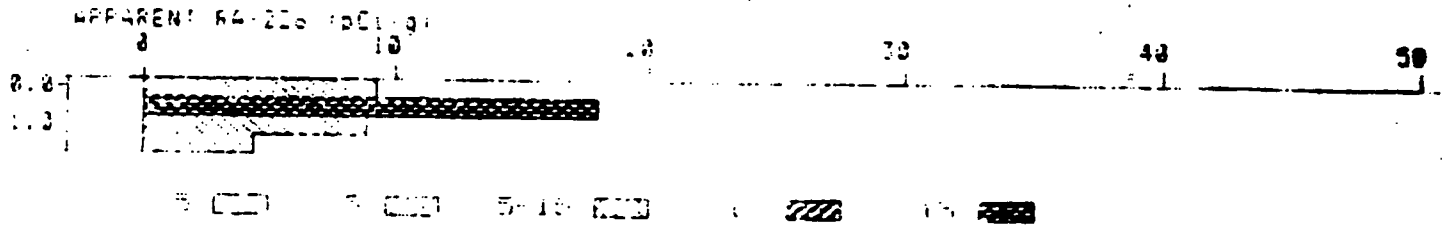
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

OLE NUMBER: 011
LOCATION: 9200.0N 7900.0E
LUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840917
ELEVATION: 4331.6 FT.
AUGER HEIGHT: -42.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJC NO.: C-3572S



Depth (m)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	580.0	9.2	1.4
0.5	833.0	18.0	1.2
1.0	577.0	5.9	1.0
1.5	724.0	4.4	1.0

Data generated by LUCMLC.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 012

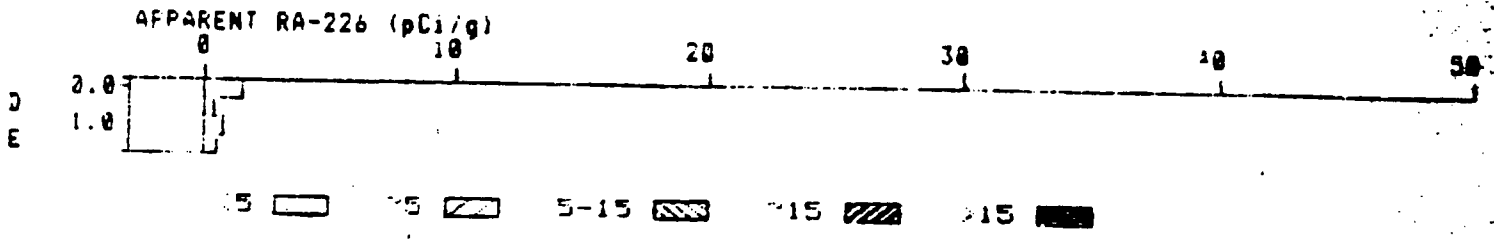
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 012
LOCATION: 9200.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840918
ELEVATION: 4343.6 FT.
AUGER HEIGHT: -51.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35729



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	177.3	1.6	1.2
0.5	116.9	0.4	1.3
1.0	88.4	0.7	1.3
1.5	110.6	0.5	1.2

This data generated by LOGCALC.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 013

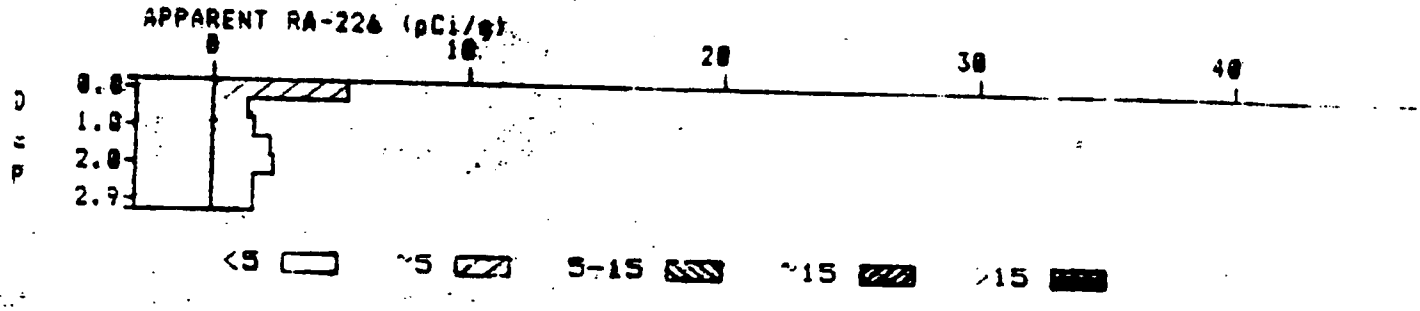
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 013
LOCATION: 9200.0N 8300.0E
FLUID LEVEL: 99.0 FT.
PHASE: I

DATE DRILLED: 840918
ELEVATION: 4337.6 FT.
AUGER HEIGHT: -29.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	376.7	5.3	1.3
0.5	225.9	1.4	1.3
1.0	200.0	1.7	1.3
1.5	210.1	2.2	1.3
2.0	210.5	2.4	1.3
2.5	133.1	1.6	1.3
2.9	120.0	1.6	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

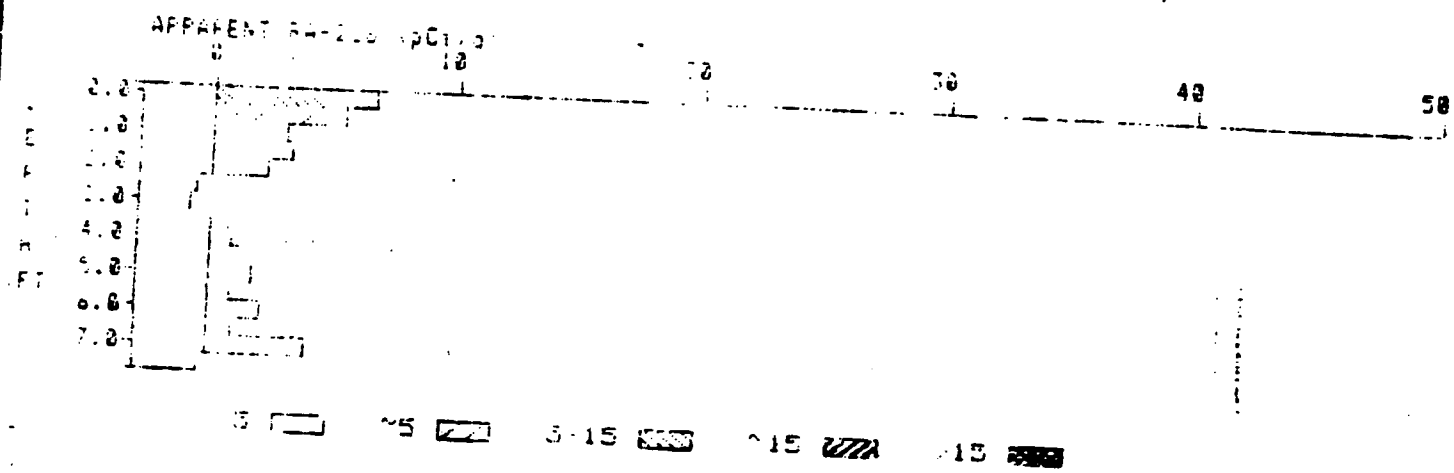
014

PROJECT: HAT

HOLE NUMBER: 014
LOCATION: 92N 85E
FLUID LEVEL: 99.0 FT.
PHASE: 2

START DATE: 840910
DATE DRILLED: 840918
ELEVATION: 4335.0 FT.
AUGER HEIGHT: 39.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	79.7	0.0	0.0
0.5	71.5	5.4	0.8
1.0	60.3	[illegible]	0.7
1.5	57.9	[illegible]	[illegible]
2.0	44.0	[illegible]	0.8
2.5	39.2	-0.6	0.6
3.0	36.8	-0.9	0.6
3.5	40.1	0.1	0.6
4.0	44.2	0.9	0.6
4.5	47.0	1.3	0.6
5.0	46.7	1.8	0.6
5.5	46.9	0.0	0.6
6.0	50.3	2.2	0.6
6.5	45.8	1.0	0.7
7.0	46.3	0.9	0.8
	37.0	-0.4	0.9
			0.5

APPARENT RADIUM-226 CONCENTRATION 015

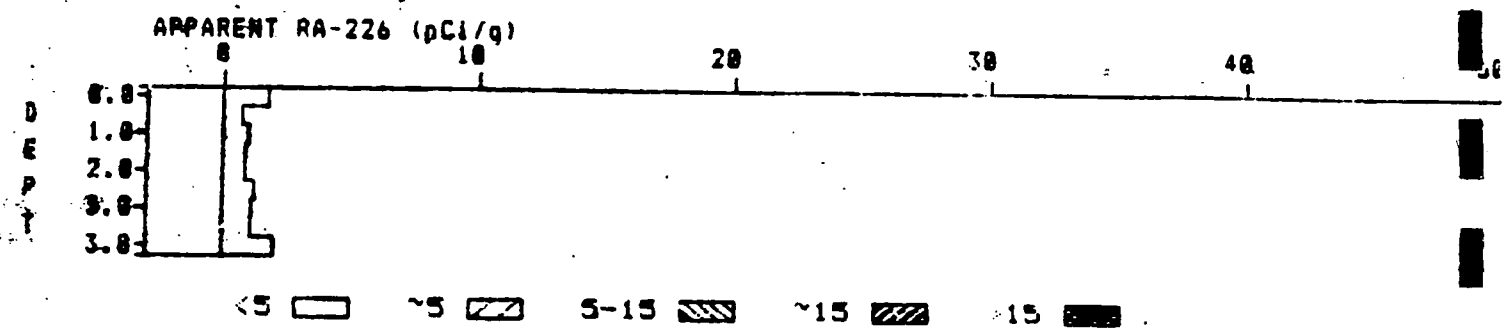
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 015
LOCATION: 9800.0N 7900.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840918
ELEVATION: 4342.1 FT.
AUGER HEIGHT: -19.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	188.3	1.8	1.2
0.5	150.0	0.7	1.2
1.0	148.6	1.0	1.2
1.5	144.1	0.9	1.2
2.0	147.1	0.9	1.2
2.5	158.9	1.3	1.2
3.0	155.3	1.1	1.2
3.5	110.7	1.1	1.2
3.8	140.8	1.9	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 016

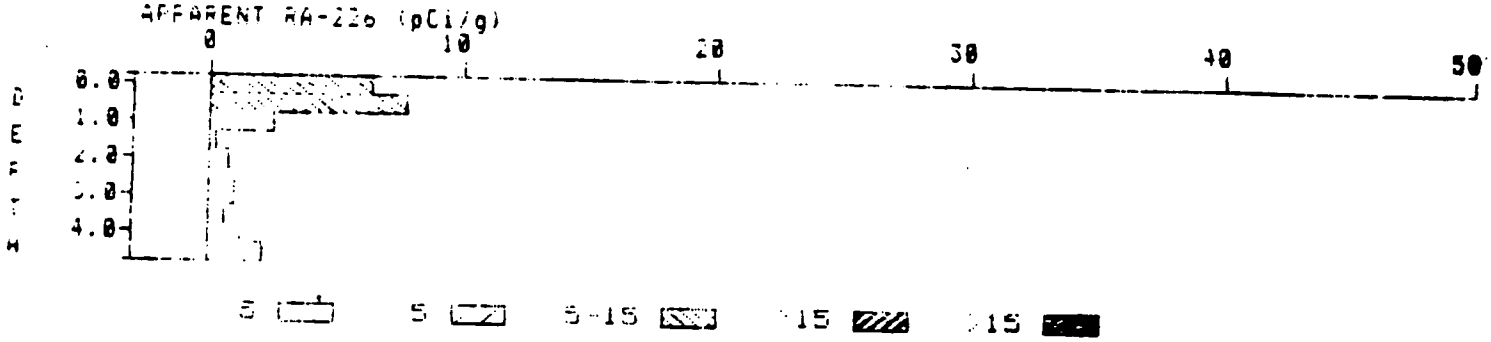
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 016
LOCATION: 9000.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840918
ELEVATION: 4348.9 FT.
AUGER HEIGHT: -12.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	434.1	6.1	1.3
0.5	434.0	7.8	1.5
1.0	258.4	4.5	1.0
1.5	152.5	0.7	1.0
2.0	141.9	0.8	1.2
2.5	144.3	1.0	1.2
3.0	144.2	1.0	1.2
3.5	139.3	0.8	1.2
4.0	112.4	1.2	1.2
4.5	156.2	2.1	1.2

This data generated by LUSCAL.C.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 017

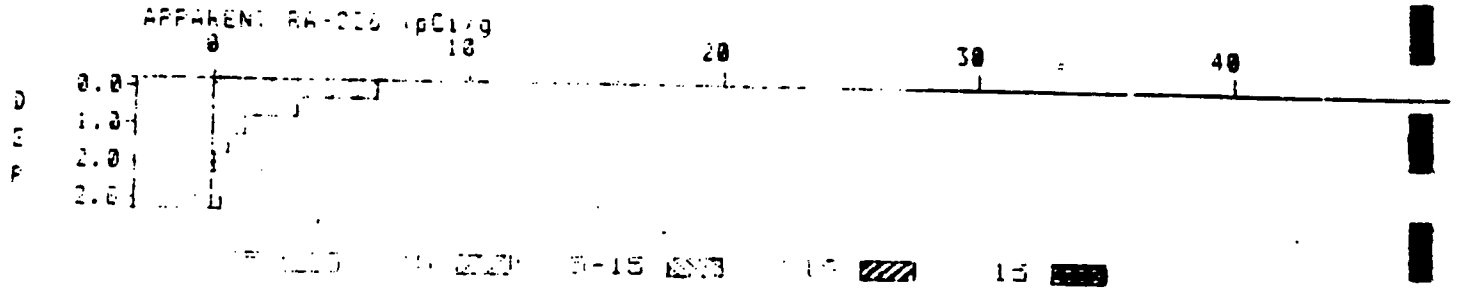
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 017
LOCATION: 9000.0N 8300.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840918
ELEVATION: 4342.1 FT.
AUGER HEIGHT: -32.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	[illegible]	0.3	1.3
0.5	[illegible]	[illegible]	[illegible]
1.0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.6	[illegible]
[illegible]	[illegible]	0.1	1.2
[illegible]	[illegible]	0.0	[illegible]
[illegible]	[illegible]	0.4	1.2

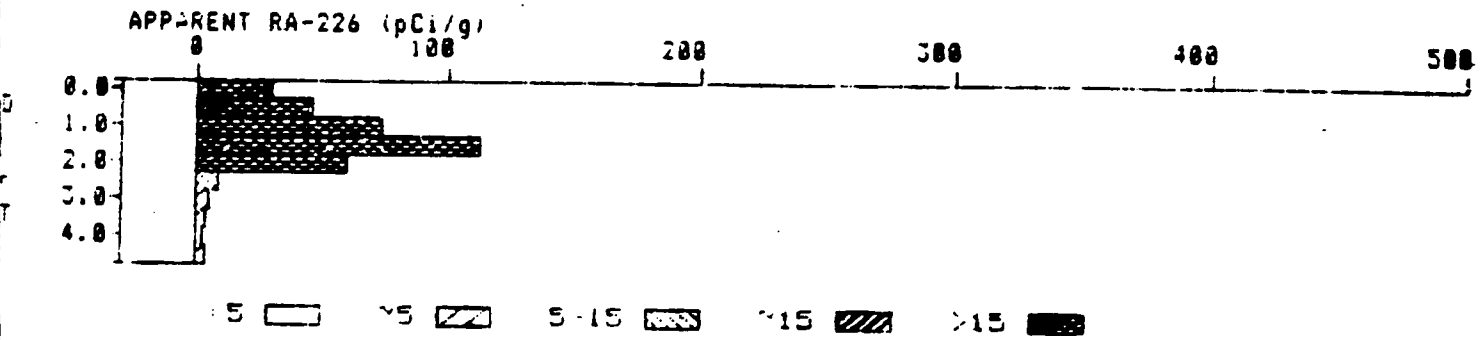
This data generated [illegible] Version [illegible] S/N 002

APPARENT RADIUM-226 CONCENTRATION 018

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 018 DATE DRILLED: 840918
LOCATION: 9000.0N 8500.0E ELEVATION: 4335.2 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -14.0 IN.
PHASE: 2

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
[illegible]	1692.0	29.8	2.5
[illegible]	2686.9	46.2	3.6
[illegible]	3940.1	74.1	5.4
[illegible]	4911.4	112.2	10.1
[illegible]	3188.5	60.0	4.5
[illegible]	1186.2	9.0	3.5
[illegible]	552.4	4.8	1.7
[illegible]	348.8	4.2	1.5
4.0	195.8	2.9	1.3
4.2	230.9	4.1	1.4

This data generated by LUGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 019

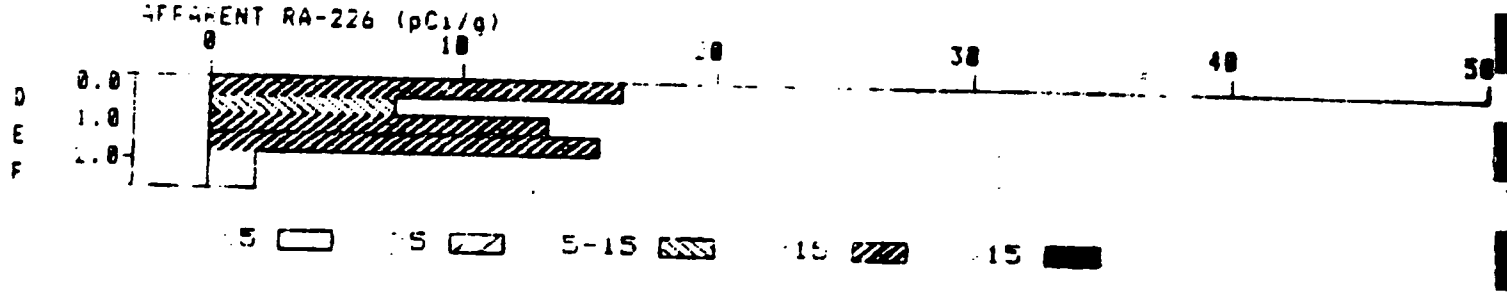
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 019
LOCATION: 9000.0N 8700.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840918
ELEVATION: 4330.3 FT.
AUGER HEIGHT: -32.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	963.2	16.2	1.7
0.5	666.2	7.4	1.7
1.0	761.6	12.4	1.7
1.5	743.8	15.4	1.7
2.0	308.9	1.4	2.6
2.5	130.2	1.9	1.5
			1.2

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 020

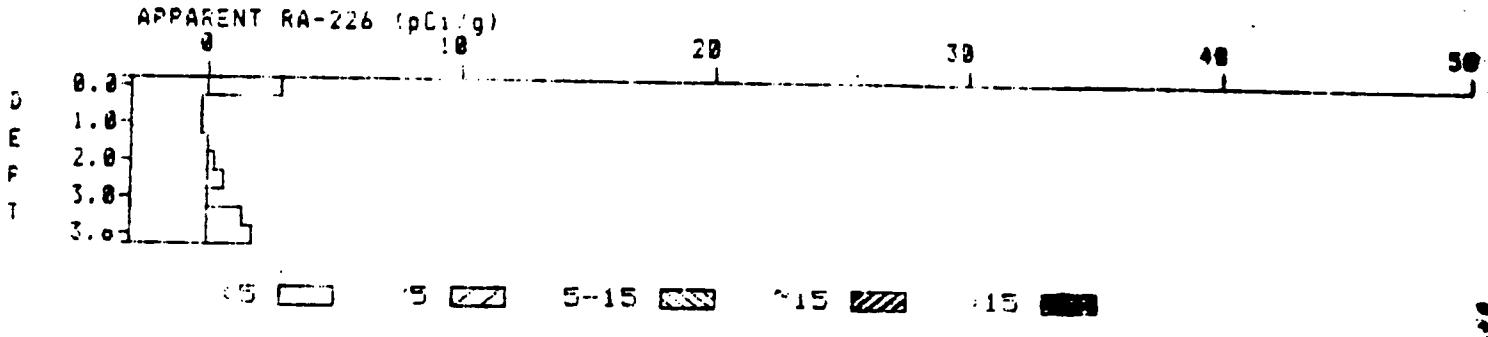
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 020
LOCATION: 8900.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840910
ELEVATION: 4340.3 FT.
AUGER HEIGHT: -20.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	247.0	2.9	1.3
0.5	123.3	-0.2	1.3
1.0	95.2	-0.2	1.2
1.5	96.8	-0.0	1.2
2.0	106.4	0.2	1.2
2.5	118.9	0.6	1.2
3.0	127.1	-0.0	1.3
3.5	105.7	1.3	1.3
3.6	127.7	1.7	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

021

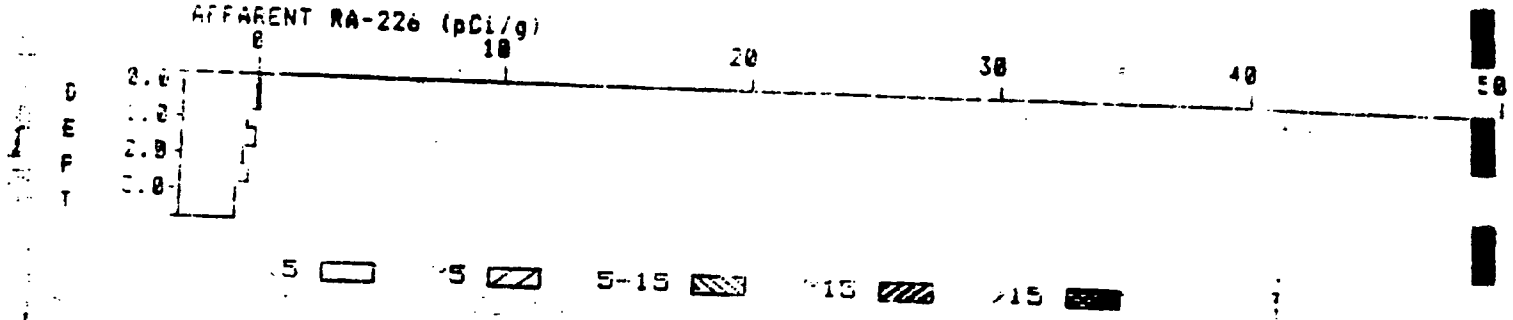
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 021
LOCATION: 89N 82E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840918
ELEVATION: 4345.0 FT.
AUGER HEIGHT: 12.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	40.1	0.1	0.5
0.5	39.8	0.2	0.6
1.0	38.2	-0.4	0.6
1.5	38.7	0.0	0.6
2.0	37.0	-0.5	0.6
2.5	36.9	-0.4	0.6
3.0	35.4	-0.7	0.6
3.5	34.9	-0.7	0.5

APPARENT RADIUM-226 CONCENTRATION 021

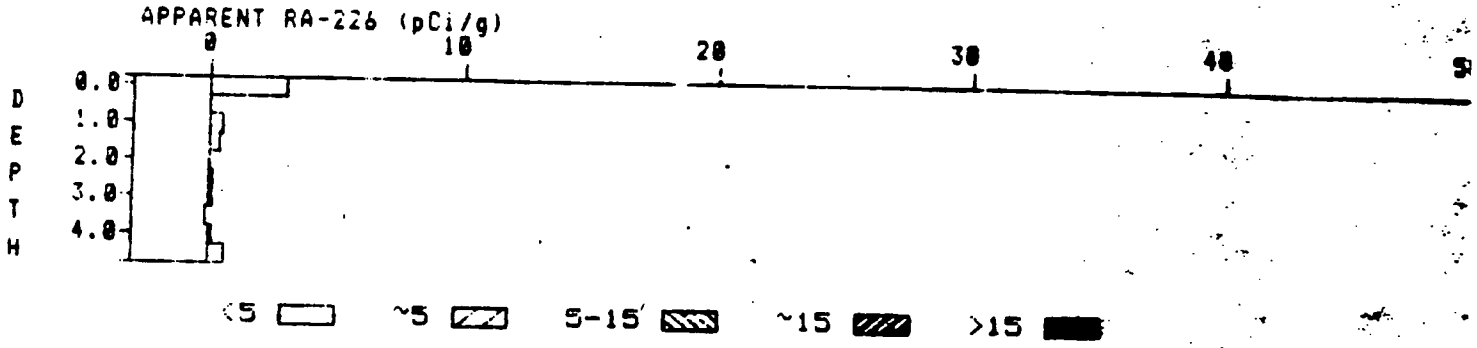
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 021
LOCATION: 8900.0N 8200.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840910
ELEVATION: 4345.5 FT.
AUGER HEIGHT: -12.0 IN.

INSTRUMENT TYPE: PRS-1 RABCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	252.4	3.0	1.3
0.5	138.3	0.0	1.3
1.0	122.7	0.5	1.2
1.5	113.3	0.4	1.2
2.0	99.7	0.0	1.2
2.5	98.5	0.1	1.2
3.0	98.9	0.1	1.2
3.5	93.8	-0.1	1.2
4.0	72.7	0.2	1.2
4.4	96.7	0.6	1.3

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[illegible] RADIUM-226 CONCENTRATION 022

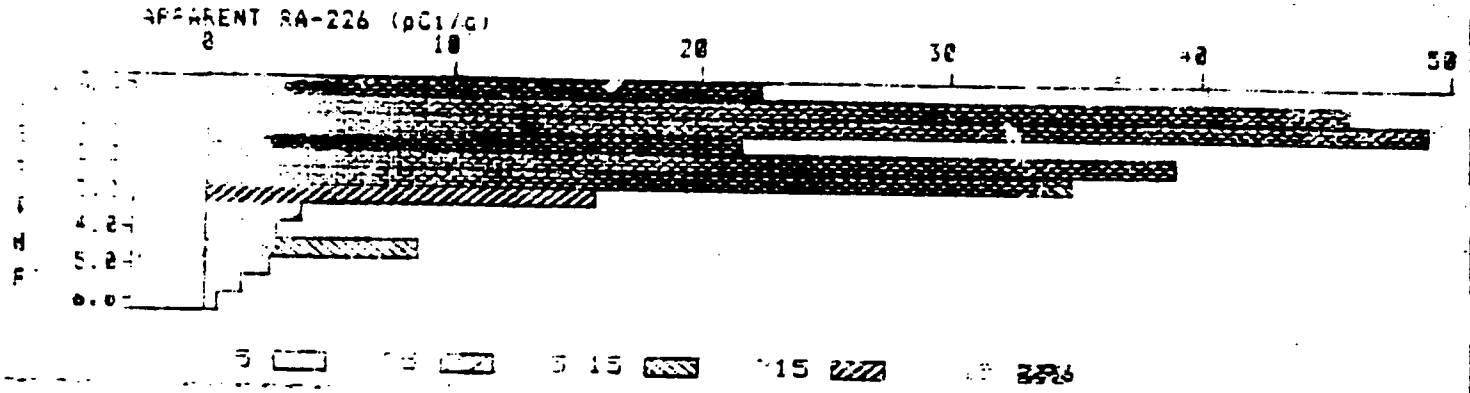
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 022
LOCATION: [illegible] 89N [illegible] 84E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840918
ELEVATION: 4339.0 FT.
AUGER HEIGHT: 7.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	176.5	22.4	0.9
0.5	281.9	46.0	2.5
[illegible]	298.6	49.1	2.0
1.5	221.1	21.7	2.5
[illegible]	255.2	39.0	1.9
[illegible]	228.0	34.9	1.2
[illegible]	145.6	15.8	1.0
[illegible]	84.0	3.9	1.2
4.0	67.0	2.9	0.9
[illegible]	64.5	0.6	1.0
[illegible]	57.0	1.6	0.8
[illegible]	49.6	1.5	0.6
6.0	42.5	0.5	0.5

APPARENT RADIUM-226 CONCENTRATION 023

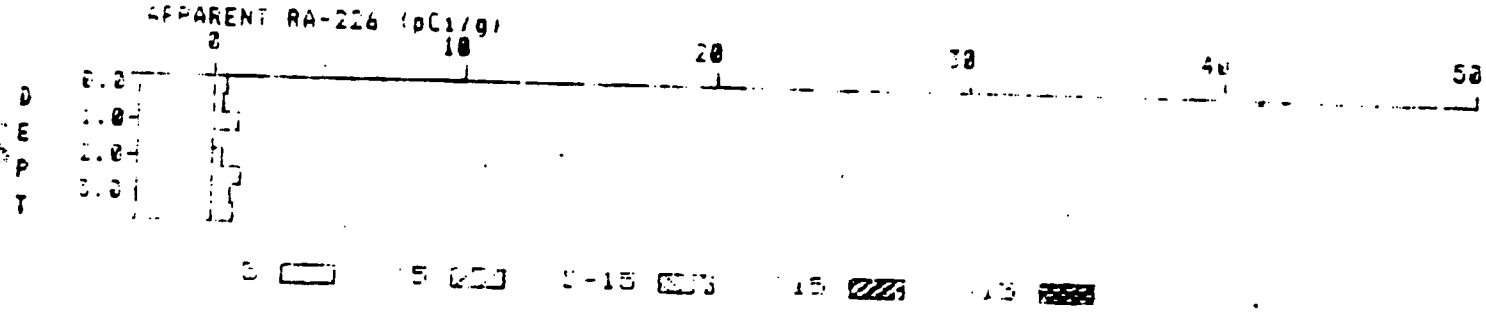
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 023
LOCATION: 88N 79E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840918
ELEVATION: 4347.0 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	42.6	0.5	0.5
0.5	42.6	0.4	0.6
1.0	43.8	1.0	0.6
1.5	41.1	-0.0	0.6
2.0	42.2	0.3	0.6
2.5	44.5	1.1	0.6
3.0	44.0	0.8	0.6
3.5	45.0	0.9	0.5

APPARENT RADIUM-226 CONCENTRATION 824

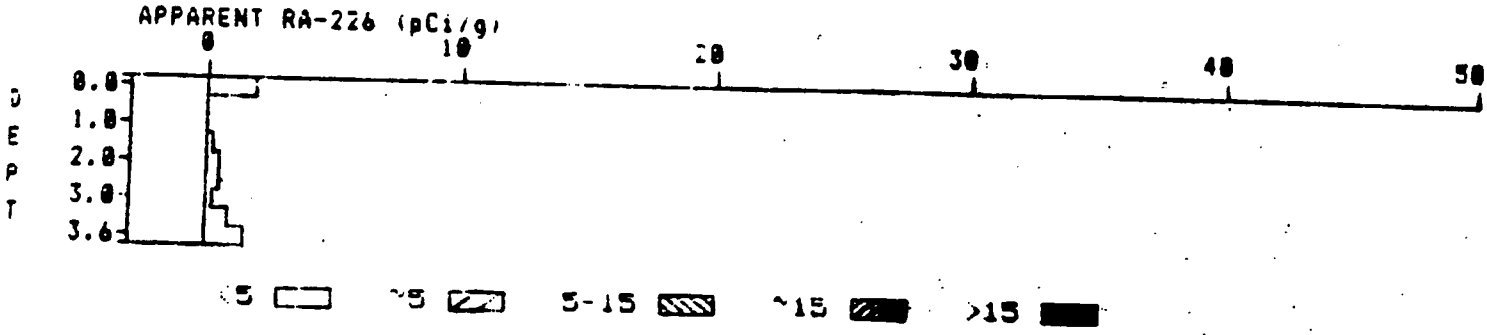
PROJECT: MEXICAN HAT, UTAH

START DATE: 840410

HOLE NUMBER: 824
LOCATION: 8000.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840918
ELEVATION: 4346.1 FT.
AUGER HEIGHT: -21.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	192.4	1.8	1.2
0.5	120.4	0.0	1.2
1.0	103.6	0.0	1.2
.5	107.5	0.2	1.2
.0	117.3	0.6	1.2
.5	118.1	0.5	1.2
.0	103.1	0.2	1.3
.5	96.3	0.8	1.3
.6	125.7	1.5	1.3

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APPARENT RADIUM-226 CONCENTRATION 025

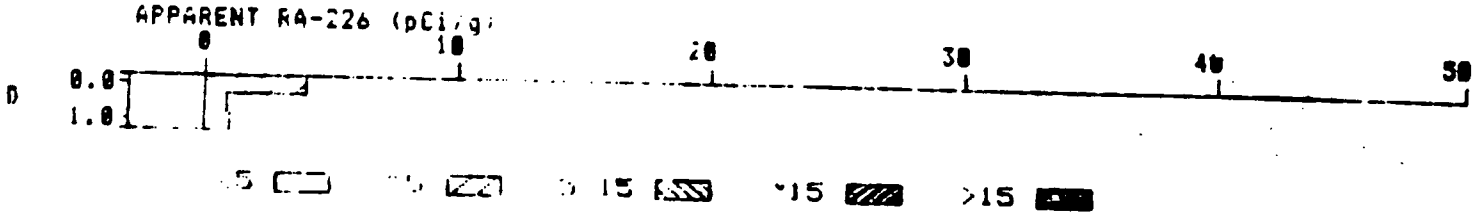
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 025
LOCATION: 8000.0N 8200.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840918
ELEVATION: 4343.4 FT.
AUGER HEIGHT: -52.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	311.[illegible]	[illegible].0	1.3
0.5	143.1	0.9	1.4
1.0	10[illegible].5	1.0	1.2

s data generated by [illegible].BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

026

PROJECT: HAF

START DATE: 840910

HOLE NUMBER: 026

LOCATION: 88N 85E

DATE DRILLED: 840910

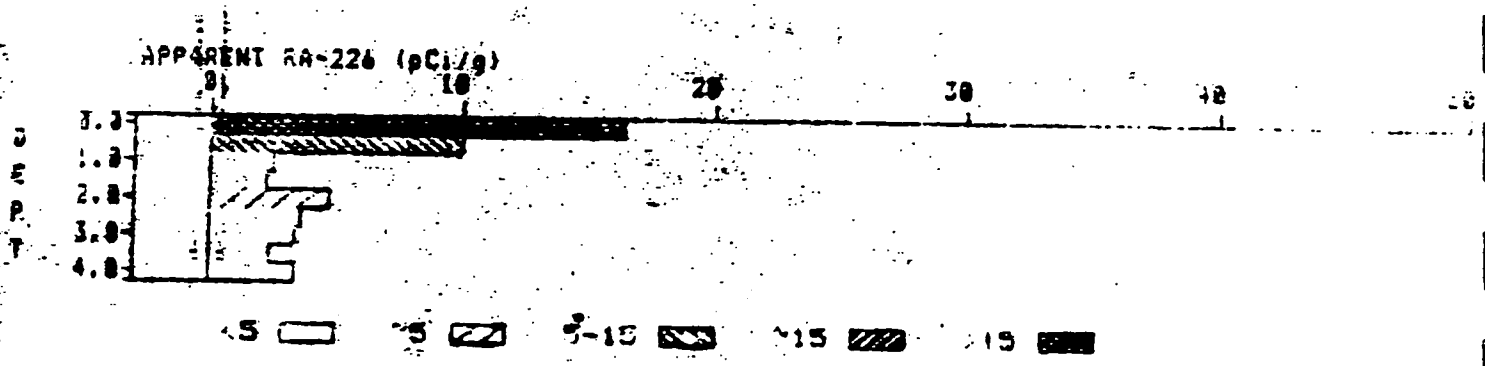
ELEVATION: 4340.0 FT.

FLUID LEVEL: 99.0 FT.

AUGER HEIGHT: 10.0 IN.

PHASE: 1

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-83 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	139.6	10.3	0.8
0.5	102.1	10.0	0.8
1.0	67.0	2.5	0.9
1.5	59.3	2.3	0.7
2.0	64.8	4.7	0.7
2.5	62.0	3.7	0.6
3.0	59.6	3.3	0.6
3.5	56.4	2.3	0.7
4.0	53.8	3.3	0.7

APPARENT RADIUM-226 CONCENTRATION

026

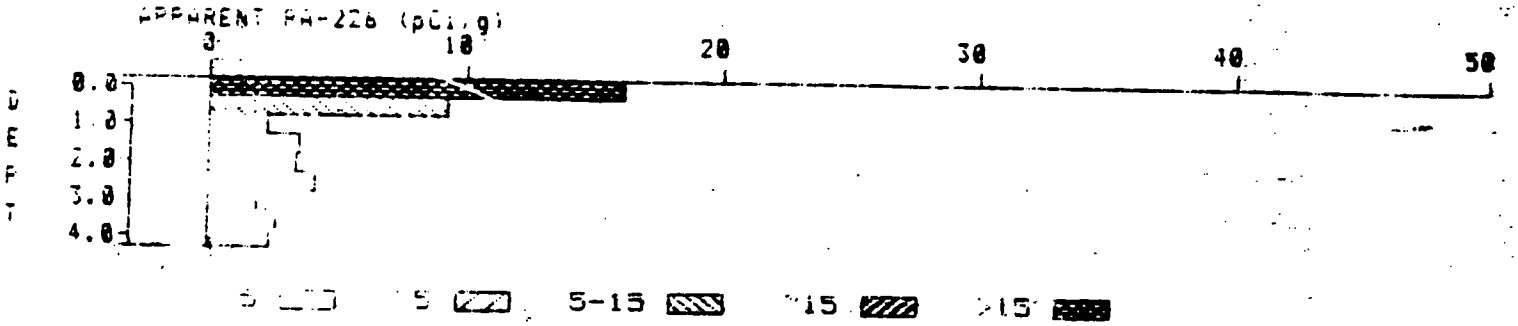
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 026
LOCATION: 88N 85E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840918
ELEVATION: 4340.0 FT.
AUGER HEIGHT: 10.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



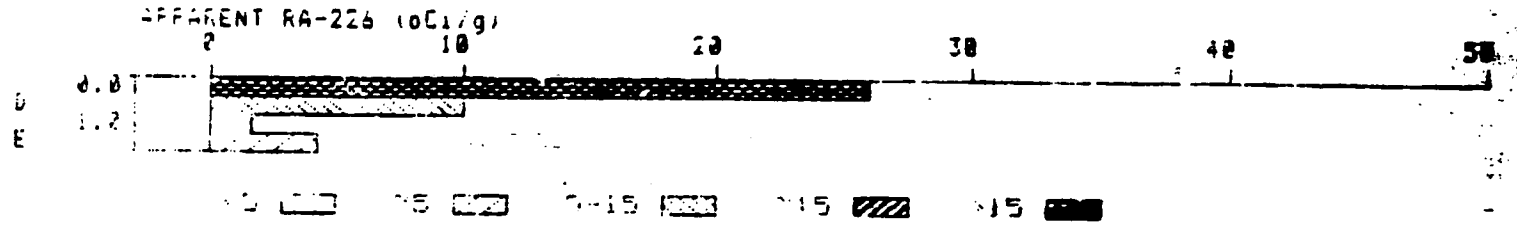
Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	138.5	16.2	0.8
0.5	98.[illegible]	9.2	0.9
1.0	88.0	2.2	0.9
1.5	82.0	3.5	0.7
2.0	80.[illegible]	3.4	0.7
2.5	81.1	4.1	0.7
3.0	74.0	1.8	0.7
3.5	64.[illegible]	2.6	0.7
4.0	43.[illegible]	2.4	0.6

APPARENT RADIUM-226 CONCENTRATION 027

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 027 DATE DRILLED: 840919
LOCATION: 8800.0N 8700.0E ELEVATION: 4344.2 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -46.0 IN.
PHASE: 2

INSTRUMENT TYPE: FRS-I RASCAL SERIAL NO. 753 BJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1485.1	25.7	2.2
0.5	765.5	10.0	1.7
1.0	276.4	1.5	2.0
1.5	229.5	4.3	1.3

Data generated by LOGCALC.BAS version 1.1 S/N 002

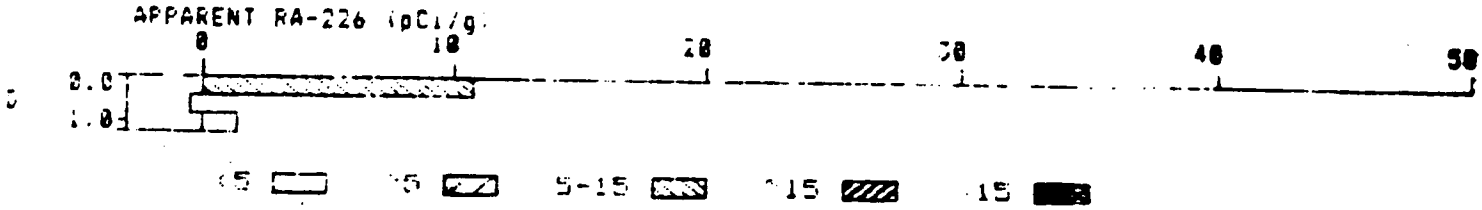
APPARENT RADIUM-226 CONCENTRATION 028

PROJECT: MEXICAN HAT, UTAH START DATE: 840918

HOLE NUMBER: 028
LOCATION: 8000.0N 8900.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4338.7 FT.
AUGER HEIGHT: -53.0 IN.

INSTRUMENT TYPE: PRS-1 RABCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	670.0	10.3	1.5
0.5	166.5	0.5	1.6
1.0	129.2	[illegible]	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 001

APPARENT RADIUM-226 CONCENTRATION

029

PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 029

LOCATION: 87N 73E

DATE DRILLED: 840921

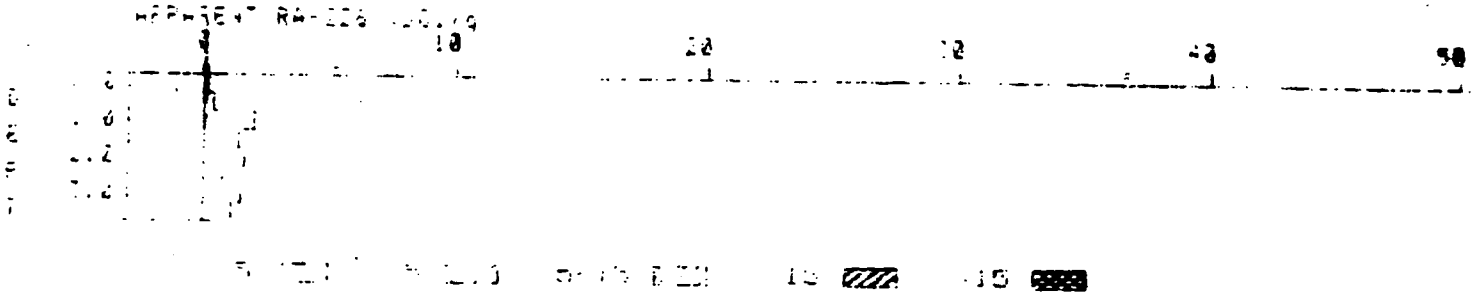
ELEVATION: 4332.0 FT.

FLUID LEVEL: 99.0 FT.

AUGER HEIGHT: 11.0 IN.

PHASE: 2

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-[illegible] GJO NO.: 1815



[illegible]	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	1-Sigma Uncertainty (pCi/g)
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

APPARENT RADIUM-226 CONCENTRATION 029

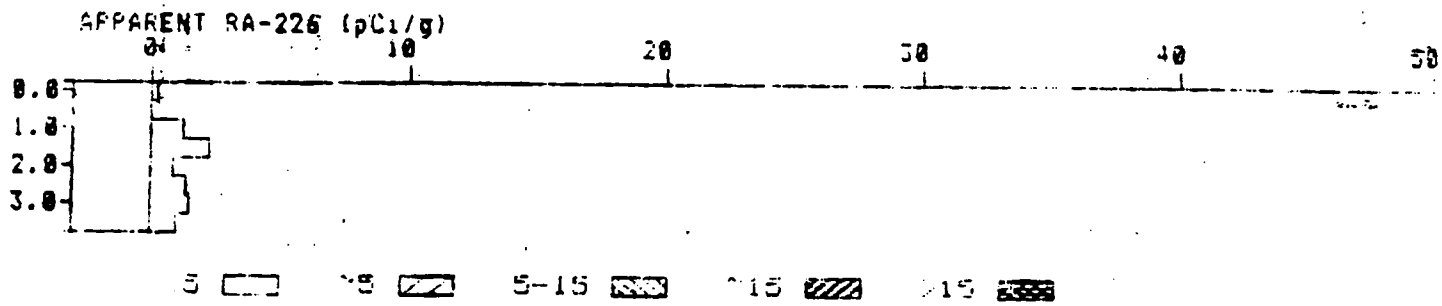
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 029
LOCATION: 87N 73E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840921
ELEVATION: 4332.0 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	40.6	0.2	0.5
0.5	41.3	-0.0	0.5
1.0	46.4	1.1	0.6
1.5	49.9	2.1	0.6
2.0	46.7	0.9	0.6
2.5	47.5	1.4	0.6
3.0	47.4	1.4	0.6
3.5	45.1	1.0	0.5

APPARENT RADIUM-226 CONCENTRATION 030

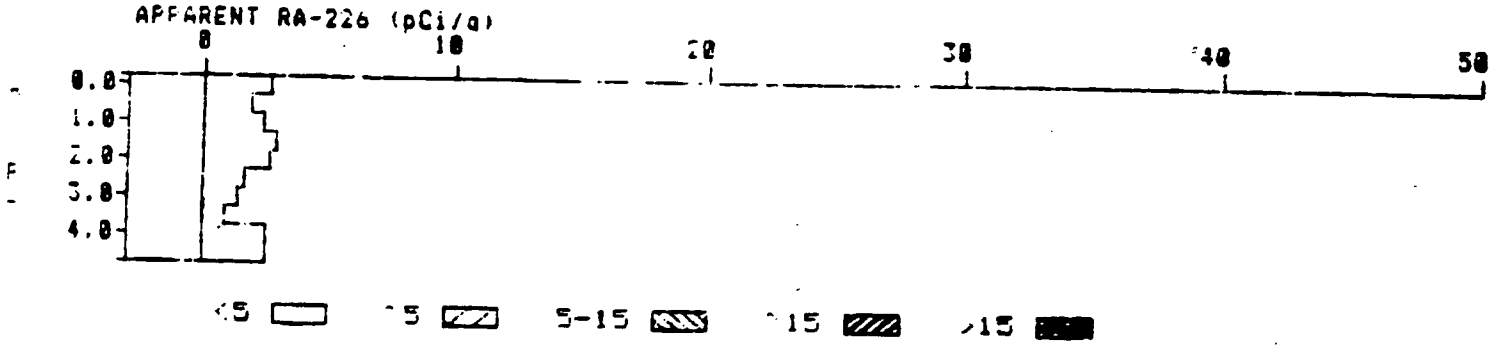
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

OLE NUMBER: 030
LOCATION: 8700.0N 7700.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840923
ELEVATION: 4355.0 FT.
AUGER HEIGHT: -13.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 BJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0	231.8	2.6	1.3
[illegible]	210.9	1.9	1.3
[illegible]	221.9	2.3	1.3
[illegible]	238.7	2.9	1.3
[illegible]	226.5	2.7	1.3
[illegible]	189.1	1.8	1.3
[illegible]	173.5	1.4	1.3
[illegible]	164.3	0.9	1.3
4.0	142.9	2.5	1.3
4.1	152.3	2.5	1.3

is data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

031

PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 031

LOCATION: 87N 82E

FLUID LEVEL: 99.0 FT.

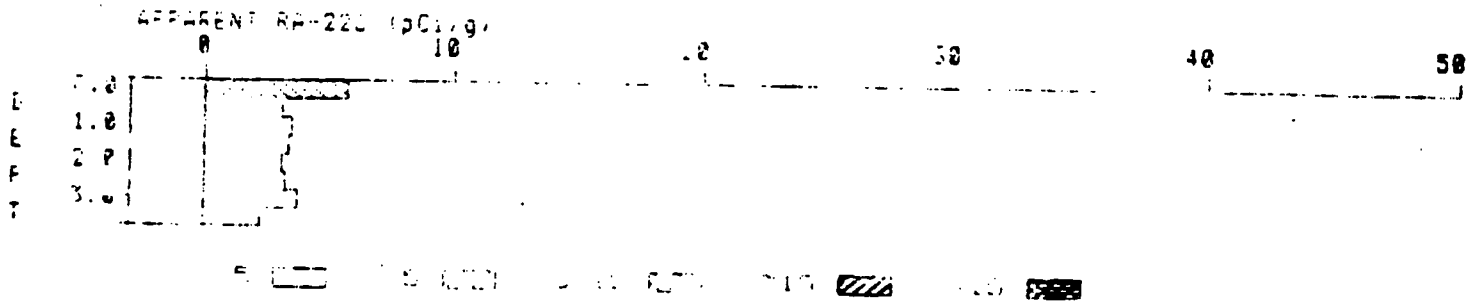
PHASE: 2

DATE DRILLED: 840918

ELEVATION: 4342.0 FT.

AUGER HEIGHT: 12.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	Original Uranium (ppm)
0.0	[illegible]	[illegible]	[illegible]
0.5	[illegible]	[illegible]	[illegible]
1.0	[illegible]	[illegible]	[illegible]
1.5	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	57.1	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	52.4	2.2	[illegible]

APPARENT RADIUM-226 CONCENTRATION 032

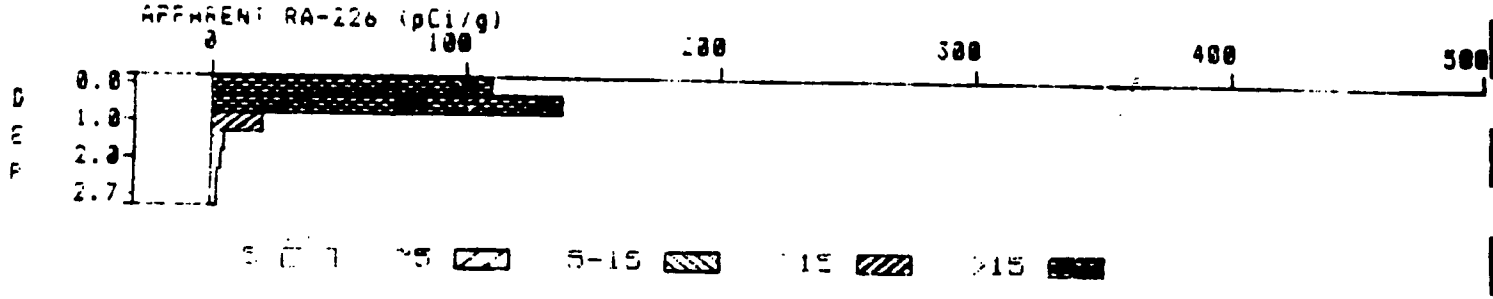
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 032
LOCATION: 8600.0N 7900.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4350.6 FT.
AUGER HEIGHT: -31.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	5993.9	110.1	7.7
0.5	5862.4	136.9	12.7
1.0	2192.2	20.4	5.7
1.5	768.2	4.6	2.7
2.0	384.6	[illegible]	1.5
2.5	180.4	[illegible]	[illegible]
2.7	179.3	[illegible]	1.3

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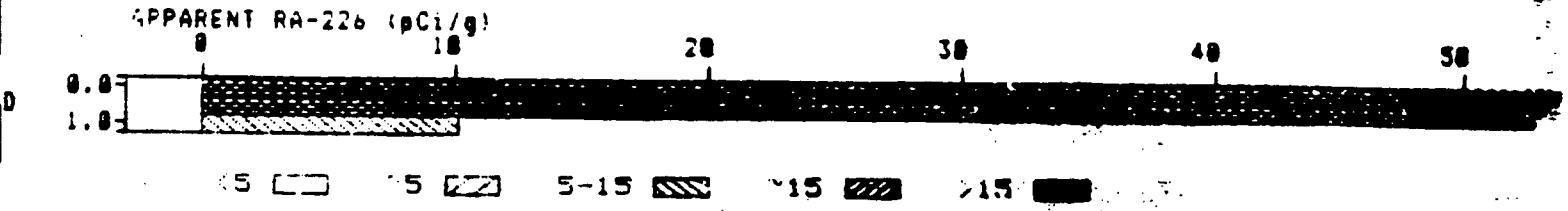
APPARENT RADIUM-226 CONCENTRATION 033

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 033 DATE DRILLED: 840910
LOCATION: 8600.0N 8100.0E ELEVATION: 4344.4 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -52.0 IN.
PHASE: 2

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	3227.6	58.5	4.3
0.5	1926.6	52.8	9.7
1.0	454.2	10.1	1.6

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 034

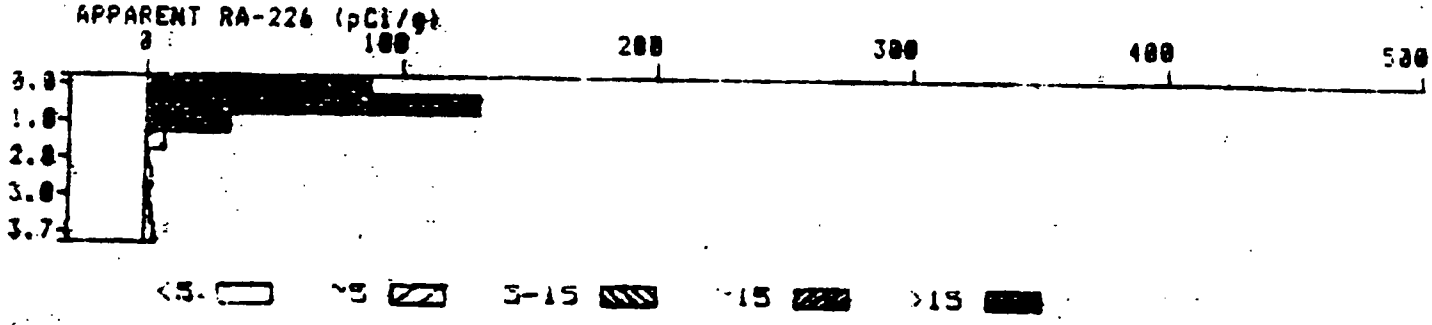
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 034
LOCATION: 8600.0N 8400.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840918
ELEVATION: 4342.6 FT.
AUGER HEIGHT: -19.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	4002.8	87.8	6.2
0.5	5460.4	130.3	12.5
1.0	2471.8	32.3	4.3
1.5	931.9	7.6	2.7
2.0	361.7	1.1	1.7
2.5	258.6	2.6	1.3
3.0	205.2	1.5	1.3
3.5	155.9	2.5	1.3
3.7	186.1	3.3	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

035

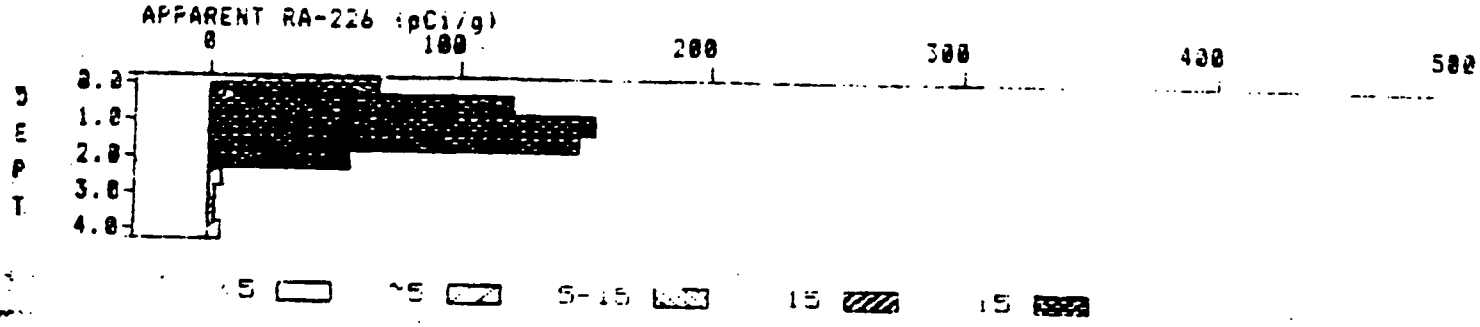
PROJECT: MAT

START DATE: 840910

HOLE NUMBER: 035
LOCATION: 86N 85E
FLUID LEVEL: 99.3 FT.
PHASE: 1

DATE DRILLED: 840918
ELEVATION: 4350.0 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



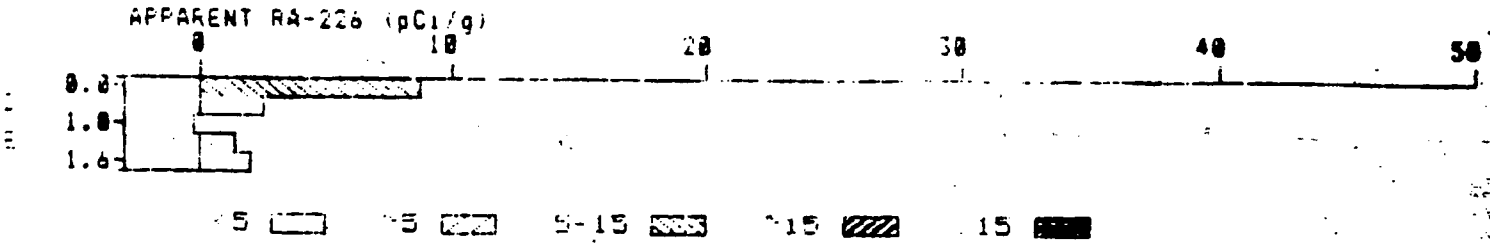
Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	455.4	67.8	2.2
0.5	728.5	120.5	4.5
1.0	883.9	154.4	6.7
1.5	810.0	147.9	6.0
2.0	429.6	55.7	[illegible]
2.5	159.1	5.5	4.1
3.0	81.3	[illegible].4	1.6
3.5	64.6	[illegible].6	1.1
4.0	59.8	4.9	0.7

>PPARENT RADIUM-226 CONCENTRATION 036

PROJECT: MEXICAN HAT, UTAH START DATE: 940910

HOLE NUMBER: 036 DATE DRILLED: 840918
LOCATION: 8600.0N 8700.0E ELEVATION: 4345.1 FT.
UID LEVEL: 99.0 FT. AUGER HEIGHT: -42.0 IN.
PHASE: 2

TRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	563.7	8.8	1.4
0.5	289.5	2.5	1.3
1.0	151.4	-0.2	1.3
1.5	116.4	1.3	1.3
1.6	135.3	2.0	1.3

ai data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 037

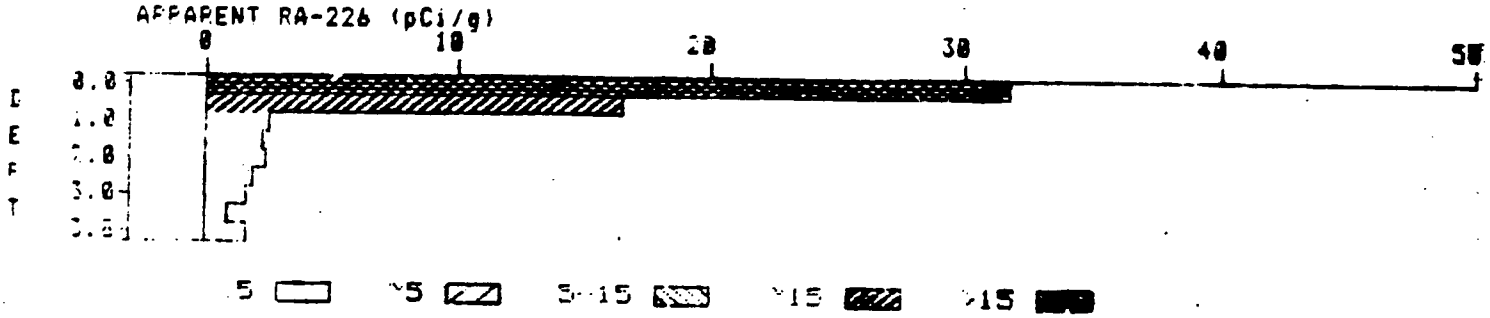
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 037
LOCATION: 8590.0N 8900.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4341.7 FT.
AUGER HEIGHT: -19.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.6	1796.0	31.7	2.6
0.5	1041.4	16.5	1.8
[illegible]	429.4	2.5	1.7
[illegible]	268.0	2.2	1.3
[illegible]	227.2	2.4	1.2
[illegible]	199.5	1.9	1.3
[illegible]	176.1	1.6	1.3
[illegible]	107.2	0.9	1.3
[illegible]	138.4	1.7	1.3

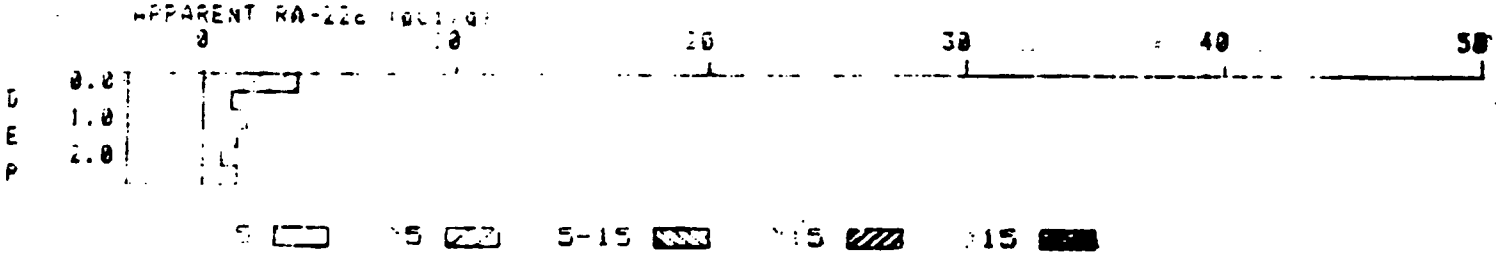
[illegible] generated by LUGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 038

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 038 DATE DRILLED: 840919
LOCATION: 8500.0N 7700.0E ELEVATION: 4351.5 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -37.0 IN.
PHASE: 2

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	274.2	[illegible].7	1.[illegible]
0.5	195.1	1.1	1.[illegible]
1.0	185.5	1.8	1.[illegible]
1.5	164.9	1.4	1.[illegible]
2.0	100.1	0.7	1.[illegible]
2.[illegible]	117.2	1.4	1.2

This data generated by LOGCALC.BAS Version 1.1 S/N 001

APPARENT RADIUM-226 CONCENTRATION 039

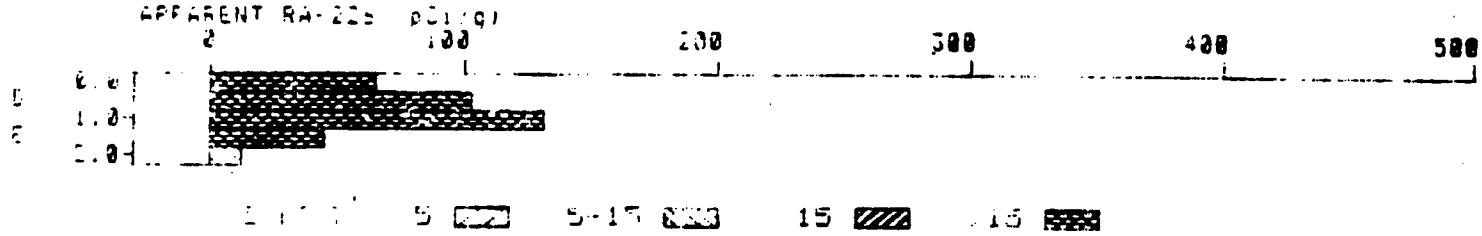
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 039
LOCATION: 8500.0N 8200.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4343.8 FT.
AUGER HEIGHT: -39.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	6611.7	65.6	4.8
0.5	5140.7	102.5	7.6
1.0	5457.0	131.6	12.3
1.5	1402.6	44.7	7.5
2.0	501.0	12.0	1.6

This data was [illegible] LOGLALL.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 040

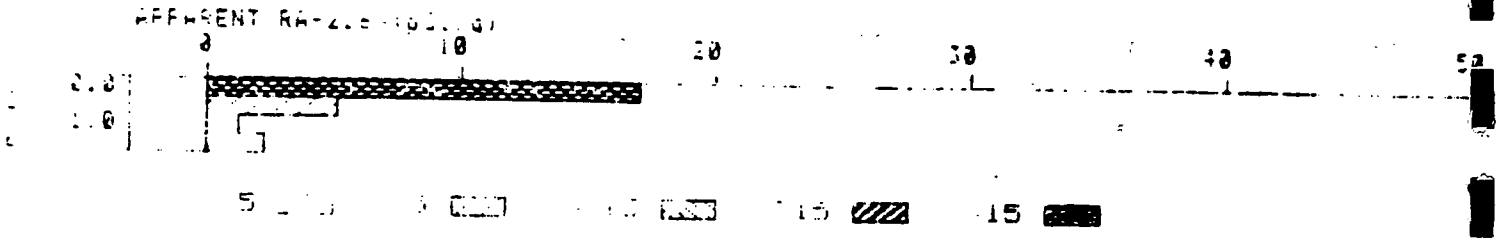
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 040
LOCATION: 8400.0N 7900.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4350.8 FT.
AUGER HEIGHT: -48.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium 226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	100.0	17.0	1.6
0.5	487.1	5.1	1.5
1.0	167.3	[illegible]	1.4
1.5	140.[illegible]	[illegible]	1.3

Data generated by GOLAR.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 041

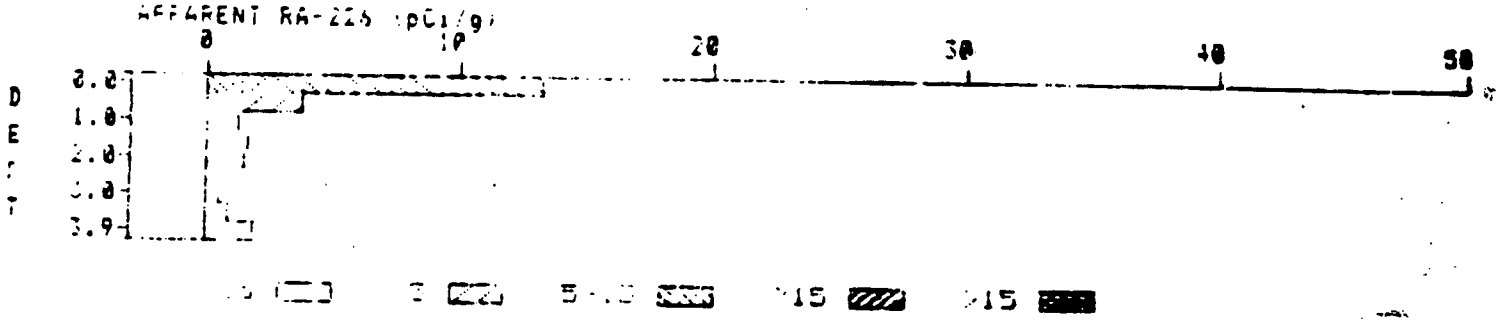
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 041
LOCATION: 8400.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4348.1 FT.
AUGER HEIGHT: -10.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.00	400.0	13.3	1.0
0.500	376.5	3.0	1.4
1.000	273.1	[illegible]	1.3
1.500	189.1	[illegible]	1.3
2.000	171.7	1.8	1.3
2.500	[illegible]	1.1	[illegible]
3.000	154.0	0.4	1.[illegible]
3.500	124.0	0.[illegible]	1.[illegible]
[illegible]	[illegible]	[illegible]	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 042

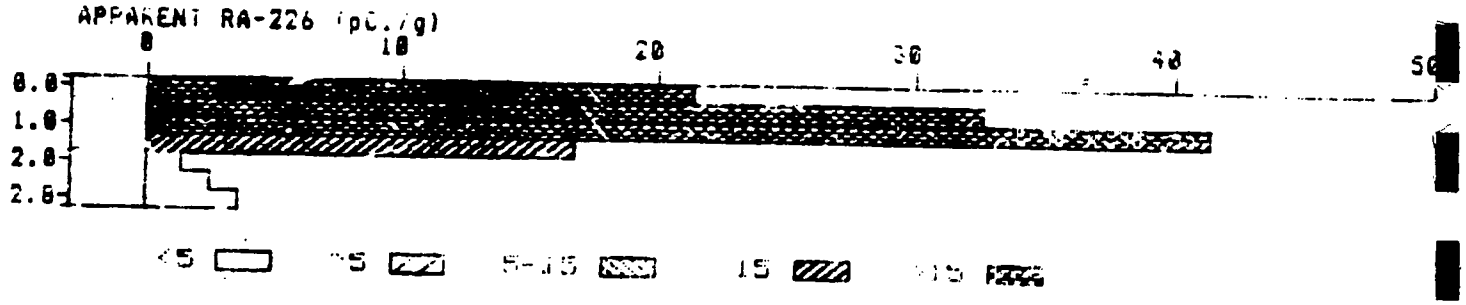
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 042
LOCATION: 8400.0N 8300.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840919
ELEVATION: 4347.4 FT.
AUGER HEIGHT: -31.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	1236.7	21.[illegible]	2.0
0.5	1709.7	32.7	2.8
1.0	1875.6	41.4	4.0
1.5	1061.6	16.8	1.8
2.0	396.7	1.[illegible]	1.8
2.5	189.0	[illegible]	[illegible]
3.0	216.4	[illegible]	1.4

This data generated by LOGCALC.BAS Version 1.1 [illegible]

APPARENT RADIUM-226 CONCENTRATION 043

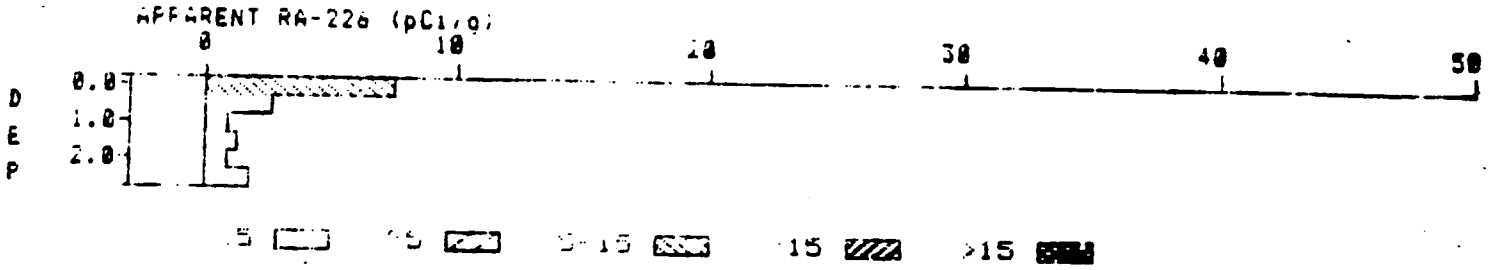
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 043
LOCATION: 8400.0N 8500.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4352.1 FT.
AUGER HEIGHT: -35.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	495.4	7.5	[illegible]
0.5	284.9	2.7	[illegible]
1.0	182.3	0.7	[illegible]
1.5	164.7	1.2	[illegible]
2.0	113.0	0.9	[illegible]
2.4	130.2	1.7	[illegible]

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 044

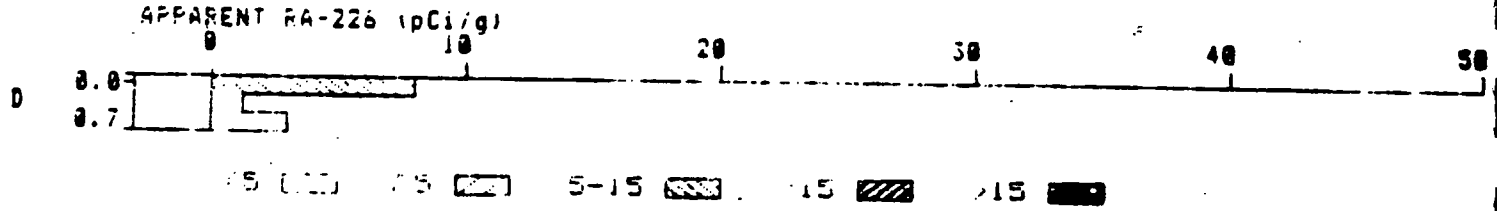
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 044
LOCATION: 8400.0N 6700.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4359.3 FT.
AUGER HEIGHT: -55.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	517.1	8.1	1.4
0.5	179.4	1.2	1.4
0.7	174.3	3.0	1.3

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APPARENT RADIUM-226 CONCENTRATION

045

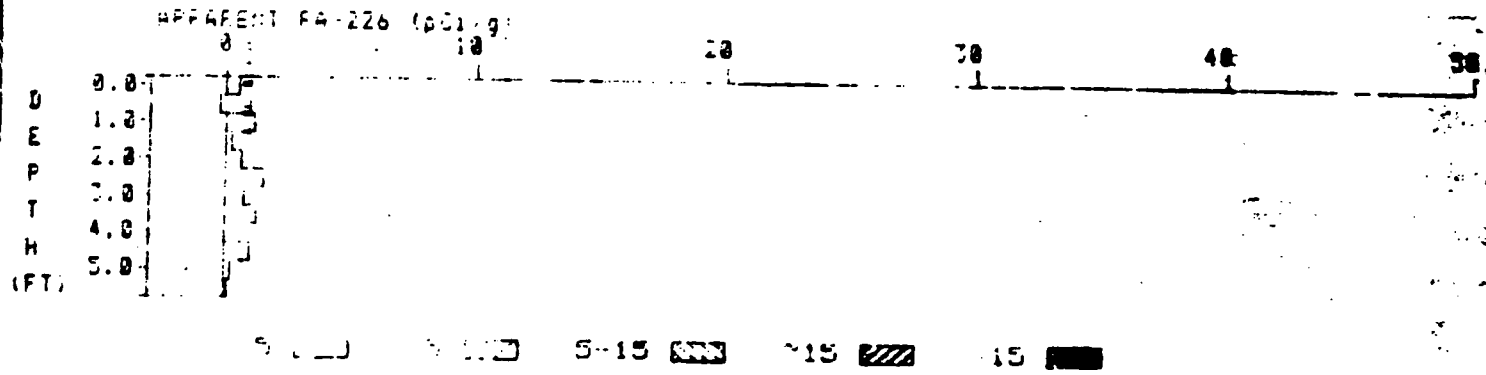
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 045
LOCATION: 83N 75E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4340.0 FT.
AUGER HEIGHT: 50.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	42.8	0.6	0.5
0.5	39.2	0.5	0.7
1.0	58.3	1.1	0.7
1.5	41.[illegible]	0.[illegible]	0.6
2.0	43.7	0.6	0.6
2.5	46.6	1.5	0.6
3.0	45.0	0.8	0.6
3.5	45.[illegible]	1.[illegible]	0.6
4.0	41.[illegible]	0.0	0.6
4.5	43.8	1.0	0.6
5.0	41.2	0.2	0.6
5.[illegible]	8[illegible]	0.1	0.6

APPARENT RADIUM-226 CONCENTRATION 046

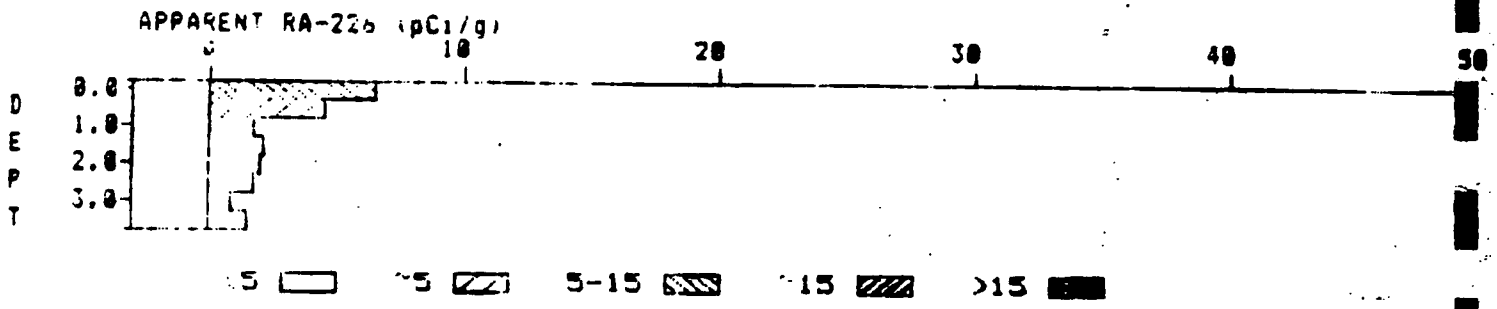
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 046
LOCATION: 8300.0N 7700.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4351.6 FT.
AUGER HEIGHT: -27.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	441.0	6.5	1.3
0.5	[illegible]	4.5	1.3
1.0	[illegible]	1.7	1.3
1.5	710.0	2.1	1.3
2.0	[illegible]	1.9	1.3
2.5	161.1	1.7	1.4
3.0	107.[illegible]	0.9	1.3
3.5	144.2	1.5	1.3

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APPARENT RADIUM-226 CONCENTRATION 047

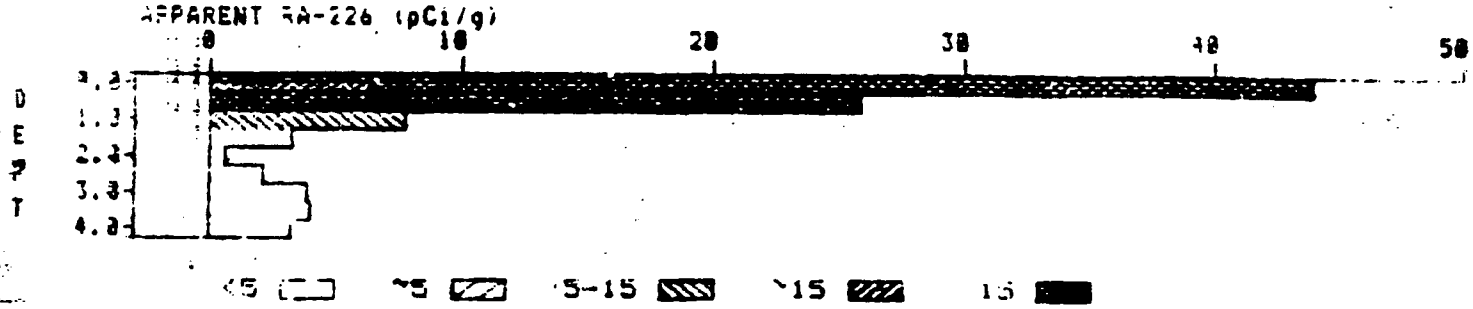
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 047
LOCATION: 82N 79E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840919
ELEVATION: 4353.0 FT.
AUGER HEIGHT: 10.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



<5 <5 5-15 >15 15

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	309.4	44.0	1.5
0.5	203.7	25.9	1.3
1.0	110.5	7.8	1.4
1.5	67.8	3.3	0.8
2.0	52.0	0.6	0.7
2.5	54.1	2.1	0.6
3.0	60.7	3.9	0.6
3.5	61.8	4.0	0.7
4.0	53.4	3.2	0.6

APPARENT RADIUM-226 CONCENTRATION 048

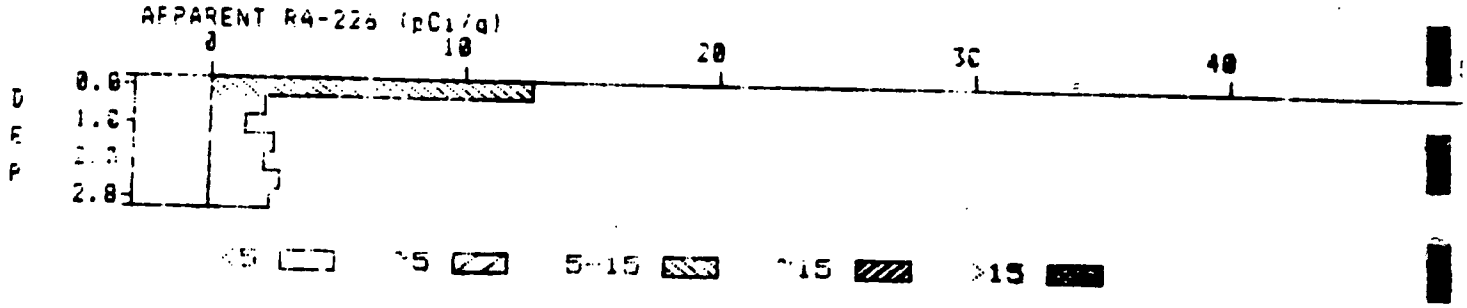
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 048
LOCATION: 8185.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4351.6 FT.
AUGER HEIGHT: -32.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	773.6	12.7	1.6
0.5	344.6	2.1	1.6
1.0	220.8	1.0	1.6
1.5	225.5	1.5	1.6
2.0	205.7	2.1	1.6
2.5	154.7	2.6	1.6
[illegible]	184.3	[illegible]	1.6

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 049

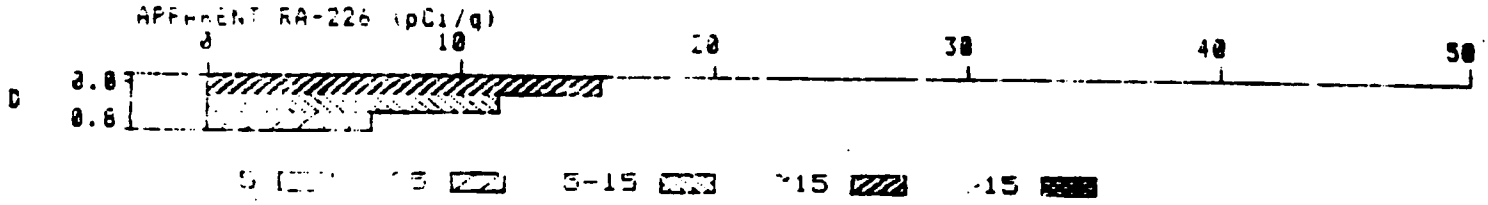
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 049
LOCATION: 8200.0N 8300.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4354.9 FT.
AUGER HEIGHT: -56.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	876.1	15.4	1.9
0.5	466.6	11.[illegible]	1.7
0.8	371.1	[illegible]	1.6

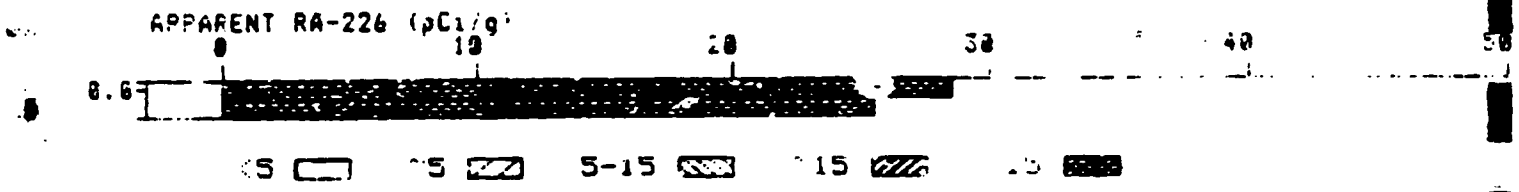
This data generated by LOGCALC.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 050

PROJECT: MEXICAN HAT, UTAH START DATE: 840918

HOLE NUMBER: 050 DATE DRILLED: 840919
LOCATION: 8200.0N 8500.0E ELEVATION: 4357.4 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -60.0 IN.
PHASE: 1

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1101.4	28.5	2.5
0.[illegible]	[illegible]16.0	25.5	2.5

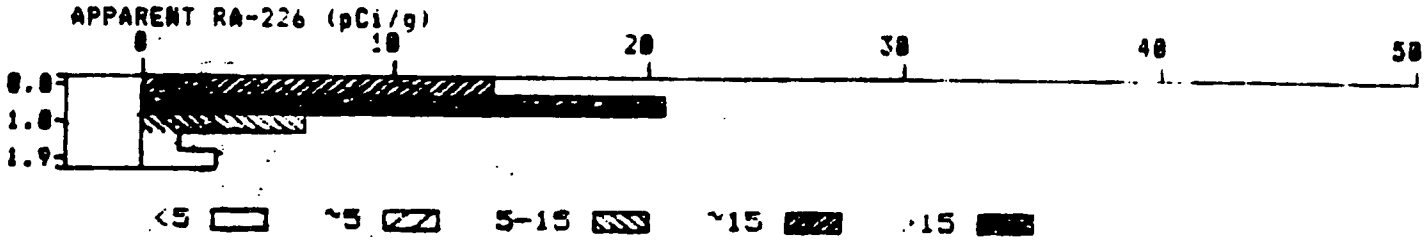
This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 051

PROJECT: MEXICAN HAT, UTAH START DATE: 840918

HOLE NUMBER: 051 DATE DRILLED: 840919
LOCATION: 8200.0N 8750.0E ELEVATION: 4352.9 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -42.0 IN.
PHASE: 1

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	836.6	13.9	1.6
0.5	953.2	20.6	2.4
1.0	519.1	6.4	1.4
1.5	187.9	1.5	1.4
1.9	195.6	3.0	1.3

data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 852

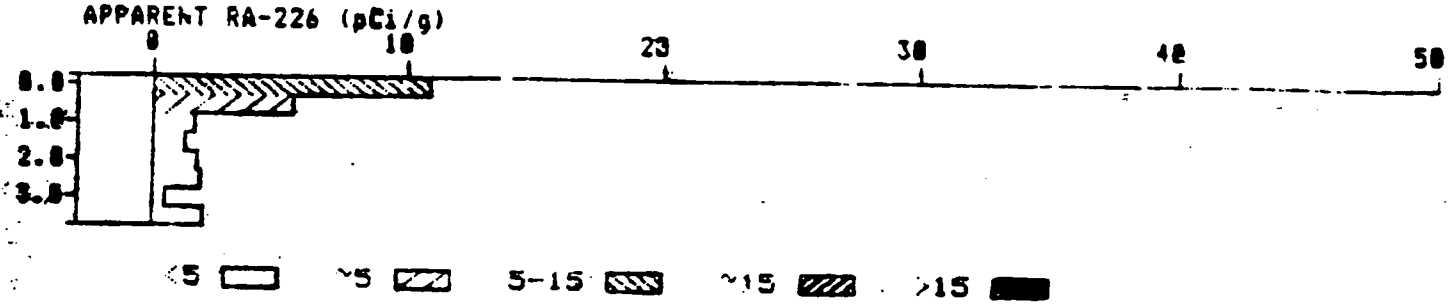
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 852
LOCATION: 8000.0N 7900.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840919
ELEVATION: 4353.2 FT.
AUGER HEIGHT: -21.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GIO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	675.2	10.8	1.5
0.5	421.8	5.5	1.[illegible]
1.0	237.7	1.6	1.[illegible]
1.5	184.4	1.2	1.[illegible]
2.0	184.9	1.7	1.[illegible]
2.5	181.3	1.8	1.[illegible]
3.0	134.8	0.5	1.[illegible]
3.5	136.9	2.0	1.[illegible]

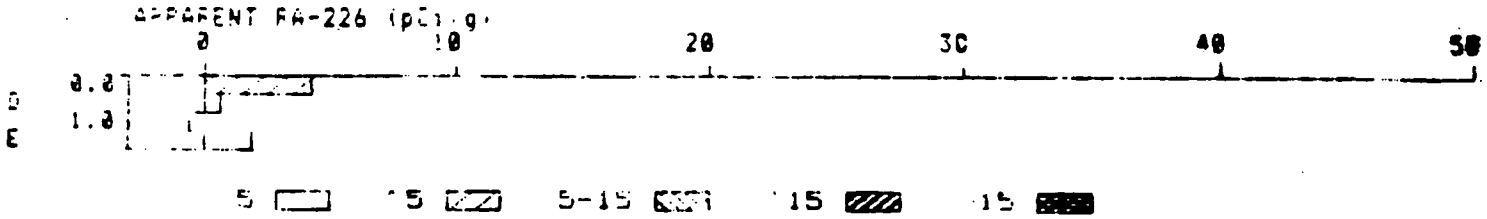
This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 053

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 053 DATE DRILLED: 840919
LOCATION: 8000.0N 8100.0E ELEVATION: 4358.7 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -45.0 IN.
PHASE: 2

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Dep (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	222.1	4.3	1.3
0.5	172.7	0.7	1.2
1.0	104.9	-0.6	1.3
1.4	129.8	1.9	1.2

Data generated by LOGCALC.BAS Version 1.1 S/N 002

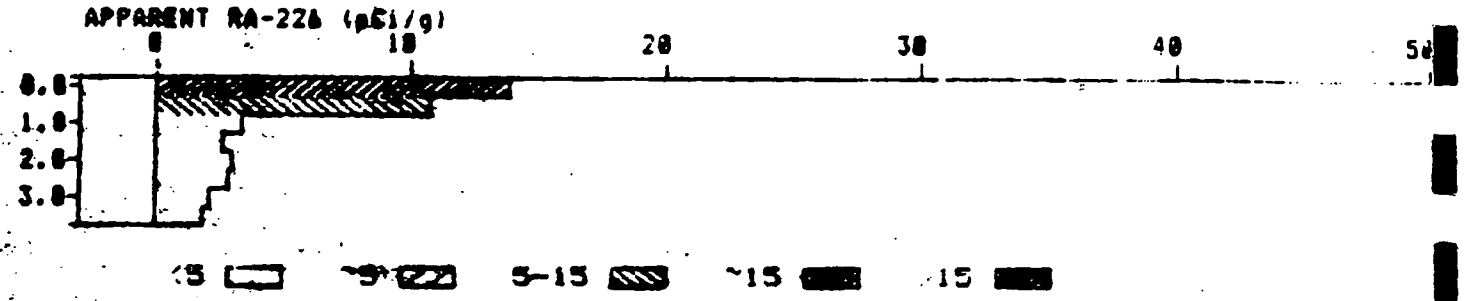
APPARENT RADIUM-226 CONCENTRATION 054

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 054
LOCATION: 8000.0N 8300.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840919
ELEVATION: 4357.6 FT.
AUGER HEIGHT: -23.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 BJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	839.0	13.9	1.6
0.5	634.9	10.7	1.5
1.0	357.5	3.4	1.4
1.5	267.5	2.6	1.3
2.0	254.9	3.0	1.3
2.5	248.6	2.8	1.3
3.0	152.4	2.2	1.4
3.5	151.2	1.8	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

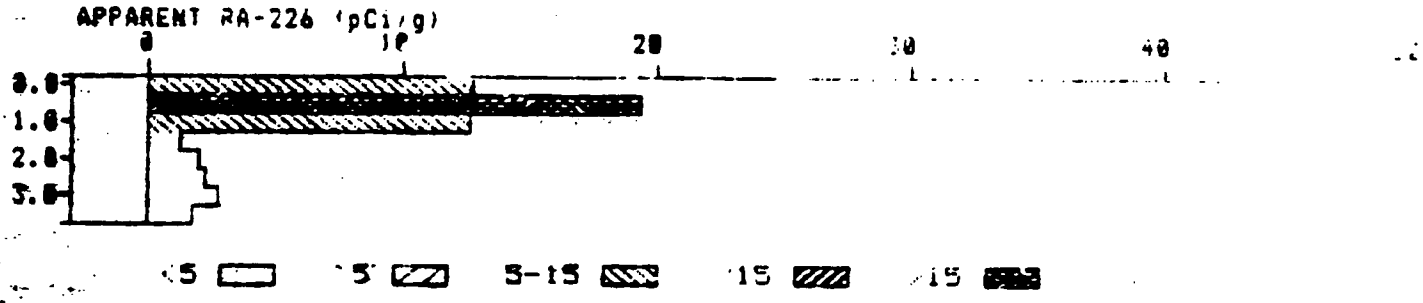
APPARENT RADIUM-226 CONCENTRATION 055

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 055
LOCATION: 7800.0N 7900.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840919
ELEVATION: 4353.2 FT.
AUGER HEIGHT: -23.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	779.4	12.8	1.6
0.5	947.8	19.4	[illegible]
1.0	701.0	12.6	1.6
1.5	303.3	1.2	1.5
2.0	228.5	2.0	1.3
2.5	220.2	2.3	[illegible]
3.0	159.1	2.7	1.4
3.5	144.9	1.7	1.3

Data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 056

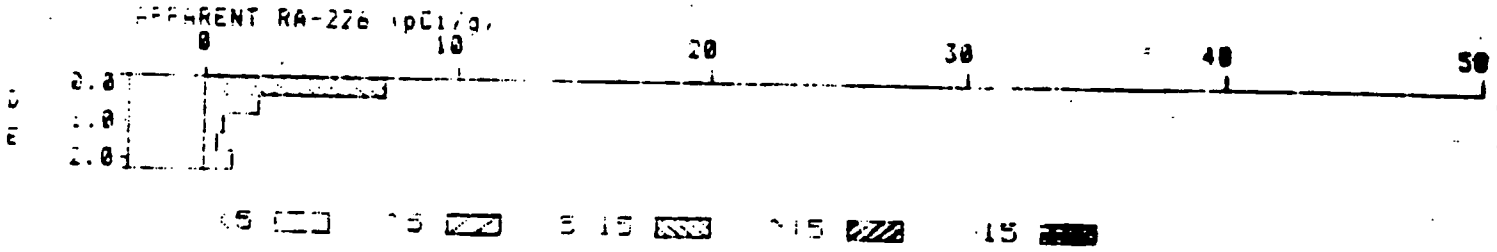
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 056
LOCATION: 7800.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840919
ELEVATION: 4360.1 FT.
AUGER HEIGHT: -41.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 BJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	476.3	7.1	1.4
0.5	260.6	[illegible]	[illegible]
1.0	165.1	0.8	[illegible]
1.5	98.5	0.5	[illegible]
2.0	119.1	1.1	[illegible]

Data generated by LOGCALC.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

071

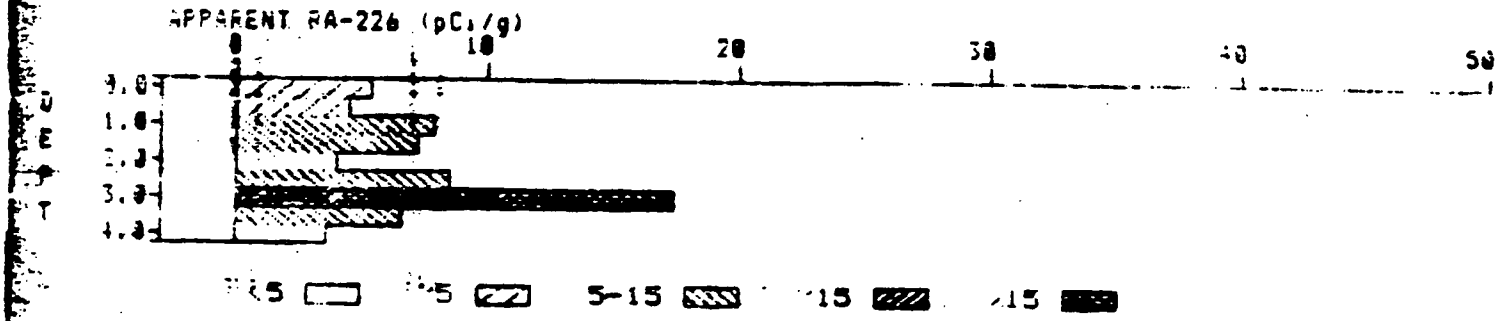
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 071
LOCATION: 10JN 01E
FLUID LEVEL: 99.0 FT.
PHASE: I

DATE DRILLED: 840920
ELEVATION: 4313.0 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	72.4	5.4	0.6
0.5	72.2	4.6	0.6
1.0	62.8	7.5	0.7
1.5	61.5	7.2	0.6
2.0	75.1	4.0	0.9
2.5	74.3	6.5	0.7
3.0	119.4	17.4	1.4
3.5	84.4	9.9	0.7
4.0	53.6	5.6	0.7

APPARENT RADIUM-226 CONCENTRATION

071

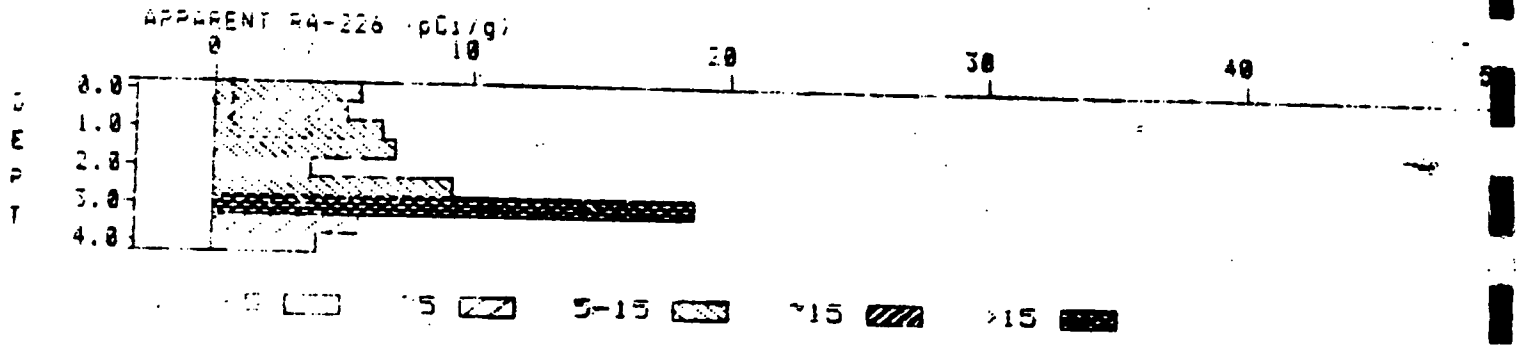
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 071
LOCATION: 103N 81E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840920
ELEVATION: 4313.0 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



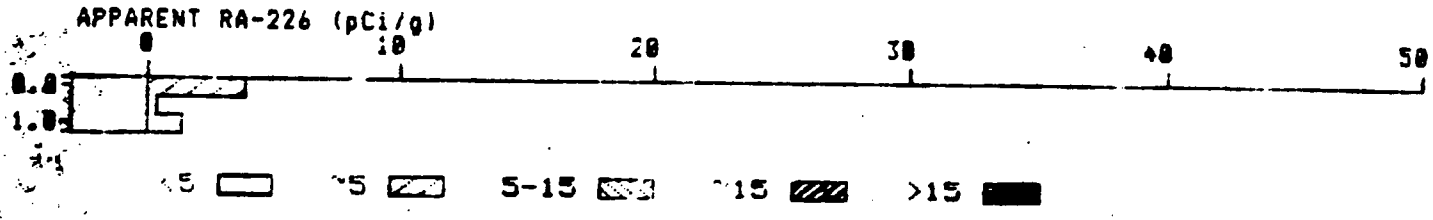
Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	74.2	5.7	0.6
0.5	73.4	5.1	0.7
1.0	78.0	6.5	0.6
1.5	79.6	7.0	0.8
2.0	74.9	5.8	0.9
2.5	77.7	7.[illegible]	0.8
3.0	[illegible]	18.6	1.8
3.50	96.9	5.7	1.9
4.0	95.2	4.0	0.7

APPARENT RADIUM-226 CONCENTRATION 072

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

LE NUMBER: 072 DATE DRILLED: 840920
LOCATION: 10200.0N 8100.0E ELEVATION: 4312.5 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -52.0 IN.
PHASE: 1

TRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	298.6	3.8	1.3
0.5	136.7	0.4	1.4
1.0	121.4	1.4	1.3

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APPARENT RADIUM-226 CONCENTRATION

073

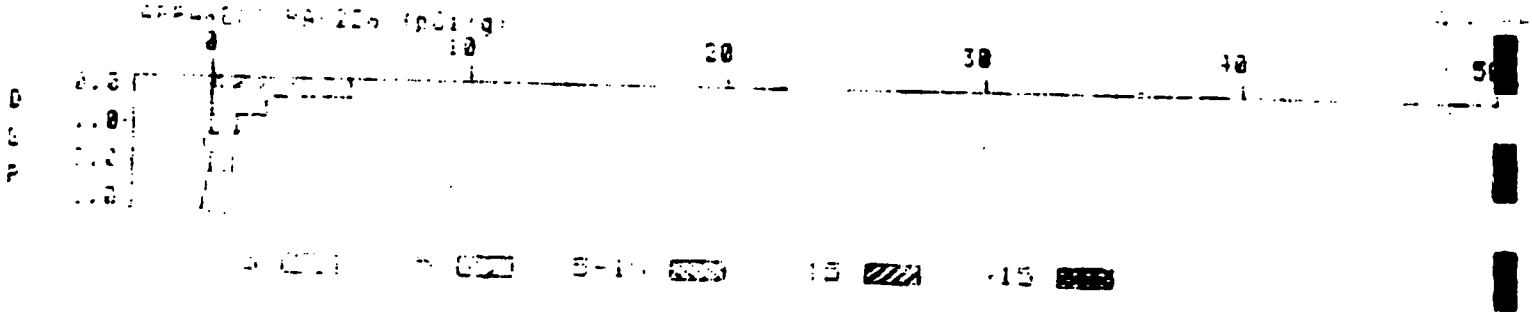
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 073
LOCATION: 100N 81E
FLUID LEVEL: 9.0 FT.
PHASE: 2

DATE DRILLED: 840920
ELEVATION: 4315.0 FT.
AUGER HEIGHT: 18.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observing Count Rate (cps)	Corrected Radium Conc. (pCi/g)	Sigma Uncertainty (pCi/g)
[illegible]	[illegible]	[illegible]	[illegible]

APPARENT RADIUM-226 CONCENTRATION

073

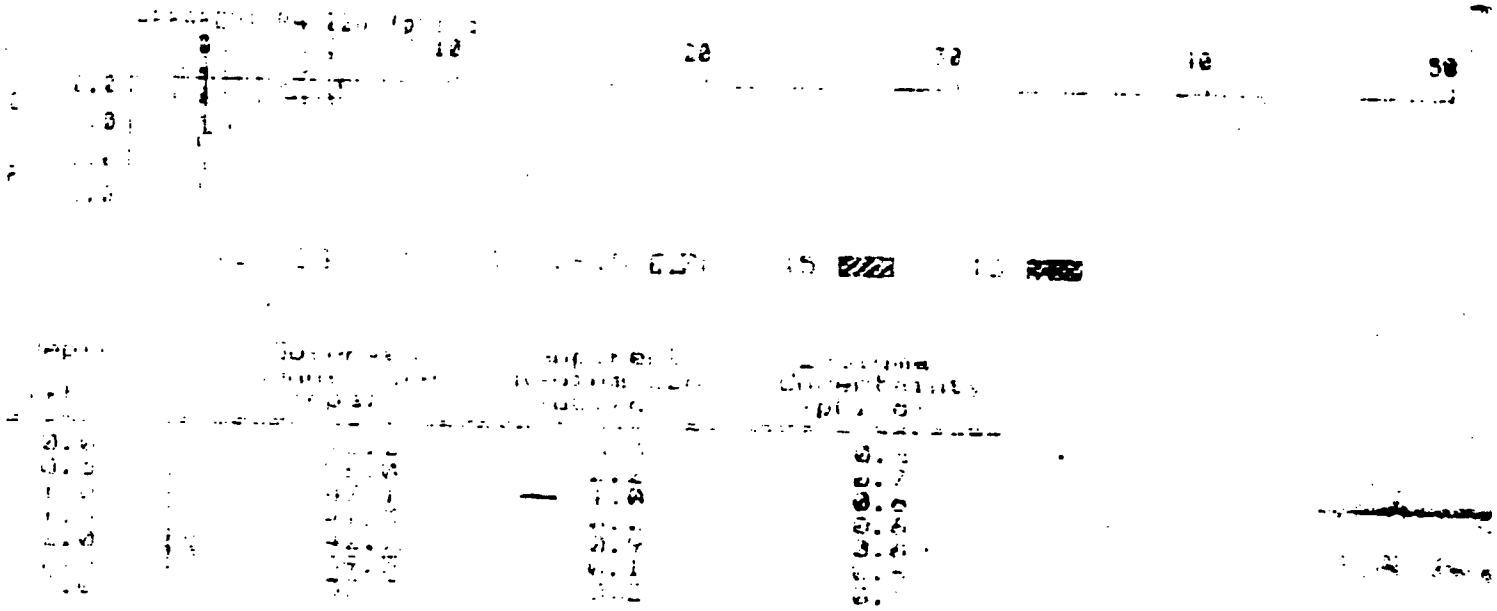
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 073
LOCATION: 100N 81E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840920
ELEVATION: 4315.0 FT.
AUGER HEIGHT: 18.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



APPARENT RADIUM-226 CONCENTRATION

074

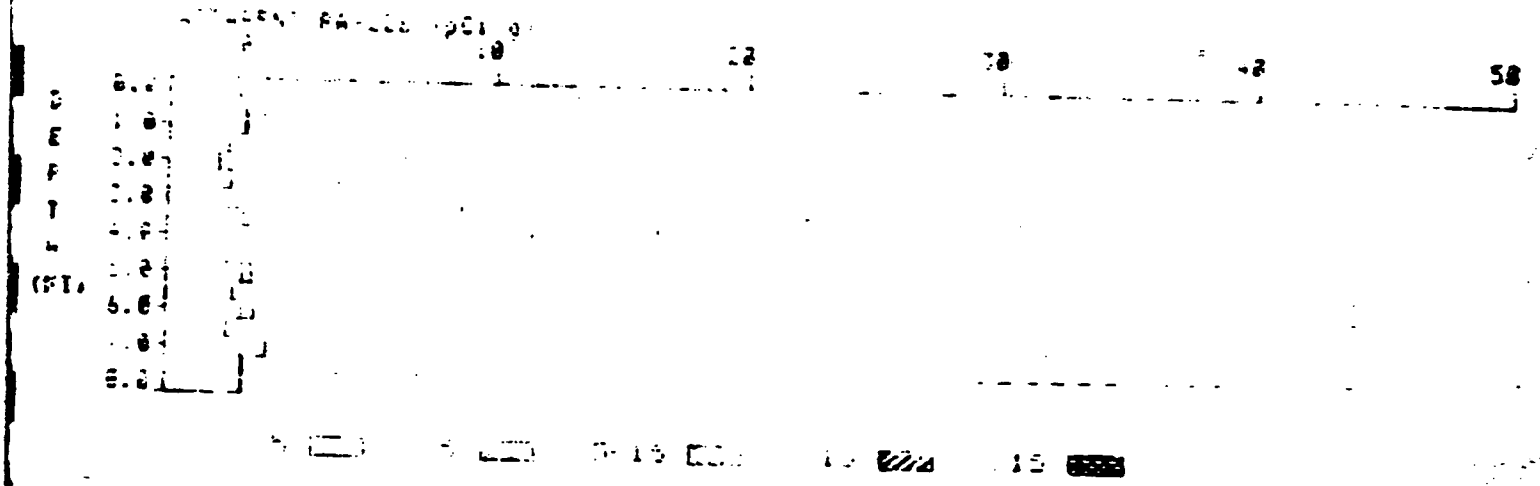
PROJECT: HAT

START DATE: 840918

HOLE NUMBER: 074
LOCATION: 99N 80E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840928
ELEVATION: 4316.0 FT.
AUGER HEIGHT: 21.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1615



(FT)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	Absolute Uncertainty (pCi/g)
0.0	76.0	-0.2	0.5
[illegible]	[illegible]	0.1	0.6
[illegible]	[illegible]	0.1	0.6
[illegible]	[illegible]	-0.7	0.6
[illegible]	[illegible]	1.0	0.5
[illegible]	[illegible]	-0.5	0.5
[illegible]	[illegible]	1.0	0.5
[illegible]	[illegible]	0.1	0.6
[illegible]	[illegible]	-0.4	0.6
[illegible]	[illegible]	-0.6	0.5
[illegible]	[illegible]	0.4	0.5
[illegible]	[illegible]	-0.4	0.6
[illegible]	[illegible]	0.6	0.6
[illegible]	[illegible]	-0.6	0.6
[illegible]	[illegible]	1.0	0.6
[illegible]	40.7	0.1	0.6
[illegible]	36.2	0.1	0.5

APPARENT RADIUM-226 CONCENTRATION 075

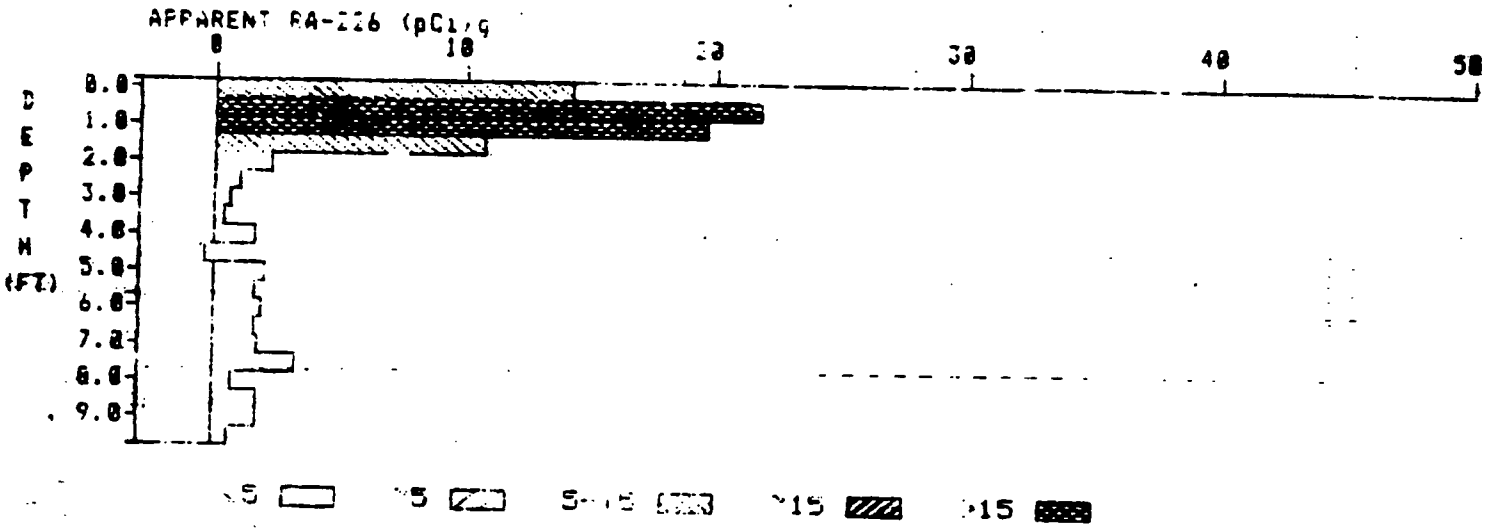
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 075
LOCATION: 99N 81E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840920
ELEVATION: 4318.0 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	126.9	14.3	0.7
0.5	155.5	21.7	1.4
1.0	146.0	17.6	1.2
1.5	105.4	10.8	0.9
2.0	64.5	-2.2	0.8
2.5	49.8	1.0	0.6
3.0	45.0	0.7	0.6
3.5	43.7	0.4	0.6
4.0	46.2	1.6	0.6
4.5	41.9	-0.3	0.6
5.0	42.6	2.0	0.7
5.5	46.6	1.6	0.7
6.0	50.5	1.9	0.6
6.5	49.9	1.6	0.6
7.0	51.0	1.7	0.6
7.5	54.5	3.2	0.6
8.0	47.9	0.8	0.6
8.5	49.3	1.8	0.6
9.0	48.1	1.7	0.6
9.5	42.8	0.6	0.5

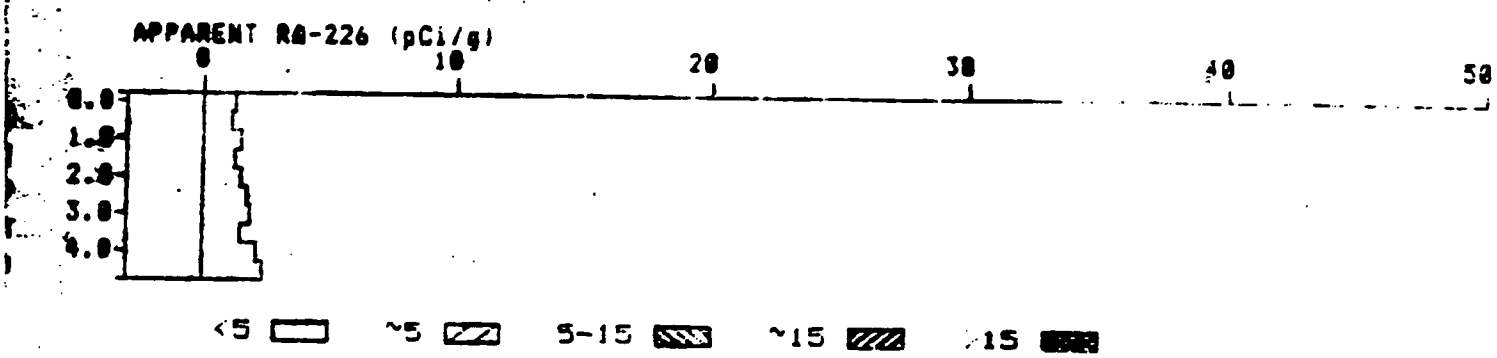
APPARENT RADIUM-226 CONCENTRATION 076

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

LE NUMBER: 076
LOCATION: 9800.0N 7700.0E
FLUID LEVEL: 99.0 FT.
PAGE: 1

DATE DRILLED: 840923
ELEVATION: 4328.4 FT.
AUGER HEIGHT: -12.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 BJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	160.6	1.2	1.2
	161.0	1.2	1.2
	169.6	1.5	1.[illegible]
	166.1	1.4	1.[illegible]
	175.8	1.5	1.[illegible]
[illegible]	185.7	1.8	1.[illegible]
[illegible]	190.2	1.9	1.[illegible]
3.5	183.1	1.4	1.[illegible]
4.0	140.7	2.2	1.[illegible]
4.5	153.9	2.4	1.[illegible]

* data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 078

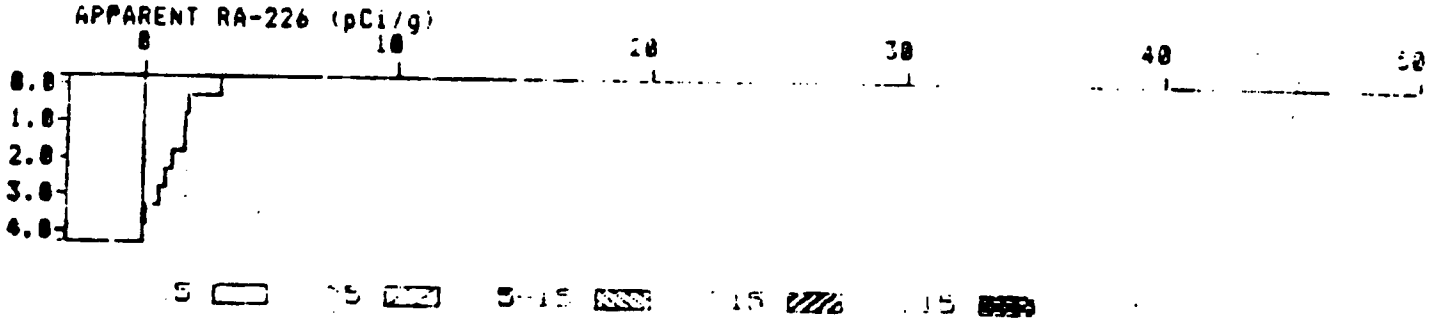
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 078
LOCATION: 9800.0N 8200.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840920
ELEVATION: 4321.7 FT.
AUGER HEIGHT: -60.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium 226 (pCi/g)	2 sigma Uncertainty (pCi/g)
0.0	175.2	3.0	1.3
0.5	180.3	1.6	1.4
1.0	183.9	1.6	1.3
1.5	174.5	1.6	1.3
2.0	156.1	1.1	1.2
2.5	142.4	0.9	1.2
3.0	126.5	0.7	1.2
3.5	104.7	0.1	1.2
4.0	96.2	0.0	1.2

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 078

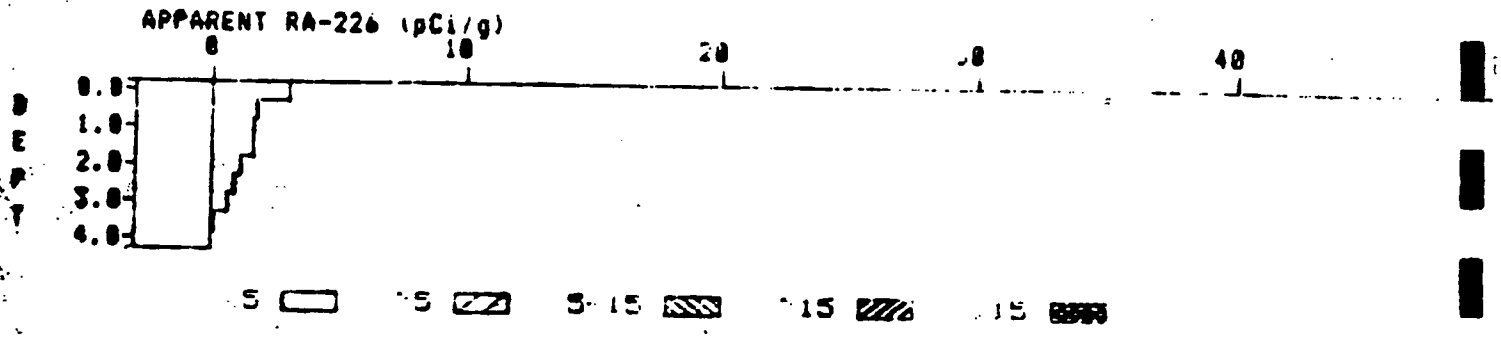
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 078
LOCATION: 9000.0N 8200.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840920
ELEVATION: 4321.7 FT.
AUGER HEIGHT: -60.0 IN.

INSTRUMENT TYPE: PRB-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	175.2	3.0	1.3
0.5	180.3	1.8	1.4
1.0	183.9	1.6	1.3
1.5	174.5	1.6	1.3
2.0	156.1	1.1	1.2
2.5	142.4	0.9	1.2
3.0	126.5	0.7	1.2
3.5	104.7	0.1	1.2
4.0	96.2	0.0	1.2

This data generated by LOGCALC.BAS Version 1.1 S/N 001

APPARENT RADIUM-226 CONCENTRATION 079

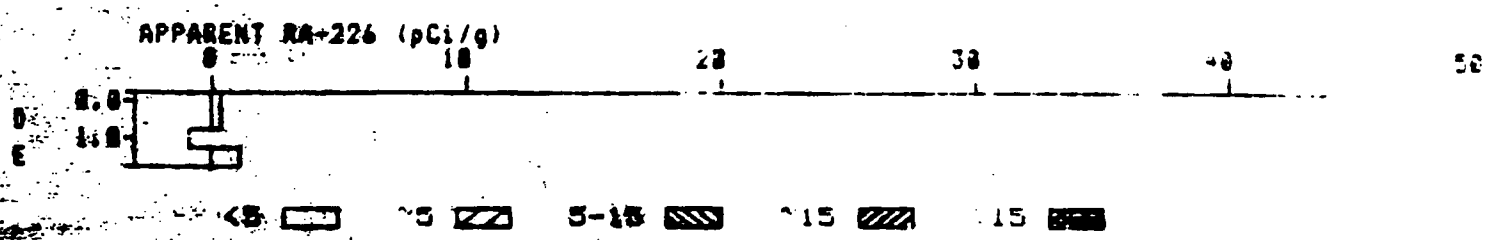
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 079
LOCATION: 9700.0N 8100.0E
FLUID LEVEL: 99.0 FT.
PHASE: I

DATE DRILLED: 840920
ELEVATION: 4318.6 FT.
AUGER HEIGHT: -35.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	115.6	0.4	1.2
0.5	107.8	0.4	1.2
1.0	80.5	-0.8	1.2
1.4	155.0	1.1	1.2

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

000

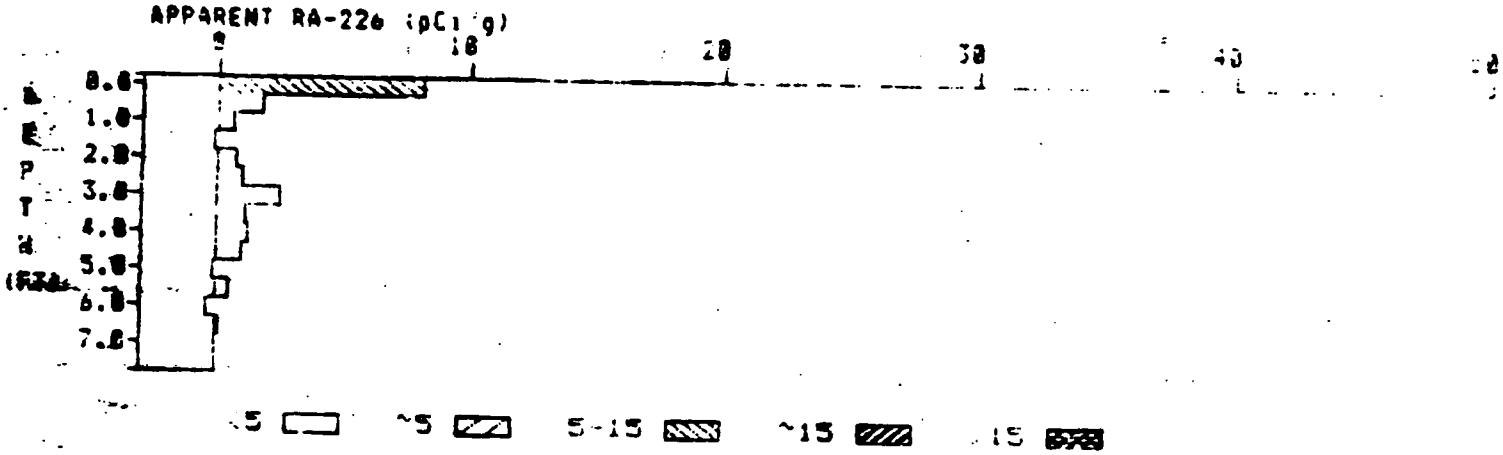
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 000
LOCATION: 97N 82E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840920
ELEVATION: 4321.0 FT.
AUGER HEIGHT: 28.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	80.9	8.1	0.6
0.5	58.3	1.7	0.8
1.0	46.4	0.6	0.6
1.5	41.8	-0.1	0.6
2.0	43.9	0.7	0.6
2.5	42.6	1.0	0.6
3.0	45.3	2.5	0.8
3.5	47.6	1.2	0.6
4.0	46.7	1.2	0.6
4.5	44.9	1.1	0.6
5.0	40.9	-0.1	0.6
5.5	41.2	0.5	0.6
6.0	38.8	-0.4	0.6
6.5	39.9	0.2	0.6
7.0	39.7	0.1	0.6
7.5	36.8	0.0	0.6

APPARENT RADIUM-226 CONCENTRATION

081

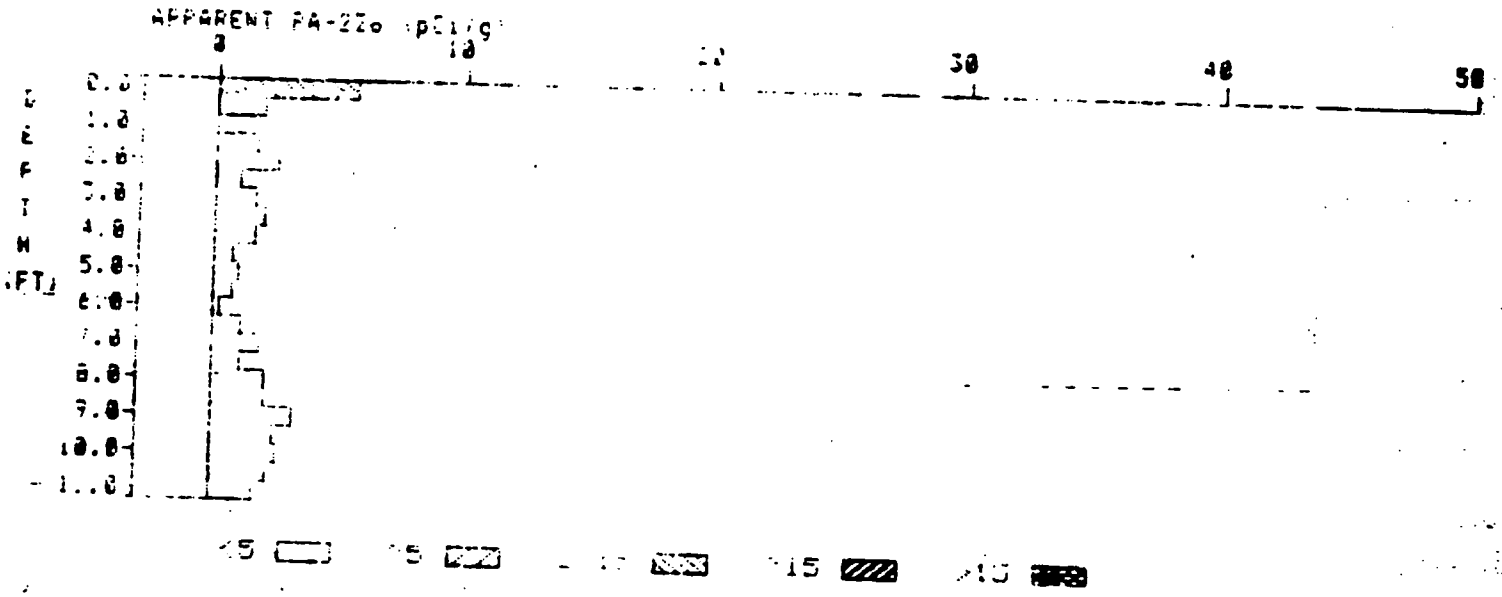
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 081
LOCATION: 97N 83E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840920
ELEVATION: 4323.0 FT.
AUGER HEIGHT: 41.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft.)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	[illegible]	[illegible]	0.6
0.5	54.9	1.0	0.7
1.0	45.1	0.0	0.7
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.5
[illegible]	48.0	[illegible]	[illegible]
[illegible]	[illegible]	1.1	[illegible]
[illegible]	[illegible]	1.0	0.6
4.0	[illegible]	1.7	0.6
4.5	48.6	1.6	0.6
5.0	[illegible]	0.7	0.6
5.5	[illegible]	1.0	0.6
6.0	[illegible]	0.7	0.6
6.5	42.6	0.2	0.6
7.0	41.2	1.2	0.7
7.5	44.7	1.8	0.8
8.0	48.0	1.1	0.6
8.5	51.7	[illegible]	0.7
9.0	[illegible]	[illegible]	0.7
9.5	56.9	[illegible]	0.7
10.0	[illegible]	[illegible]	0.7
10.5	55.0	[illegible]	0.7
11.0	[illegible]	[illegible]	0.7
[illegible]	58.2	1.0	0.5

APPARENT RADIUM-226 CONCENTRATION 082

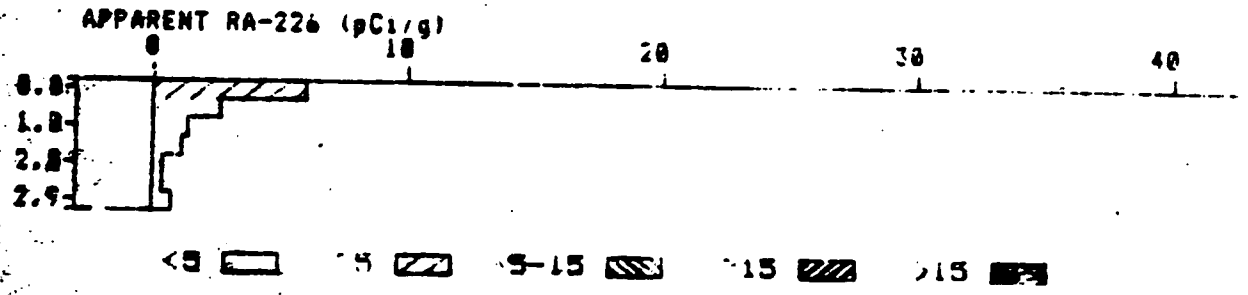
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 082
LOCATION: 9700.0N 8600.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840920
ELEVATION: 4332.1 FT.
AUGER HEIGHT: -29.0 IN.

INSTRUMENT TYPE: PRB-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	414.2	6.0	1.3
0.5	267.5	2.7	1.1
1.0	189.8	1.4	1.3
1.5	157.4	1.2	1.2
2.0	127.1	0.4	1.2
2.5	88.7	0.4	1.3
2.9	96.7	0.8	1.2

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APPARENT RADIUM-226 CONCENTRATION

083

PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 083

LOCATION: 96N 82E

DATE DRILLED: 840920

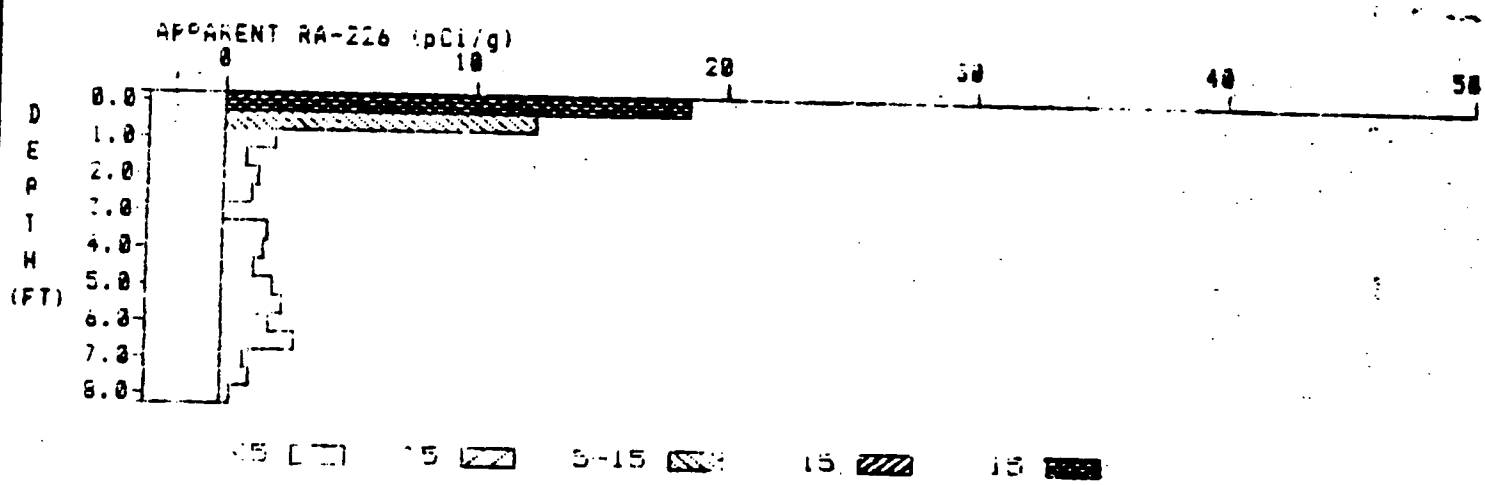
FLUID LEVEL: 99.0 FT.

ELEVATION: 4322.0 FT.

PHASE: 2

AUGER HEIGHT: 22.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	152.7	18.5	0.9
0.5	113.[illegible]	12.3	1.0
[illegible]	65.[illegible]	[illegible].0	1.0
[illegible]	[illegible]	0.9	0.7
[illegible]	47.[illegible]	1.[illegible]	0.6
[illegible]	45.[illegible]	1.[illegible]	0.6
[illegible]	39.[illegible]	-0.1	0.6
[illegible]	42.[illegible]	1.0	0.6
4.0	47.[illegible]	1.0	0.7
[illegible]	46.[illegible]	1.3	0.7
[illegible]	51.0	1.[illegible]	0.7
[illegible]	52.0	2.[illegible]	0.7
6.0	51.9	1.9	0.7
[illegible]	[illegible]	[illegible]	0.7
7.0	43.[illegible]	0.8	0.[illegible]
7.5	48.[illegible]	1.1	0.7
8.0	38.5	0.4	0.6

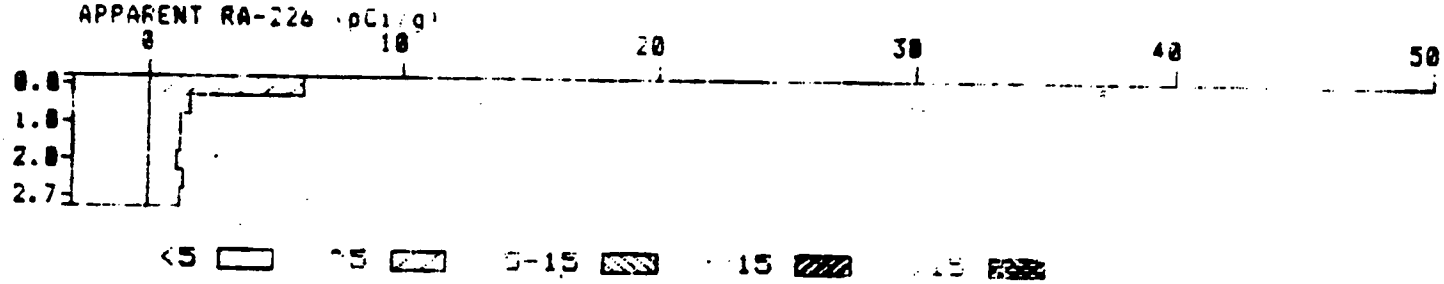
APPARENT RADIUM-226 CONCENTRATION 085

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 085
LOCATION: 9500.0N 8200.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4332.5 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	660.6	6.2	1.2
0.5	371.4	1.7	1.3
1.0	278.5	1.2	1.2
1.5	258.5	1.3	1.2
2.0	250.2	1.2	1.2
2.5	253.1	1.3	1.2
2.7	245.8	1.2	1.2

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APPARENT RADIUM-226 CONCENTRATION

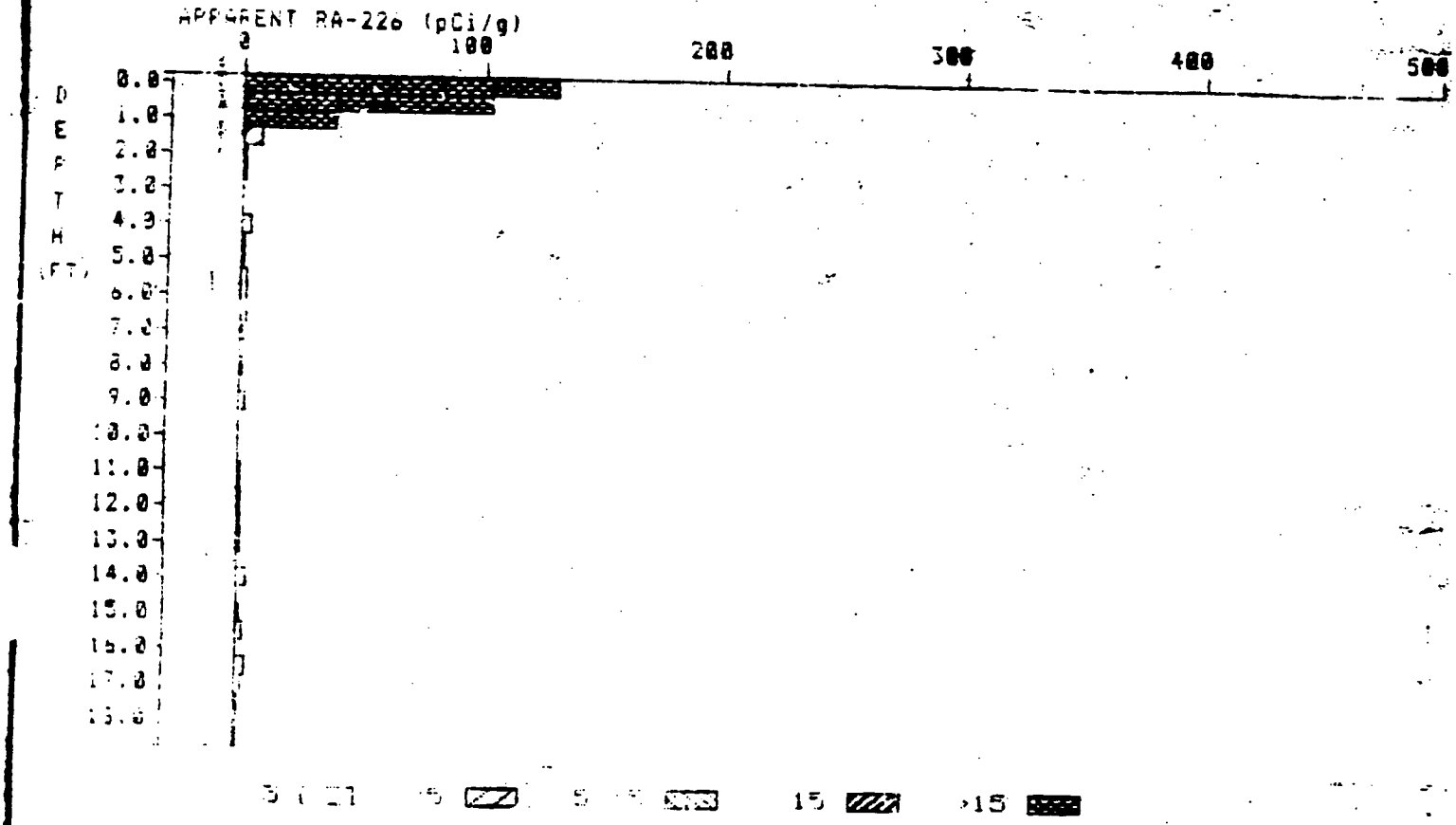
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 086
LOCATION: 94N 82E
FLUID LEVEL: 16.0 FT.
PHASE: 2

DATE DRILLED: 840920
ELEVATION: 4328.0 FT.
AUGER HEIGHT: 15.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (FT)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	840.1	130.6	3.7
0.5	625.0	102.1	4.5
1.0	521.0	[illegible]	3.0
1.5	136.1	[illegible]	1.0
2.0	70.4	[illegible]	1.2
2.5	50.2	[illegible]	[illegible]
3.0	44.[illegible]	[illegible]	0.0
3.5	41.4	[illegible]	0.7
4.0	48.0	[illegible]	0.7
4.5	49.7	[illegible]	0.7
5.0	50.0	[illegible]	0.0
5.5	[illegible]	[illegible]	0.0
6.0	[illegible]	[illegible]	0.7
6.5	54.1	[illegible]	0.7
7.0	50.0	[illegible]	0.0
7.5	43.9	0.[illegible]	0.6
8.0	44.0	0.[illegible]	0.6
8.5	46.3	[illegible]	0.7
9.0	43.0	[illegible]	0.8
9.5	43.9	0.5	0.0
10.0	41.7	0.1	0.6
10.5	42.9	0.0	0.0
11.0	44.5	1.0	0.6
11.5	44.4	0.0	0.0
12.0	44.8	0.7	0.0
[illegible]	[illegible]	[illegible]	[illegible]

APPARENT RADIUM-226 CONCENTRATION 007

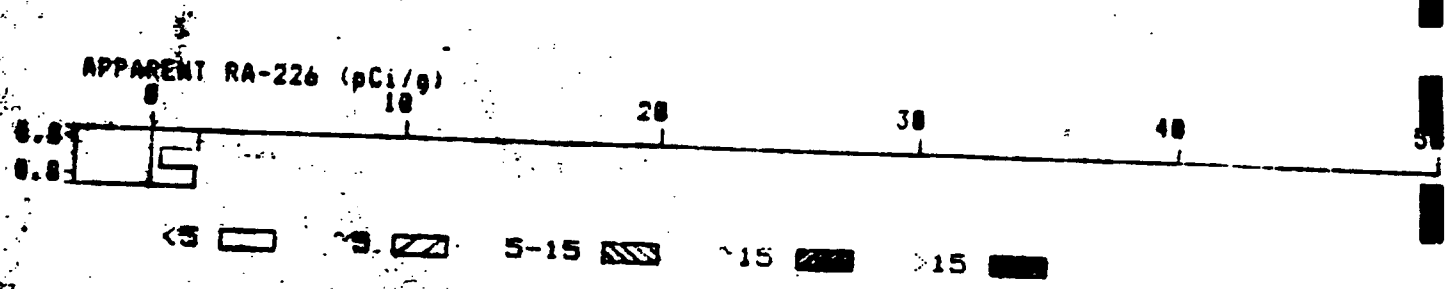
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 007
LOCATION: 9400.0N 8300.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840920
ELEVATION: 4336.0 FT.
AUGER HEIGHT: -55.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-sigma Uncertainty (pCi/g)
0.0	192.2	1.9	1.2
0.5	100.6	0.4	1.3
0.8	147.5	1.8	1.3

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APPARENT RADIUM-226 CONCENTRATION

088

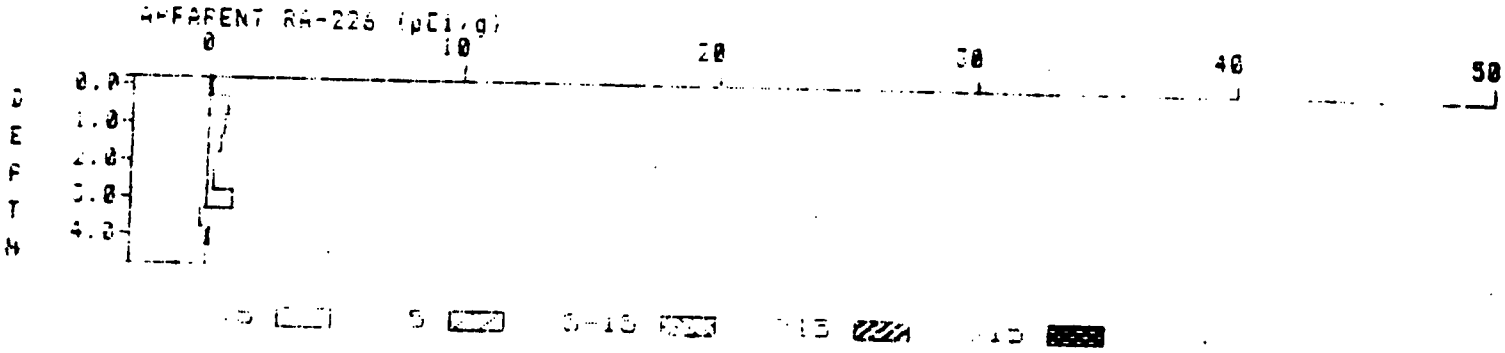
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 088
LOCATION: 93N 75E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840921
ELEVATION: 4330.0 FT.
AUGER HEIGHT: 59.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	36.4	0.1	0.5
0.5	39.8	0.7	0.7
[illegible]	42.8	0.6	0.6
[illegible]	42.1	0.5	0.6
[illegible]	40.6	0.5	0.6
[illegible]	41.[illegible]	0.[illegible]	0.5
[illegible]	43.[illegible]	1.0	0.6
[illegible]	[illegible]	-0.1	0.[illegible]
[illegible]	[illegible]	0.1	0.5
4.5	37.6	0.0	0.5

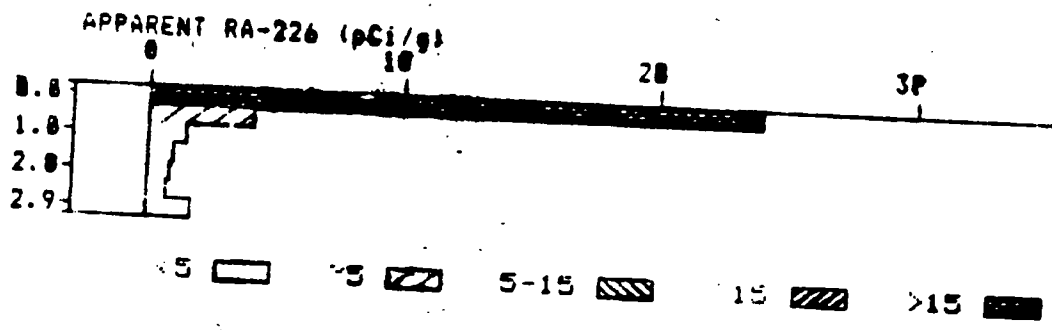
APPARENT RADIUM-226 CONCENTRATION 101

PROJECT: MEXICAN HAT, UTAH

HOLE NUMBER: 101
LOCATION: 9799.9N 8989.9E
FLUID LEVEL: 99.0 FT.
PHASE: 1

START DATE: 840910
DATE DRILLED: 840921
ELEVATION: 4322.6 FT.
AUGER HEIGHT: -29.0 IN.

INSTRUMENT TYPE: PRS-1 RADCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1382.5	24.0	2.1
0.5	586.4	4.2	1.8
1.0	285.8	1.5	1.4
1.5	176.5	1.0	1.4
2.0	152.2	0.9	1.4
2.5	189.0	0.8	1.2
2.9	132.2	1.7	1.3
			1.3

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APPARENT RADIUM-226 CONCENTRATION

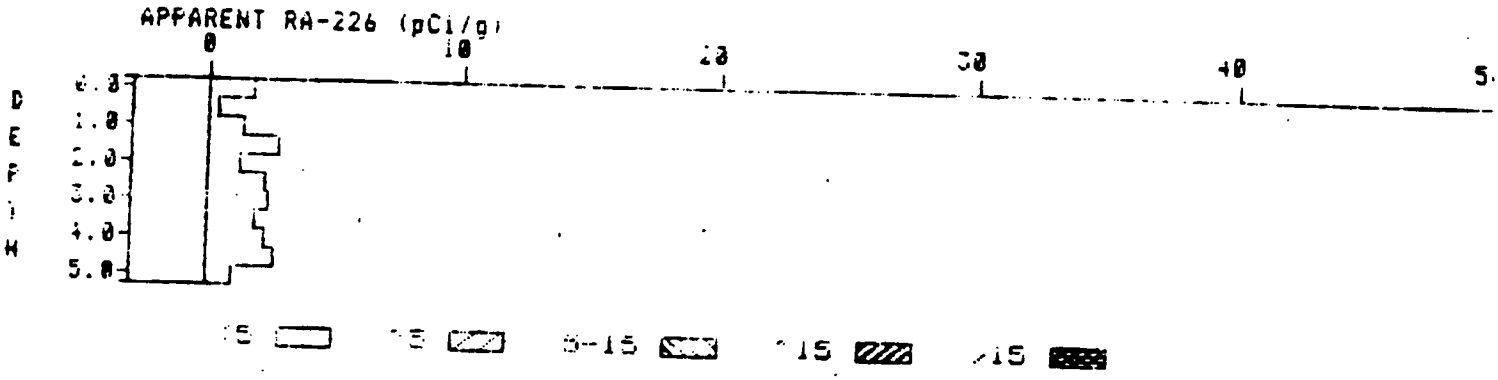
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 102
LOCATION: 98N 91E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840921
ELEVATION: 4315.0 FT.
AUGER HEIGHT: 45.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	50.3	1.8	0.5
0.5	45.1	0.[illegible]	0.6
1.0	45.6	1.4	0.7
1.5	45.6	[illegible]	0.7
2.0	49.2	1.2	0.6
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.6
4.0	51.9	1.9	0.6
4.5	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.6
5.0	48.9	1.1	0.5

APPARENT RADIUM-226 CONCENTRATION

10:

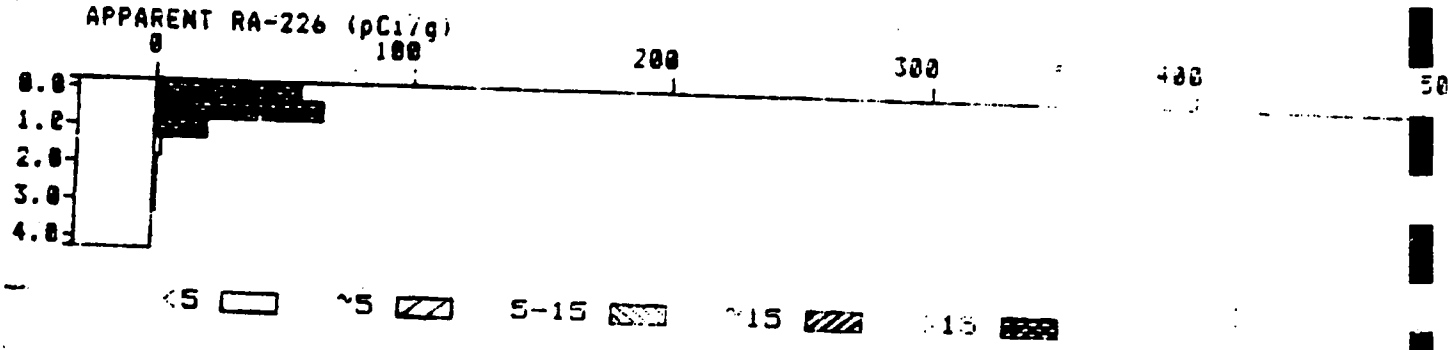
PROJECT: NAT

START DATE: 840910

HOLE NUMBER: 183
LOCATION: 97N 93E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840921
ELEVATION: 4305.0 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	386.0	56.5	1.8
0.5	368.5	65.2	4.0
1.0	191.5	19.5	1.9
1.5	87.6	2.4	1.7
2.0	59.0	1.7	0.7
2.5	50.4	1.4	0.6
3.0	47.0	1.3	0.6
3.5	42.2	0.1	0.6
4.0	38.4	0.5	0.6

APPARENT RADIUM-226 CONCENTRATION 104

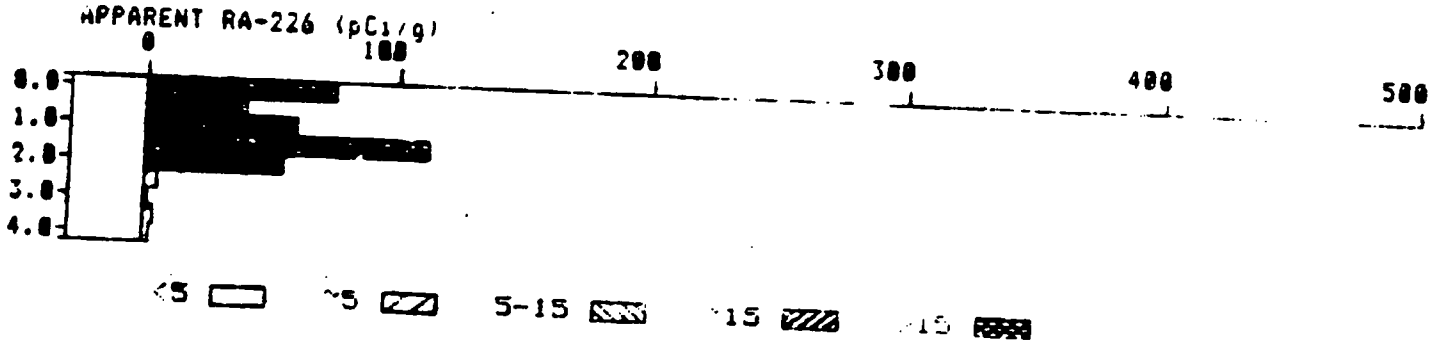
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 104
LOCATION: 9682.2N 9488.7E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840921
ELEVATION: 4315.0 FT.
AUGER HEIGHT: -17.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	4083.6	74.4	5.3
0.5	3001.0	40.3	5.1
1.0	3602.3	60.4	4.7
1.5	4806.4	113.1	10.7
2.0	2970.0	54.8	4.1
2.5	996.2	5.4	3.5
3.0	482.4	1.7	1.7
3.5	214.7	3.7	1.5
4.0	170.6	2.3	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 105 9530 9048

LOCATION: 95N 96E

DATE DRILLED: 840921

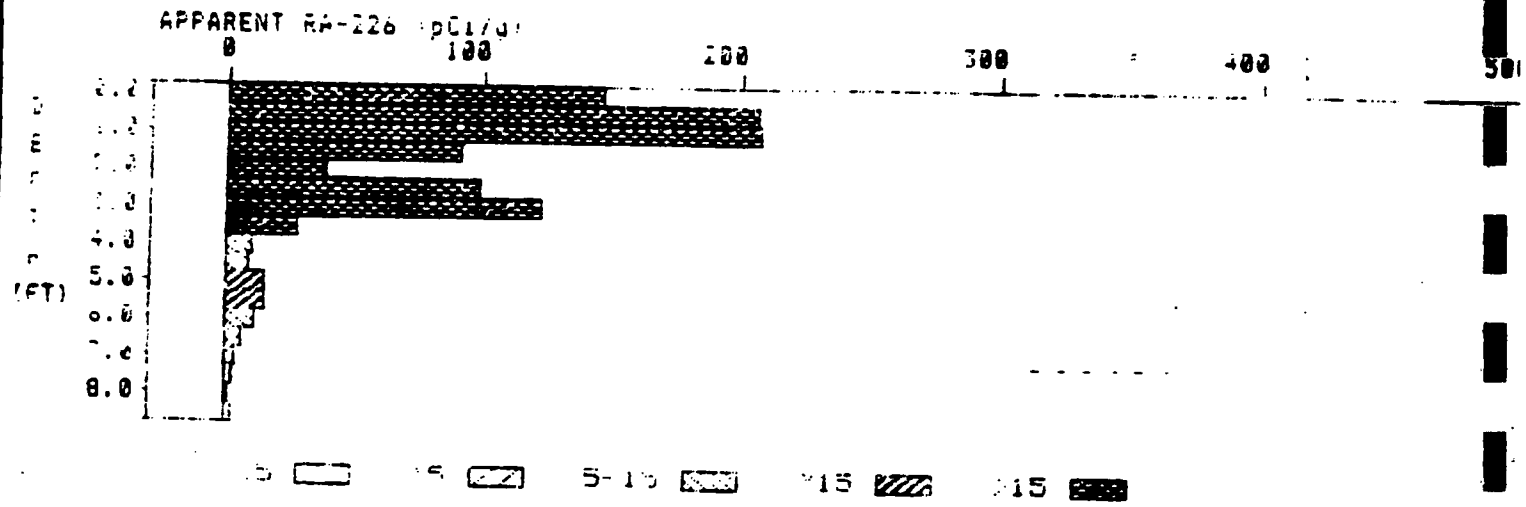
FLUID LEVEL: 99.0 FT.

ELEVATION: 4315.0 FT.

PHASE: 2

AUGER HEIGHT: 13.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)		2-Sigma Uncertainty (pCi/g)
0.0	938.4	140.6		4.4
0.5	1176.5	205.9	186/187	8.7
[illegible]	1132.5	207.[illegible]		10.4
[illegible]	869.[illegible]	91.3		5.4
[illegible]	451.0	39.[illegible]	70.6	8.2
[illegible]	576.4	95.[illegible]		4.[illegible]
[illegible]	626.7	122.[illegible]		8.[illegible]
[illegible]	284.[illegible]	27.4	53.3	4.6
4.0	118.[illegible]	10.[illegible]		[illegible]
4.5	109.6	7.1		1.[illegible]
[illegible]	125.1	14.7	12.5	1.1
[illegible]	1[illegible]	15.5		1.1
6.0	104.[illegible]	10.7		0.[illegible]
[illegible]	81.[illegible]	[illegible]		0.8
[illegible]	67.4	4.[illegible]		0.8
[illegible]	57.0	[illegible]		0.7
8.[illegible]	51.6	1.6		0.7
8.5	50.4	1.7		0.5

APPARENT RADIUM-226 CONCENTRATION 106

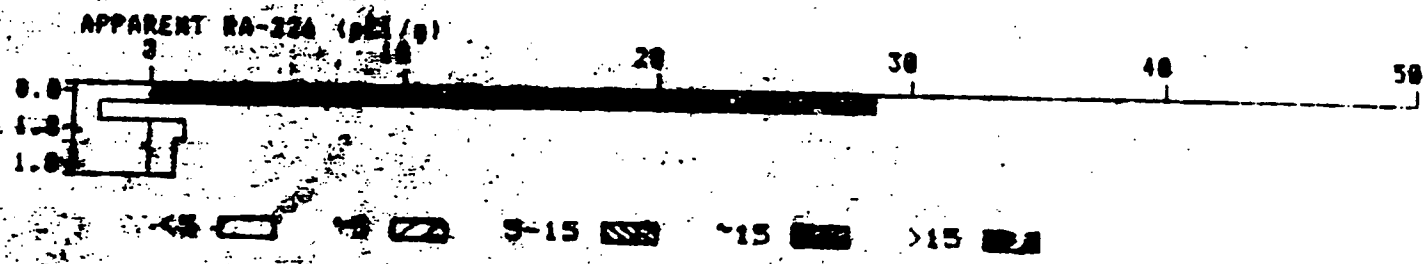
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 106
LOCATION: 9999.7N 9768.6E
FLUID LEVEL: [illegible] FT.
PHASE: 1

DATE DRILLED: 840921
ELEVATION: 4312.3 FT.
AUGER HEIGHT: -45.0 IN.

INSTRUMENT TYPE: PRS-1 RADCAL SERIAL NO. 753 BJO NO.: C-35729



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1619.4	23.5	2.4
0.5	426.0	-2.0	2.7
1.0	282.0	1.4	1.5
1.5	114.2	1.0	1.3
2.0	139.6	1.0	1.2

Data generated by [illegible]CALC.BAS Version 1.1 S/N 002

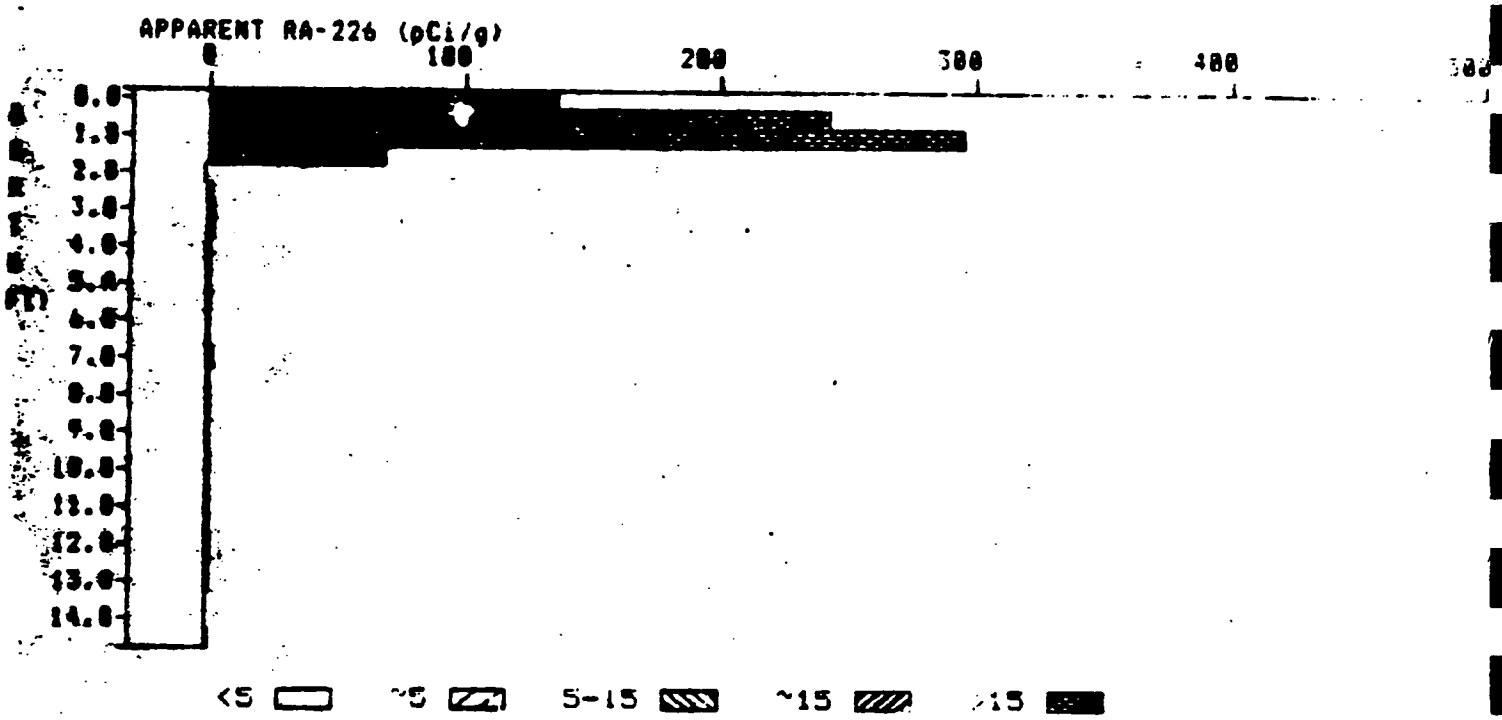
APPARENT RADIUM-226 CONCENTRATION 107

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 107
LOCATION: 9287.8N 9849.4E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840921
ELEVATION: 4300.0 FT.
AUGER HEIGHT: -10.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	7372.6	135.8	9.5
0.5	11563.7	242.2	18.5
1.0	12353.1	294.4	27.5
1.5	5218.1	68.6	9.2
2.0	1341.5	-1.6	7.2
2.5	465.6	1.1	2.1
3.0	289.2	2.5	1.3
3.5	247.9	2.9	1.3
4.0	159.6	1.8	1.4
4.5	135.9	1.8	1.3
5.0	180.1	1.5	1.3
5.5	182.2	1.7	1.3
6.0	180.3	1.5	1.3
6.5	186.7	1.7	1.3
7.0	191.9	1.9	1.3
7.5	189.9	1.8	1.3
8.0	181.9	1.7	1.3
8.5	169.7	1.4	1.3
9.0	122.5	1.0	1.4
9.5	118.9	1.5	1.3
8.0	157.3	1.1	1.2
8.5	155.7	1.3	1.2
1.0	138.6	0.7	1.2
11.5	135.6	0.7	1.2
12.0	143.4	0.9	1.2
12.5	152.6	1.1	1.2
13.0	159.7	1.5	1.3
13.5	131.4	0.6	1.2
14.0	93.2	0.1	1.3
14.5	184.8	1.0	1.2

APPARENT RADIUM-226 CONCENTRATION 108

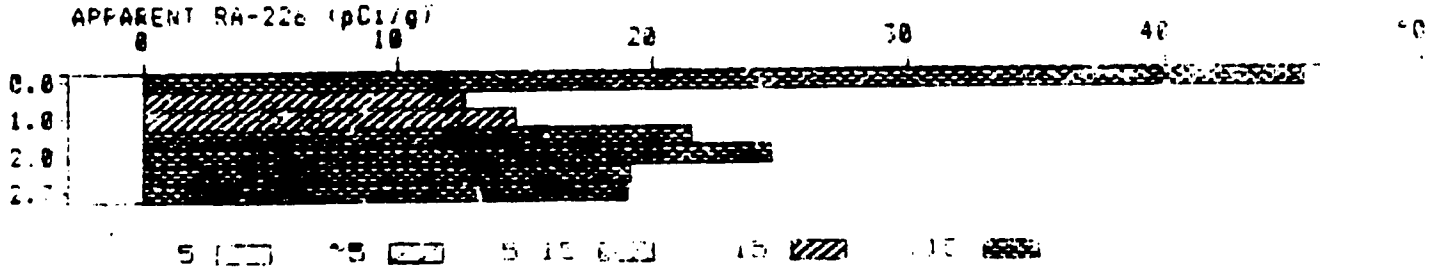
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 108
LOCATION: 9823.5N 9802.1E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4315.0 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 733 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	3926.8	45.4	1.5
0.5	1940.8	12.6	1.9
1.0	1614.2	14.6	1.6
1.5	1867.2	21.5	1.4
2.0	2032.5	24.6	1.5
2.5	1804.7	19.1	1.4
2.7	1721.8	19.0	1.4

This data generated by LOGCALC.BAS Version 1.1 6/11/90

APPARENT RADIUM-226 CONCENTRATION 109

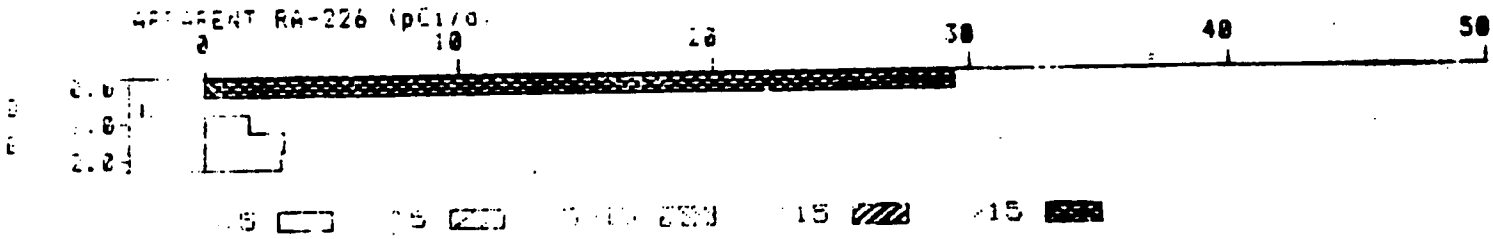
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 109
LOCATION: 8824.8N 9720.3E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840923
ELEVATION: 4296.8 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35729



Depth (ft)	Observed Count Rate (cps)	Apparent Radium 226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2597.5	27.4	1.5
0.5	674.7	2.5	2.8
1.0	406.9	1.7	1.4
1.5	404.4	3.1	1.2
2.0	393.7	3.0	1.2

Data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

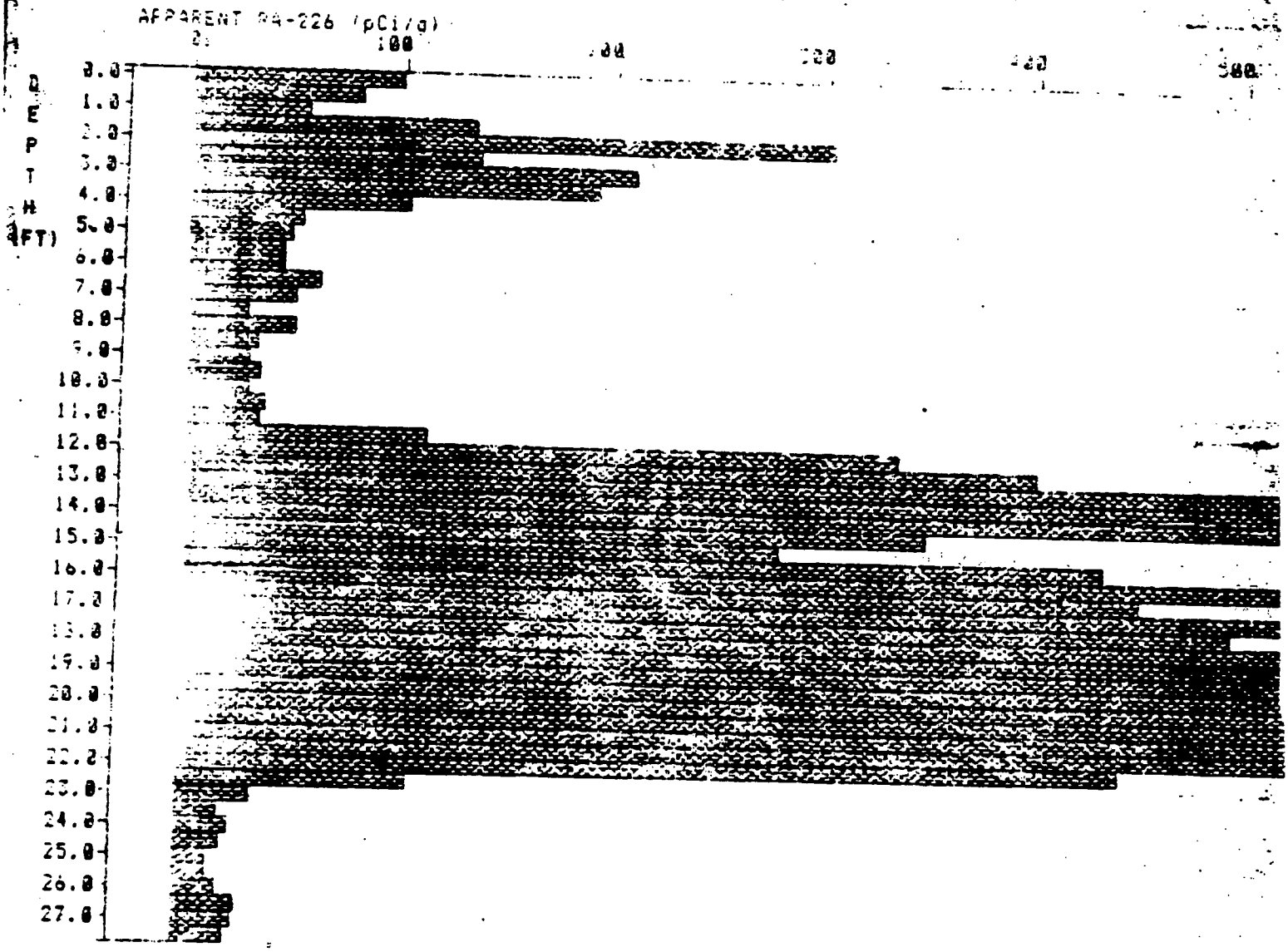
PROJECT: HAT01

START DATE: 840908

HOLE NUMBER: 110
LOCATION: 86N 95E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4336.0 FT.
AUGER HEIGHT: 25.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium Conc. (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	543.5	[illegible]	[illegible]
.5	560.7	[illegible]	[illegible]
1.0	551.7	55.2	[illegible]
[illegible]	734.4	[illegible]	[illegible]
2.0	1479.3	[illegible]	[illegible]
[illegible]	1064.5	[illegible]	[illegible]
[illegible]	925.0	[illegible]	10.5
[illegible]	1041.0	147.0	13.7
4.0	723.3	103.6	[illegible]
[illegible]	453.2	54.3	4.5
[illegible]	365.1	49.2	2.8

CONTINUED ON FOLLOWING FRAME

CONTINUED FROM PREVIOUS FRAME

APPARENT RADIUM-226 CONCENTRATION 112

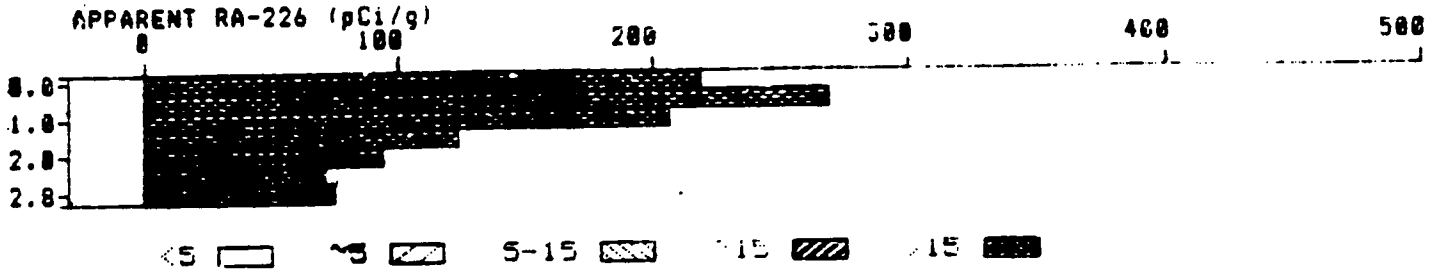
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 112
LOCATION: 8298.7N 9223.5E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4329.5 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	18392.4	219.0	6.7
0.5	20180.3	268.9	11.5
1.0	16637.2	206.6	6.9
1.5	11467.3	124.2	5.2
2.0	8492.5	93.7	3.7
2.5	6733.9	71.7	1.3
2.8	6352.7	74.5	2.6

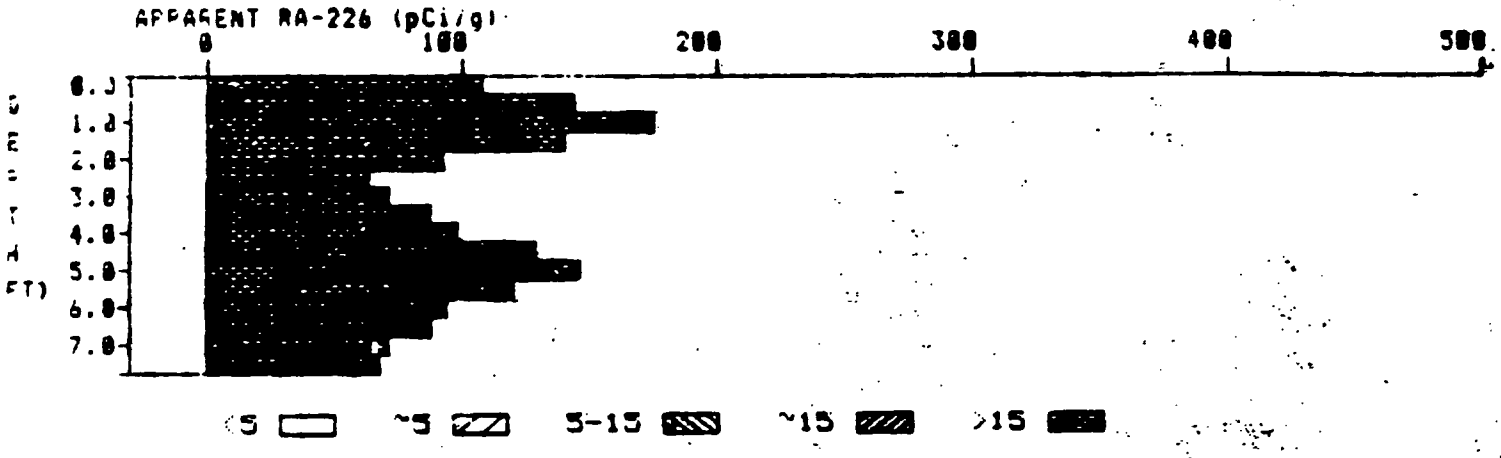
This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 113

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 113 DATE DRILLED: 840923
LOCATION: 8388.4N 9134.6E ELEVATION: 4332.2 FT.
LIQUID LEVEL: 99.0 FT. AUGER HEIGHT: 0 3 IN.
PHASE: 2

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	9085.9	107.3	3.5
0.5	11662.3	143.8	4.0
1.0	13197.6	174.8	7.5
1.5	11319.2	139.9	4.0
2.0	8347.1	93.0	3.5
2.5	6392.7	64.1	3.9
3.0	6468.4	70.8	2.9
3.5	7498.0	87.8	3.0
4.0	8610.7	97.5	3.5
4.5	10484.3	129.3	4.4
5.0	11371.4	146.8	5.8
5.5	9995.4	119.9	3.9
6.0	8301.5	93.7	3.4
6.5	7392.9	87.6	3.0
7.0	6317.7	71.2	2.7
7.5	5791.9	67.8	2.4

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 114

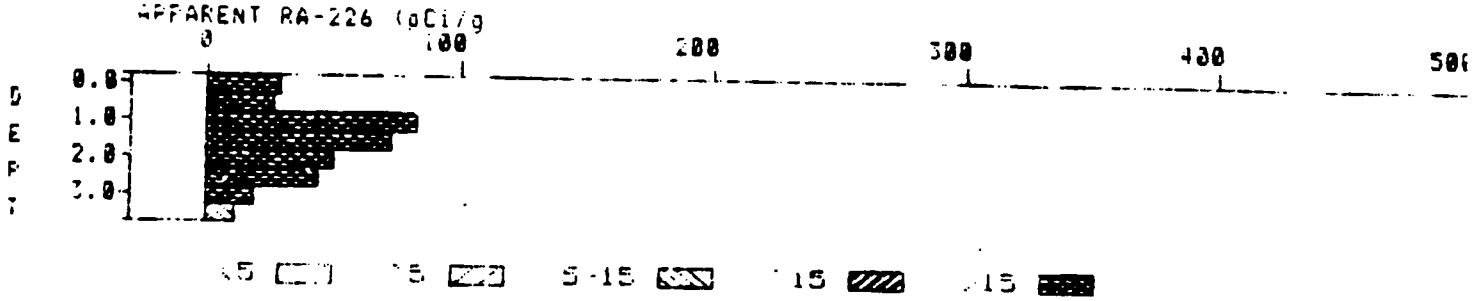
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 114
LOCATION: 8241.3N 9894.7E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840923
ELEVATION: 4329.1 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2531.2	28.6	1.5
0.5	3214.6	26.6	3.[illegible]
1.0	5821.7	82.7	5.0
1.5	5687.[illegible]	72.5	3.1
2.0	4438.3	49.7	2.1
2.5	3526.4	44.0	2.1
3.0	1774.7	18.2	1.7
3.5	[illegible]	11.6	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 115

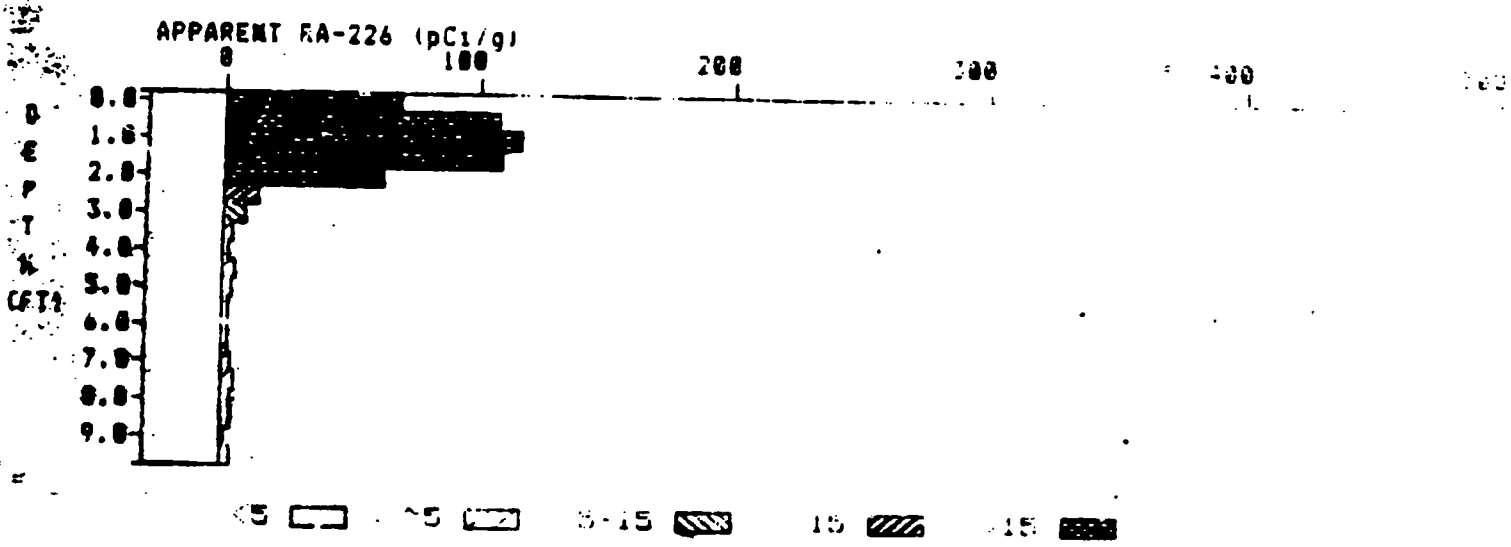
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 115
LOCATION: 8442.4N 8963.6E
FLUID LEVEL: 99.8 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4332.9 FT.
AUGER HEIGHT: -11.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	3750.1	68.2	4.9
0.5	5344.3	107.0	8.0
1.0	5843.6	115.9	8.5
1.5	5301.5	108.5	8.3
2.0	3393.6	62.4	4.6
2.5	1394.4	13.[illegible]	[illegible]
3.0	718.5	8.7	1.7
3.5	395.[illegible]	[illegible]	1.4
4.0	210.8	2.3	1.5
4.5	246.6	4.0	1.7
5.0	274.8	[illegible]	1.5
5.5	243.5	[illegible]	1.3
6.0	255.[illegible]	[illegible]	1.3
6.5	265.5	[illegible]	1.[illegible]
7.0	296.[illegible]	5.7	1.[illegible]
7.5	332.5	5.1	1.[illegible]
8.0	292.[illegible]	3.5	1.[illegible]
8.5	272.7	3.5	1.[illegible]
9.0	165.8	1.9	.4
9.5	222.3	3.0	1.4

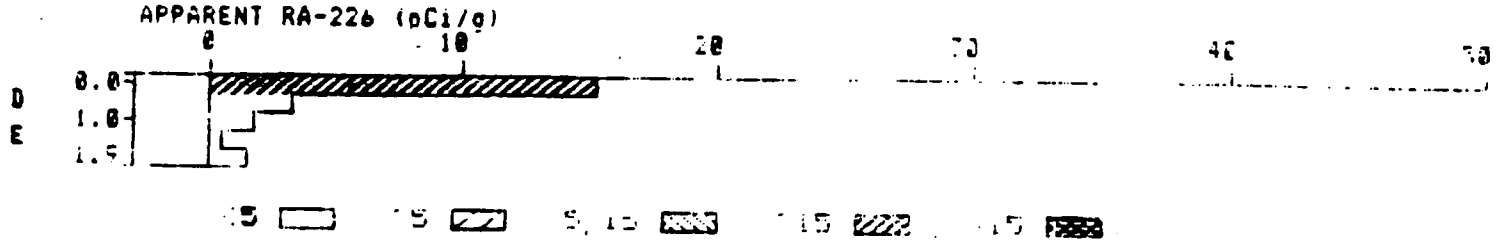
This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 116

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 116 DATE DRILLED: 840922
LOCATION: 8600.4N 9008.3E ELEVATION: 4336.4 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -40.0 IN.
PHASE: 1

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	913.6	15.3	1.7
0.5	412.3	3.3	1.5
1.0	234.4	1.8	1.[illegible]
1.0	125.2	0.5	1.4
1.5	116.3	1.5	1.[illegible]

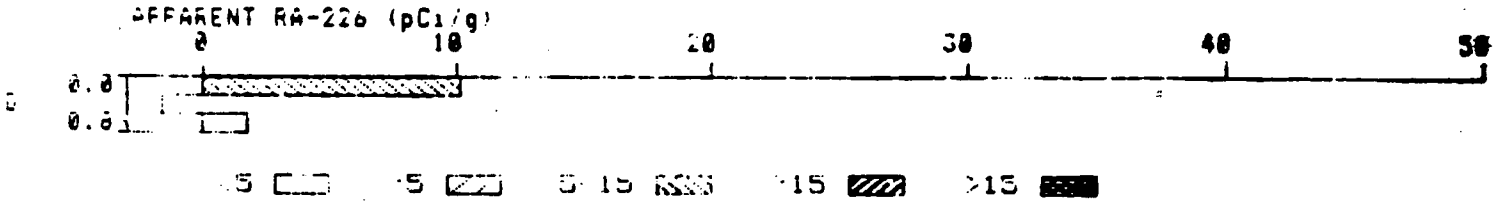
Data generated by LUCCALC.BAS Version 1.1 [illegible]

APPARENT RADIUM-226 CONCENTRATION 117

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 117 DATE DRILLED: 840922
LOCATION: 8734.3N 9096.6E ELEVATION: 4334.5 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -54.0 IN.
PHASE: 2

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	631.2	10.1	1.5
0.5	132.7	-1.7	1.6
0.0	128.6	1.7	1.3

This data generated by LOGCALC.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 118

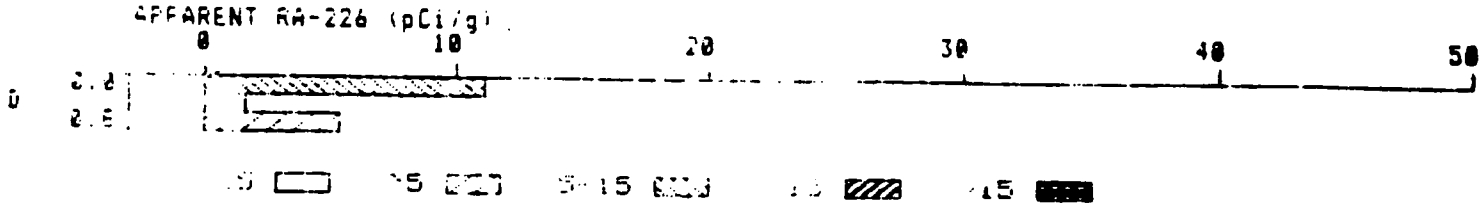
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 118
LOCATION: 8851.8N 8979.5E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840921
ELEVATION: 4338.4 FT.
AUGER HEIGHT: -53.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	689.5	11.1	1.5
0.5	247.8	1.6	1.7
0.6	256.3	5.3	1.5

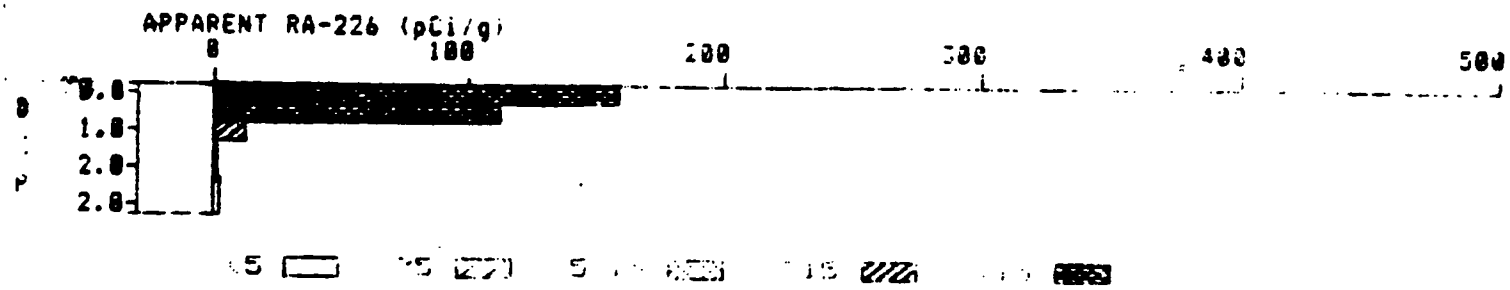
This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 119

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 119 DATE DRILLED: 840921
LOCATION: 9003.5N 9074.0E ELEVATION: 4334.9 FT.
LIQUID LEVEL: 99.0 FT. AUGER HEIGHT: -31.0 IN.
PHASE: 1

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium [illegible] (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	8580.2	[illegible]	11.6
0.5	5704.5	[illegible]	[illegible]
1.0	1888.0	[illegible]	[illegible]
[illegible]	598.1	[illegible]	[illegible]
[illegible]	278.9	[illegible]	[illegible]
[illegible]	158.4	[illegible]	[illegible]
3	194.4	[illegible]	[illegible]

This data generated by LOGCALC.BAS Version 1.1 S/N 00[illegible]

APPARENT RADIUM-226 CONCENTRATION

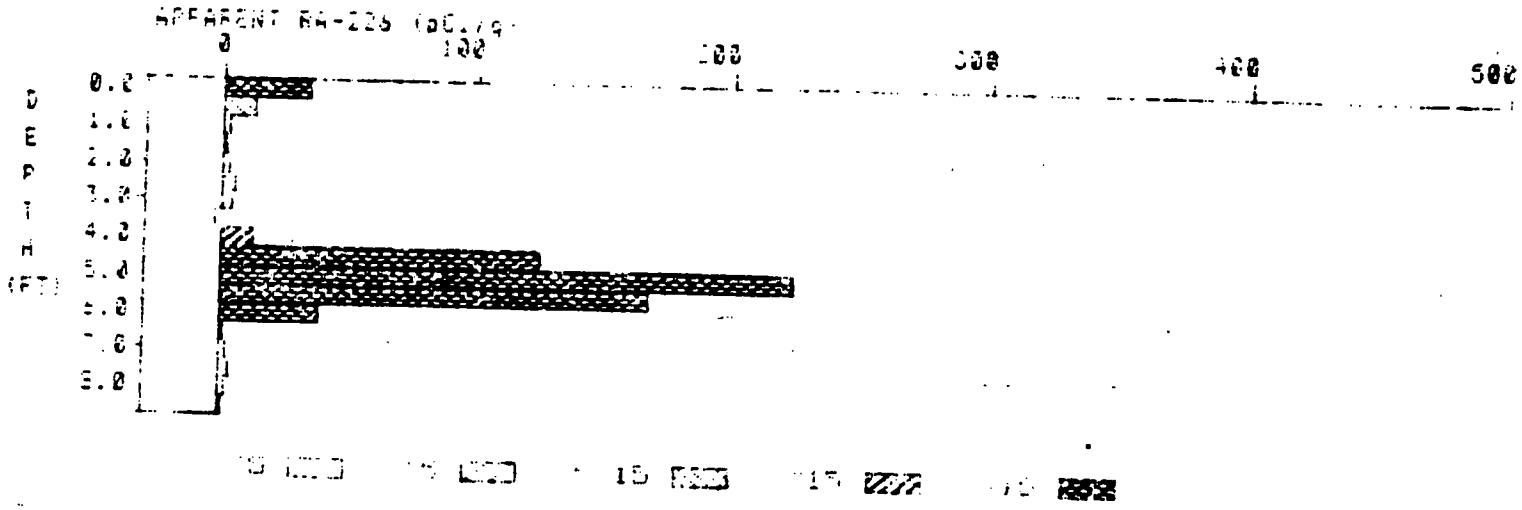
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 120
LOCATION: 90N 88E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840921
ELEVATION: 4331.0 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	1 Sigma Uncertainty (pCi/g)
0.0	24.1	3.7	1.2
0.5	135.0	11.9	1.6
1.0	75.2	2.1	1.0
1.5	58.2	1.6	0.9
2.0	60.3	2.1	0.9
2.5	56.4	1.6	0.7
3.0	70.3	4.0	0.7
3.5	58.4	2.9	0.8
4.0	211.6	11.7	1.4
4.5	645.4	25.6	8.0
5.0	1140.7	125.6	12.5
5.5	427.7	223.7	14.4
6.0	396.2	167.4	8.4
6.5	136.1	39.1	5.7
7.0	75.4	1.2	4.3
7.5	64.1	2.3	1.3
8.0	54.1	0.9	0.7
8.5	47.8	0.1	0.7
		1.4	0.5

APPARENT RADIUM-226 CONCENTRATION

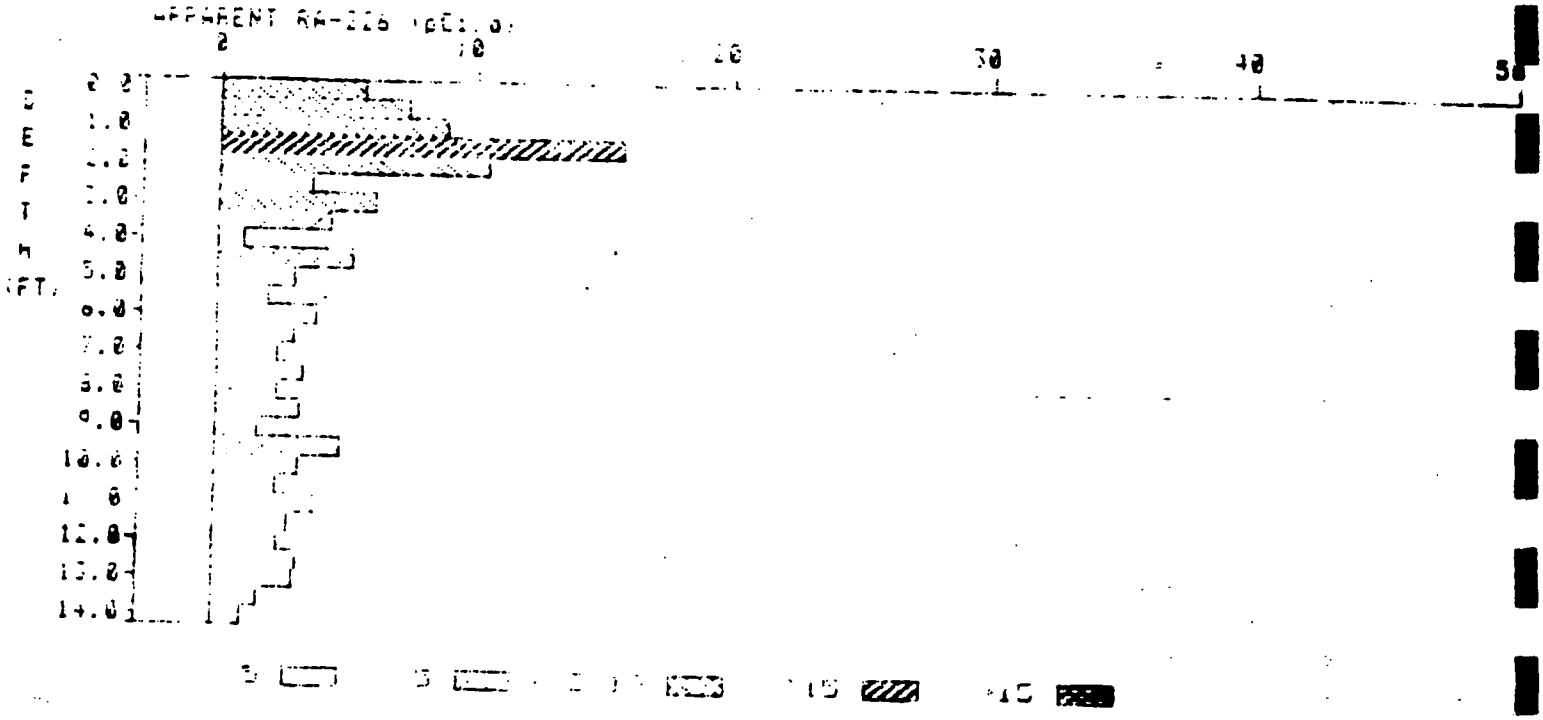
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 121
LOCATION: 91N 87E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840921
ELEVATION: 4331.0 FT.
AUGER HEIGHT: 8.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Dep (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	[illegible]	[illegible]	0.6
0.5	85.0	[illegible]	0.8
1.0	97.7	[illegible]	0.8
[illegible]	118.6	15.8	1.2
[illegible]	100.5	10.1	0.9
[illegible]	[illegible]	[illegible]	0.5
[illegible]	[illegible]	5.2	0.7
[illegible]	[illegible]	4.4	0.7
[illegible]	[illegible]	1.0	0.8
[illegible]	[illegible]	[illegible]	0.8
[illegible]	[illegible]	[illegible]	0.7
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.7
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	1.0	0.8
[illegible]	[illegible]	4.8	0.8
[illegible]	[illegible]	[illegible]	0.7
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.7
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	0.6
[illegible]	56.4	3.1	0.6
14.0	50.8	1.6	0.6
[illegible]	44.8	1.1	0.5

APPARENT RADIUM-226 CONCENTRATION 1:22

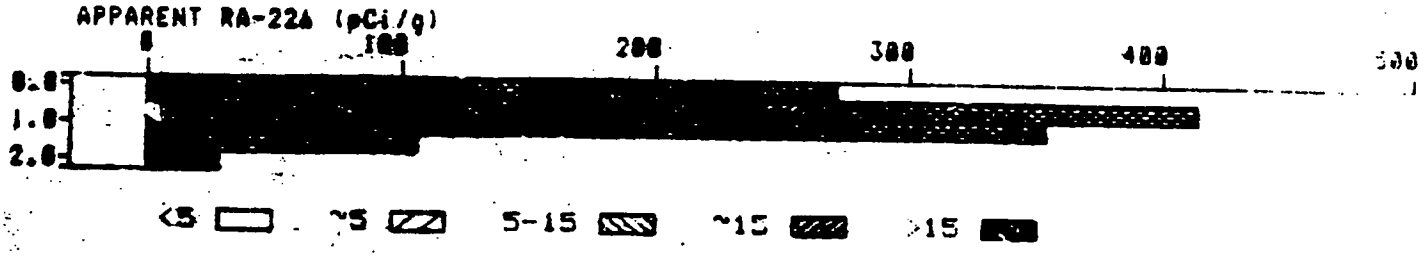
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 122
LOCATION: 9373.1N 8783.1E
FLUID LEVEL: 99.8 FT.
PHASE: 1

DATE DRILLED: 840921
ELEVATION: 4330.1 FT.
AUGER HEIGHT: -40.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	14607.5	270.8	18.6
0.5	19050.9	413.4	33.0
1.0	16285.4	354.2	29.1
1.5	5699.5	105.8	27.4
2.0	1161.7	29.6	3.0

data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 123

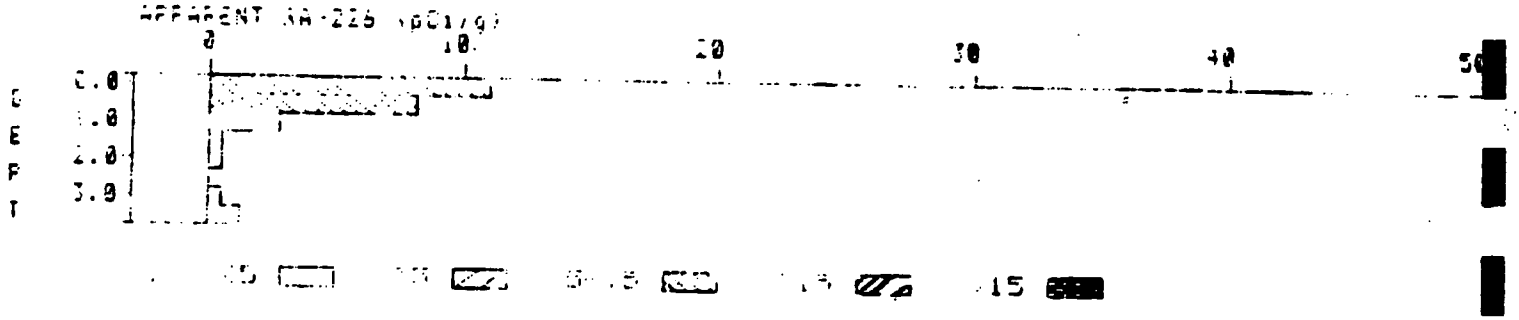
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 123
LOCATION: 9641.9N 3775.4E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840921
ELEVATION: 4332.7 FT.
AUGER HEIGHT: -24.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	602.4	11.0	1.5
0.5	506.5	6.1	1.4
1.0	485.2	2.7	1.3
1.5	162.2	2.5	1.3
2.0	127.0	0.5	1.2
2.5	110.6	0.0	1.2
3.0	87.2	0.3	1.2
3.5	109.5	1.3	1.2

This data generated by LOGCALC. Version 1.1 S/N 001

HAT 124

APPARENT RADIUM-226 CONCENTRATION 124

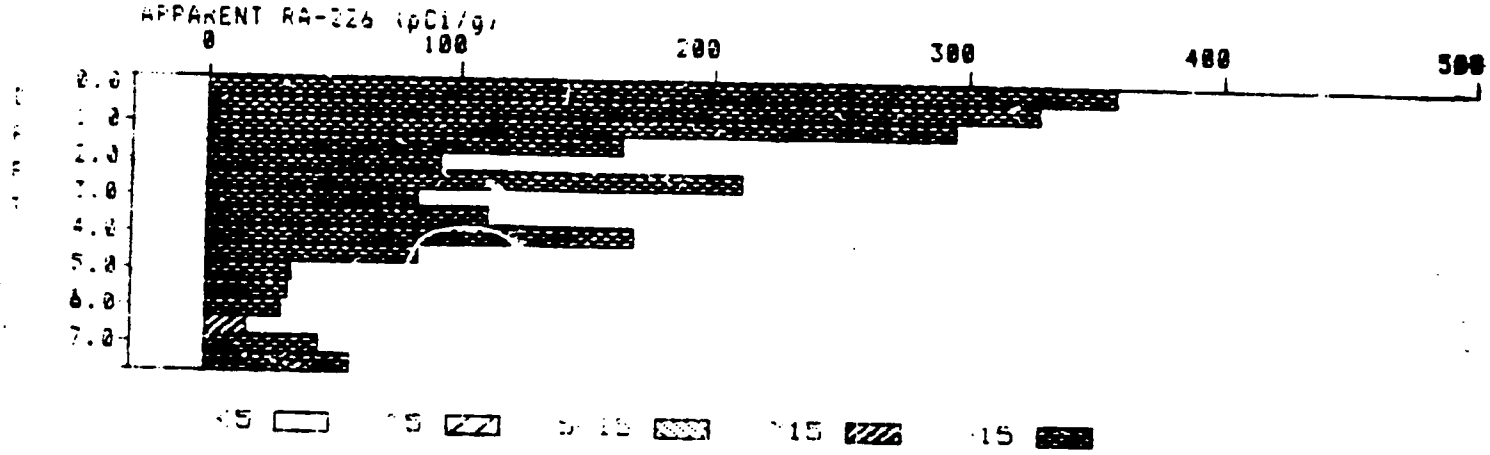
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 124
LOCATION: 9960.0N 9246.4E
FLUID LEVEL: 99.0 FT.
PHASE: 3

DATE DRILLED: 840923
ELEVATION: 4313.7 FT.
AUGER HEIGHT: -34.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.5	19272.4	337.8	24.6
0.5	17373.4	327.[illegible]	[illegible]
1.0	14881.3	276.0	21.3
[illegible]	9880.2	16[illegible].6	13.5
[illegible]	5619.1	92.0	28.3
[illegible]	6536.2	211.4	27.0
[illegible]	6072.8	8[illegible]	11.0
[illegible]	6386.9	11[illegible].8	8.1
[illegible]	7461.2	168.0	14.7
[illegible]	4772.1	83.[illegible]	[illegible].1
[illegible]	2577.4	33.2	4.6
[illegible]	1970.2	22.1	2.8
[illegible]	1707.1	29.8	[illegible].5
[illegible]	1473.2	15.8	[illegible].9
[illegible]	1910.9	45.4	9.[illegible]
7.[illegible]	2249.1	57.9	5.[illegible]

This data generated by LOGCALC.BAS. Version 1.1 S/N 002

HAT 125

APPARENT RADIUM-226 CONCENTRATION 125

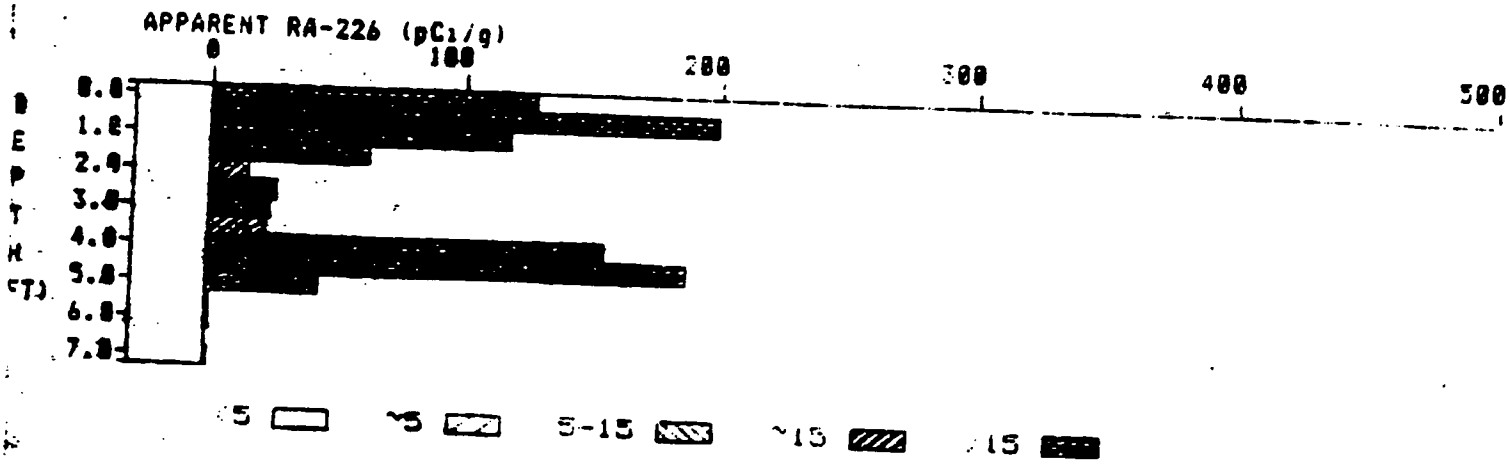
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 125
LOCATION: 10151.5N 9290.2E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4317.3 FT.
AUGER HEIGHT: -39.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NU.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0	6954.4	128.0	8.9
[illegible]	8803.9	198.5	17.1
1.0	6313.6	117.0	8.7
1.5	3268.1	62.6	12.4
2.0	1168.0	14.7	5.7
2.5	1593.3	26.1	4.4
3.0	1729.9	23.3	5.0
3.5	2728.2	22.6	7.8
4.0	6931.6	155.2	13.4
4.5	7800.1	188.0	18.1
5.0	3333.5	43.2	5.9
5.5	947.2	1.2	4.4
6.0	734.3	0.7	1.6
6.5	52.0	0.1	1.4
7.0	181.1	1.6	1.2

This data generated by LOGCALC.SAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 158

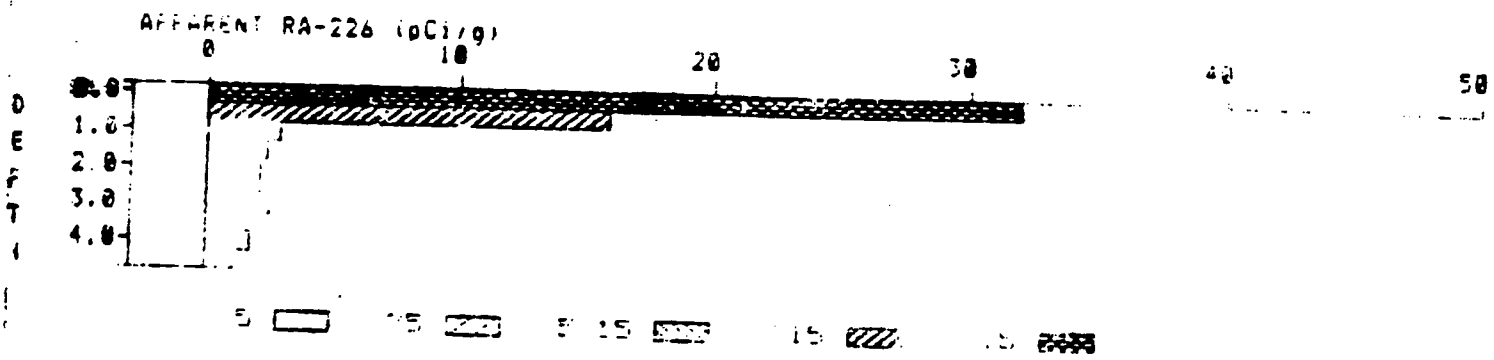
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 158
LOCATION: 10446.0N 11862.5E
LUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4257.3 FT.
AUGER HEIGHT: -11.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1810.6	32.0	[illegible]
.5	1028.1	15.6	2.[illegible]
1.0	436.2	[illegible]	1.6
[illegible]	271.4	[illegible]	1.5
[illegible]	222.5	[illegible]	[illegible]
2.5	213.1	2.1	1.[illegible]
3.0	214.1	2.1	[illegible]
3.5	190.2	2.4	[illegible]
4.0	[illegible]	1.7	[illegible]
4.5	[illegible]	1.6	1.[illegible]
[illegible]	[illegible]	1.2	[illegible]

This data generated by LJGCALC.BAS Version 1.1 S/N 001

APPARENT RADIUM-226 CONCENTRATION

151

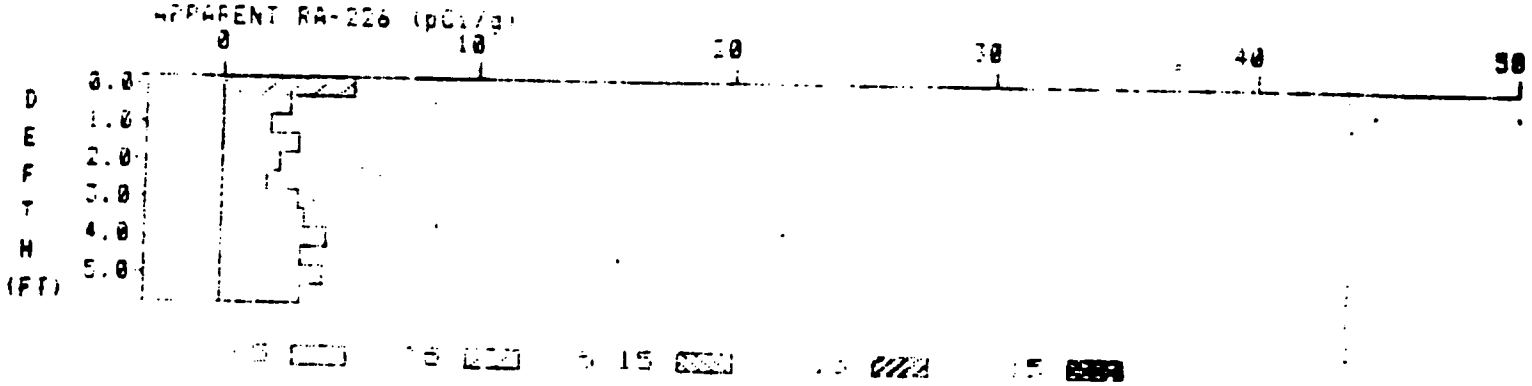
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 151
LOCATION: 98N 96E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840921
ELEVATION: 4305.0 FT.
AUGER HEIGHT: 48.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	1 Sigma Uncertainty (pCi/g)
0.0	71.1	0.2	0.6
0.5	56.2	0.5	0.6
1.0	46.0	1.0	0.8
1.5	55.5	1.0	0.7
2.0	53.0	2.0	0.7
2.5	52.2	1.0	0.7
3.0	57.7	1.1	0.7
3.5	57.7	1.1	0.7
4.0	62.7	1.2	0.8
4.5	60.2	1.1	0.8
5.0	61.0	1.0	0.8
5.5	56.2	1.1	0.8

APPARENT RADIUM-226 CONCENTRATION 152

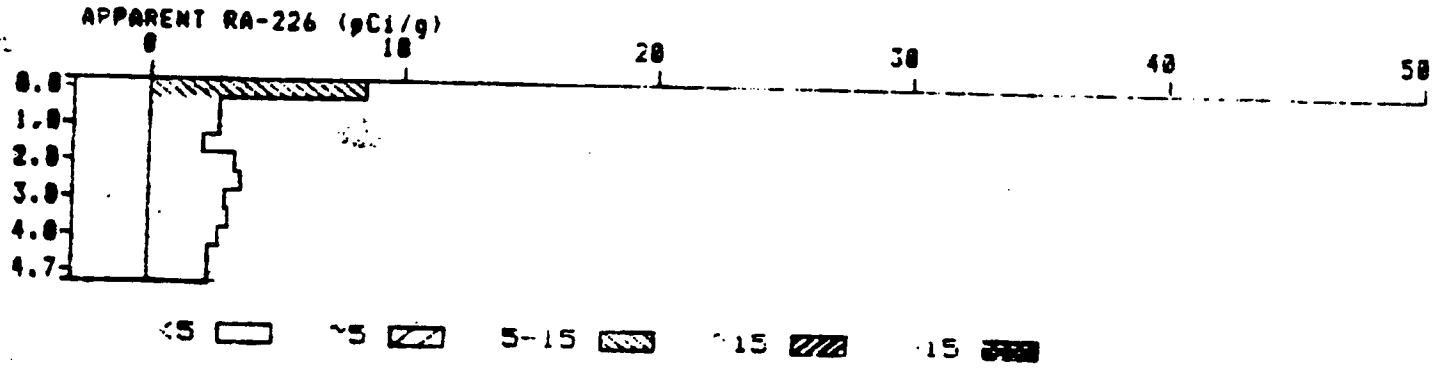
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 152
LOCATION: 9980.7N 9847.1E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4295.7 FT.
AUGER HEIGHT: -5.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35726



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	548.7	8.5	1.4
0.5	315.7	2.7	1.[illegible]
1.0	256.8	2.7	1.[illegible]
1.5	234.0	2.2	1.[illegible]
2.0	263.8	2.3	1.[illegible]
2.5	275.3	2.6	1.[illegible]
3.0	262.3	2.1	1.[illegible]
3.5	258.4	2.2	1.[illegible]
4.0	241.1	2.7	1.3
4.5	160.7	2.4	1.4
4.7	145.6	2.3	1.3

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APPARENT RADIUM-226 CONCENTRATION

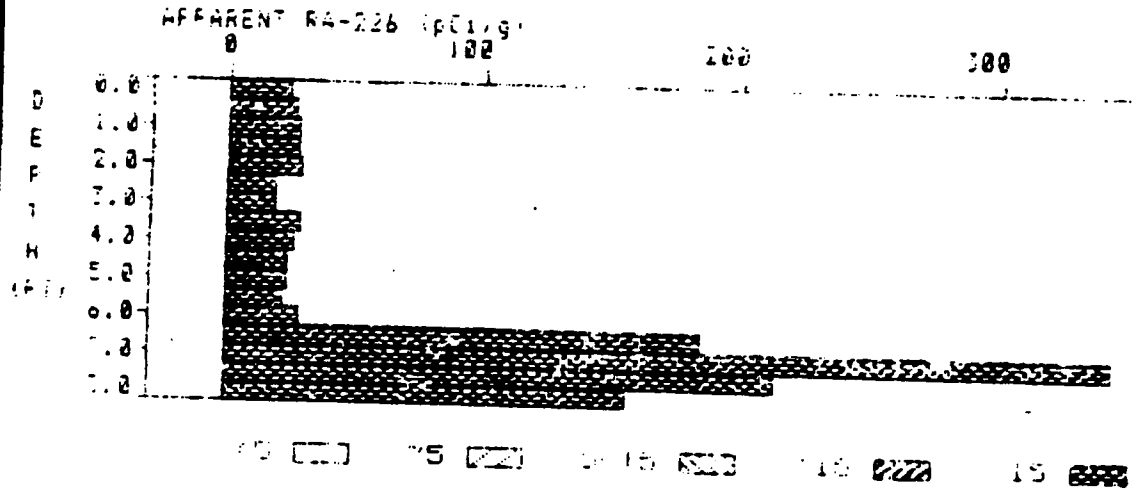
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 153
LOCATION: 99N 100E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840922
ELEVATION: 4292.0 FT.
AUGER HEIGHT: 22.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	1-Sigma Uncertainty (pCi/g)
0.0	185.4	[illegible]	0.9
0.[illegible]	198.0	[illegible]	1.3
[illegible]	203.8	[illegible]	1.3
[illegible]	200.3	[illegible]	1.3
[illegible]	202.1	[illegible]	1.3
[illegible]	169.1	[illegible]	1.4
[illegible]	144.7	[illegible]	1.4
[illegible]	164.5	[illegible]	2.7
[illegible]	195.8	[illegible]	2.8
[illegible]	192.6	[illegible]	1.4
[illegible]	179.8	[illegible]	1.2
[illegible]	242.0	[illegible]	1.4
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1129.3	[illegible]	10.4
[illegible]	1716.1	105.5	6.1
[illegible]	1348.7	[illegible]	21.9
[illegible]	847.3	213.7	7.6
[illegible]	[illegible]	156.2	9.7

APPARENT RADIUM-226 CONCENTRATION 154

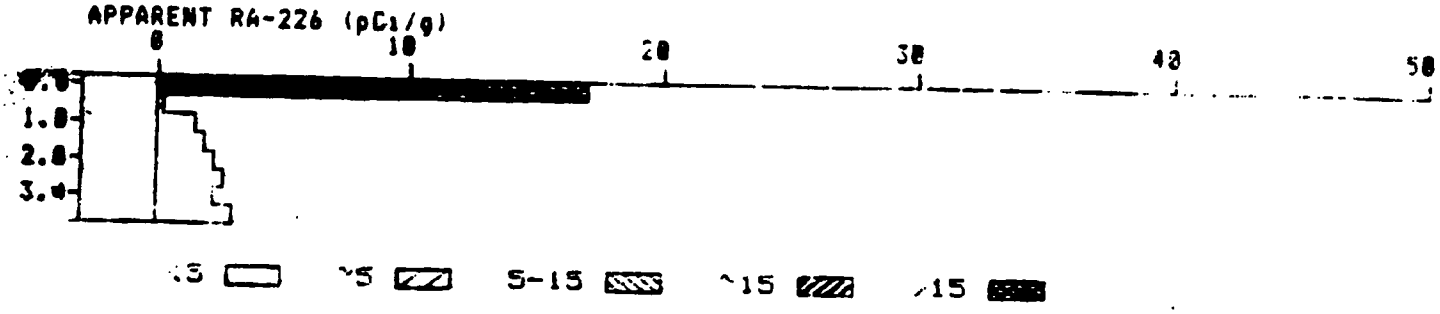
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

LE NUMBER: 154
LOCATION: 18109.2N 18339.7E
LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4282.0 FT.
AUGER HEIGHT: -23.0 IN.

UMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1004.8	17.0	1.8
0.5	346.9	0.[illegible]	1.8
[illegible]	222.3	1.5	1.[illegible]
[illegible]	204.5	1.8	1.[illegible]
[illegible]	215.7	2.[illegible]	1.[illegible]
[illegible]	228.6	2.6	1.3
[illegible]	162.4	2.[illegible]	1.4
[illegible]	178.0	3.0	1.3

is data generated by LCGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 155

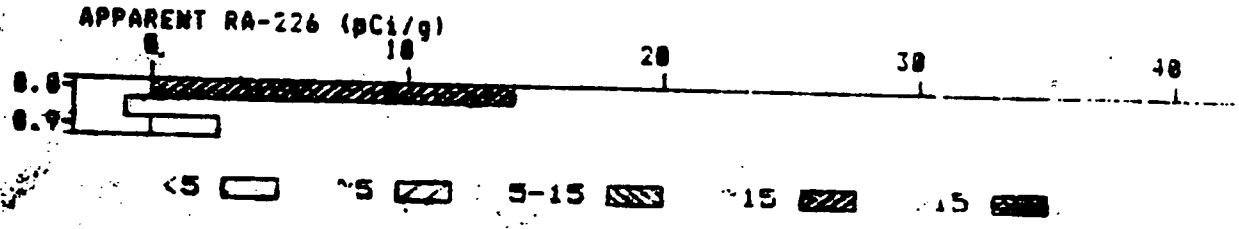
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 155
LOCATION: 10159.3N 10478.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4287.3 FT.
AUGER HEIGHT: -52.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	853.9	14.2	1.6
0.5	218.7	-1.0	2.0
0.9	160.6	2.7	1.3

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 156

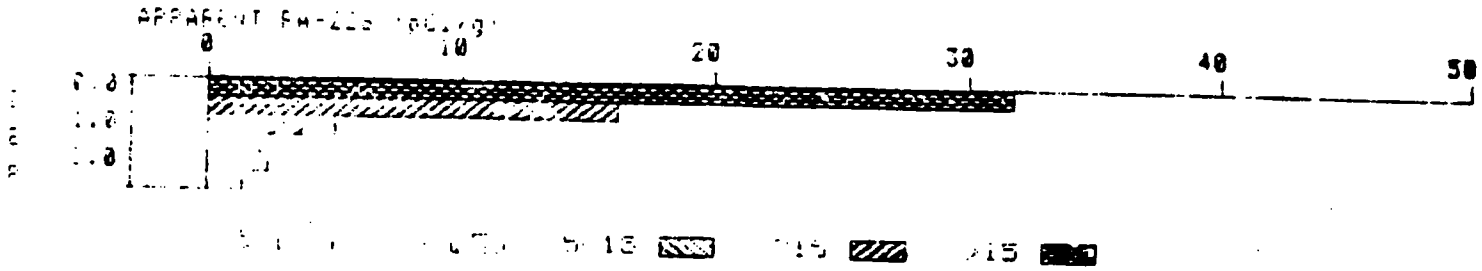
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 156
LOCATION: 10262.8N 10614.2E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840922
ELEVATION: 4268.0 FT.
AUGER HEIGHT: -36.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1273.6	31.7	2.0
0.5	1046.7	16.2	1.0
1.0	502.3	5.0	1.0
1.5	4.2	2.0	1.3
2.0	[illegible]	[illegible]	1.3
2.5	[illegible]	1.3	1.3

This data [illegible] by [illegible].BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 157

LOCATION: 103N 107E

DATE DRILLED: 840922

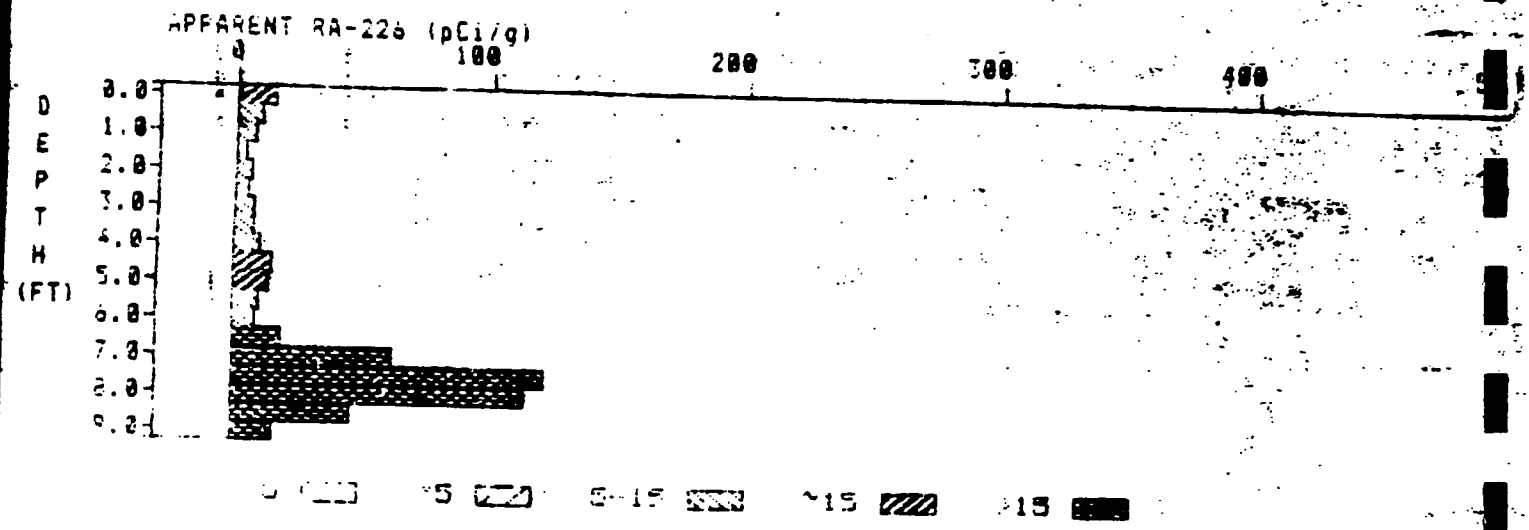
FLUID LEVEL: 99.0 FT.

ELEVATION: 4260.0 FT.

PHASE: 2

AUGER HEIGHT: 6.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
[illegible]	132.7	15.2	0.8
[illegible]	103.3	7.8	1.0
[illegible]	86.7	7.7	0.9
[illegible]	71.6	7.8	0.9
[illegible]	76.7	6.5	0.8
[illegible]	75.7	5.3	0.8
[illegible]	82.6	7.1	0.8
[illegible]	89.2	7.7	0.9
[illegible]	101.0	9.6	1.0
[illegible]	100.4	15.6	1.6
[illegible]	110.9	10.7	1.0
[illegible]	112.5	10.3	1.1
[illegible]	127.4	9.1	1.0
[illegible]	214.0	19.1	3.0
[illegible]	430.0	62.4	2.0
[illegible]	663.5	121.1	6.0
[illegible]	630.7	114.3	6.0
[illegible]	351.9	46.3	2.0
[illegible]	126.3	16.1	0.8

APPARENT RADIUM-226 CONCENTRATION 158

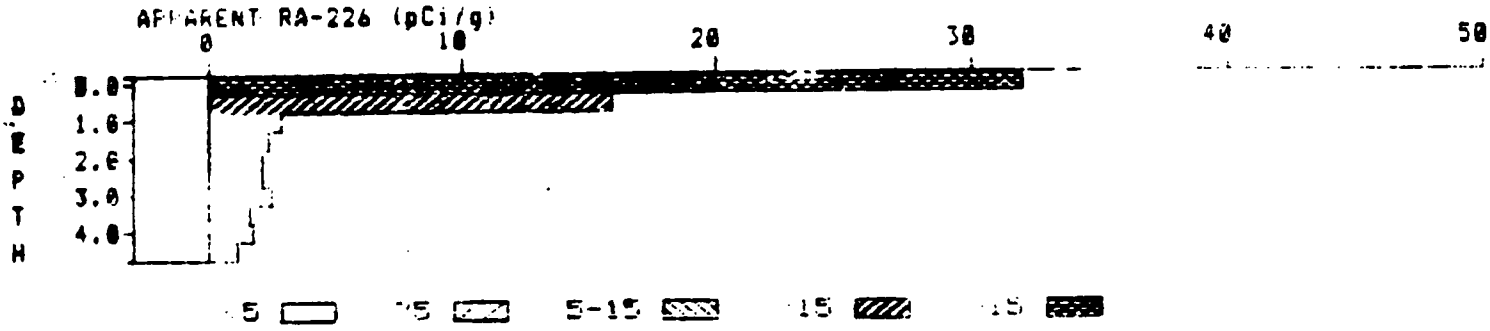
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 158
LOCATION: 10446.0N 11062.5E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4257.3 FT.
AUGER HEIGHT: -11.0 IN.

INSTRUMENT TYPE: DRD-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1810.6	32.0	2.0
0.5	1028.1	15.8	1.8
1.0	438.2	2.9	1.6
.5	271.4	2.3	1.[illegible]
.0	222.5	2.1	1.[illegible]
2.5	213.1	2.1	1.[illegible]
3.0	214.1	2.4	1.[illegible]
3.[illegible]	190.2	1.7	1.[illegible]
4.0	129.6	1.8	1.[illegible]
4.5	122.9	1.2	1.[illegible]

This data generated by LOGCALC.BAS Version 1.1 S/N 00.[illegible]

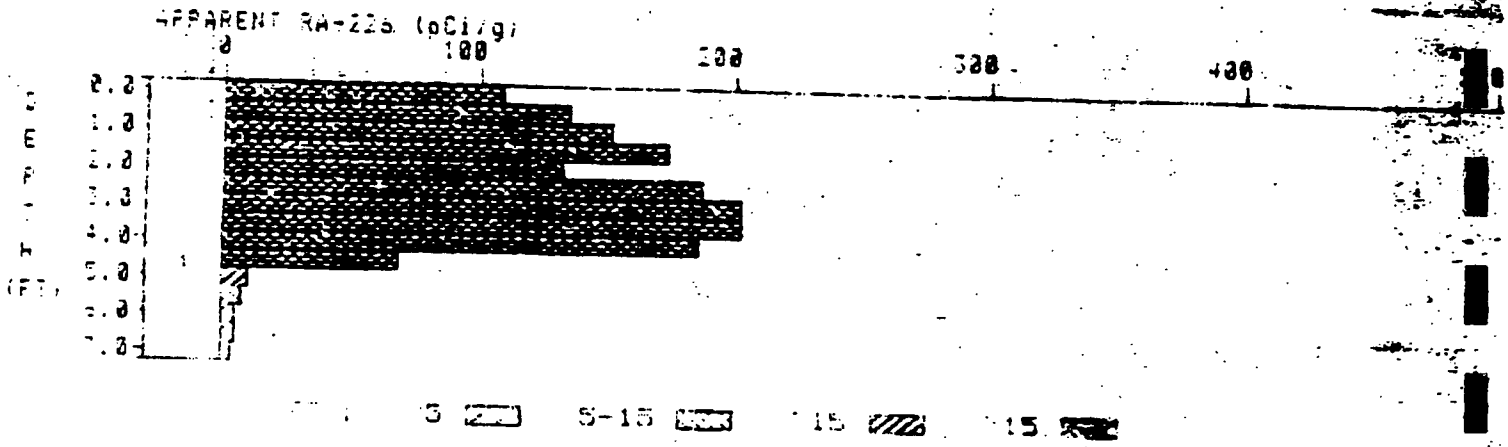
APPARENT RADIUM-226 CONCENTRATION

PROJECT: HAT

HOLE NUMBER: 159
LOCATION: 102N 110E
FLUID LEVEL: 99.0 FT.
PHASE: 2

START DATE: 840910
DATE DRILLED: 840922
ELEVATION: 4267.0 FT.
AUGER HEIGHT: 30.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



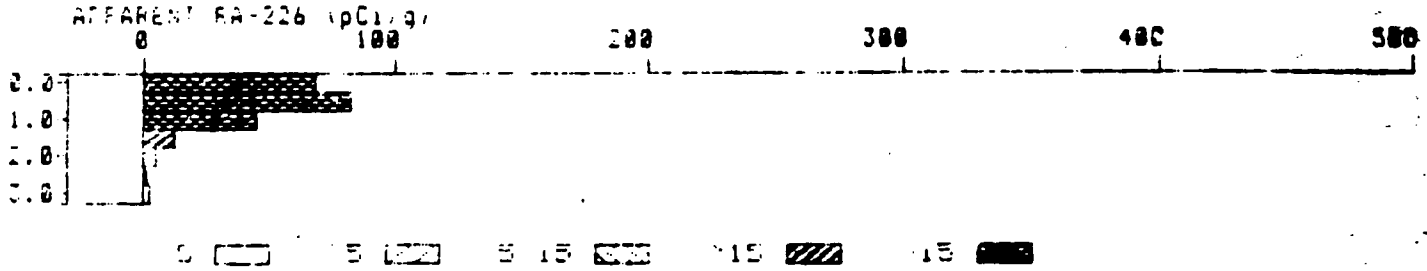
Depth (ft)	Observed Count rate (CPS)	Apparent Radium-226 (pCi/g)	2-sigma Uncertainty (pCi/g)
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	155.6	4.4
[illegible]	[illegible]	151.8	4.0
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.8
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	3.1
[illegible]	[illegible]	186.	1.8
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.9
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.8

PPARENT RADIUM-226 CONCENTRATION 160

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 160 DATE DRILLED: 840922
LOCATION: 10107.4N 11416.3E ELEVATION: 4236.8 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: -28.0 IN.
PHASE: 2

STRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
[illegible]	3778.6	68.7	5.0
[illegible]	1860.5	83.0	5.9
[illegible]	2489.3	44.6	7.4
[illegible]	1111.6	12.	2.4
[illegible]	496.2	4.4	1.6
[illegible]	202.0	1.5	1.0
[illegible]	150.0	2.2	1.3

is data generated by LOGCALC.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

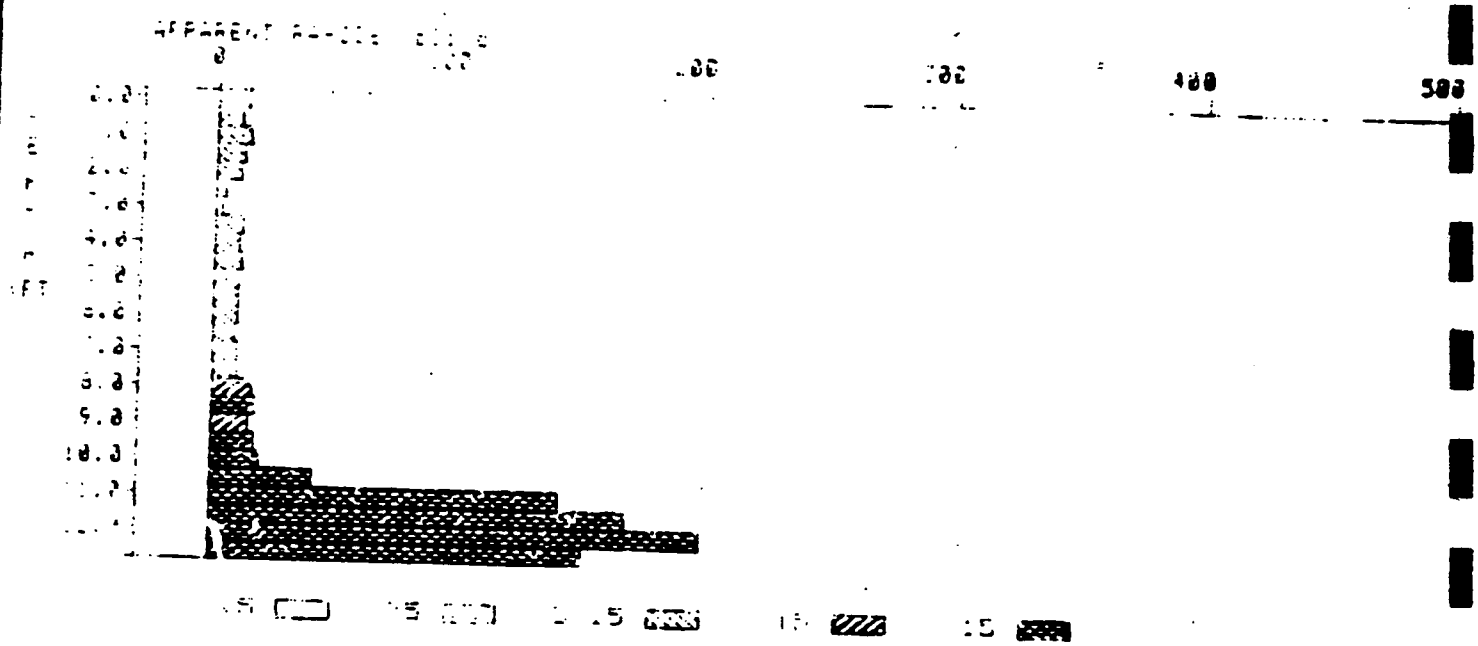
PROJECT: HAT

START DATE: 840910

HOLE NUMBER: 161
LOCATION: 101N 116E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840922
ELEVATION: 4233.0 FT.
AUGER HEIGHT: 23.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	Uncertainty
0.0	110.0	12.4	0.7
0.5	108.5	9.[illegible]	0.[illegible]
1.0	110.0	[illegible]	1.0
[illegible]	107.[illegible]	[illegible]	[illegible]
2.0	96.[illegible]	10.[illegible]	0.8
[illegible]	[illegible]	[illegible]	0.8
[illegible]	91.0	[illegible]	[illegible]
[illegible]	107.5	11.[illegible]	[illegible]
4.0	102.1	10.2	[illegible]
4.5	100.[illegible]	11.4	0.8
5.0	10[illegible].8	10.[illegible]	0.8
[illegible]	10[illegible]	10.4	0.8
[illegible]	97.7	9.[illegible]	0.8
6.0	95.5	8.5	0.8
[illegible]	100	[illegible]	0.[illegible]
[illegible]	10[illegible]	[illegible]	0.[illegible]
[illegible]	11[illegible]	10.[illegible]	1.0
[illegible]	12[illegible]	10.[illegible]	[illegible]
[illegible]	141	14.8	[illegible]
10.0	104.[illegible]	10.1	[illegible]
[illegible]	[illegible]	17.6	[illegible]
[illegible]	[illegible]	41.4	[illegible]
[illegible]	618.[illegible]	141.7	[illegible]
11.[illegible]	1026.7	157.1	[illegible]
12.0	1154.7	196.[illegible]	[illegible]
12.5	958.4	[illegible]	4.0

APPARENT RADIUM-226 CONCENTRATION 163

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 163 DATE DRILLED: 840924
LOCATION: 9818.1N 11532.8E ELEVATION: 4245.8 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: 0.0 IN.
PHASE: 1

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S

Depth (ft.)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	11384.1	134.9	4.[illegible]
0.5	14523.6	180.5	6.1
1.0	16178.6	195.4	6.1
1.5	17281.1	208.8	6.5
2.0	17782.8	213.3	6.6
2.5	17970.4	218.9	6.9
3.0	17226.2	209.5	6.6
3.5	15628.0	185.2	5.8
4.0	14142.9	163.2	5.[illegible]
4.5	13552.3	163.0	5.2
5.0	12573.7	156.3	5.[illegible]
5.5	10255.4	137.5	[illegible]
6.0	4900.0	44.8	4.0
6.5	1837.1	8.2	[illegible]
7.0	1038.4	7.6	1.6
7.5	825.3	5.4	1.[illegible]
[illegible]	1130.2	11.6	1.3

This data generated by LOGCALC.BAS Version 1.1 5/1/[illegible]

APPARENT RADIUM-226 CONCENTRATION 164

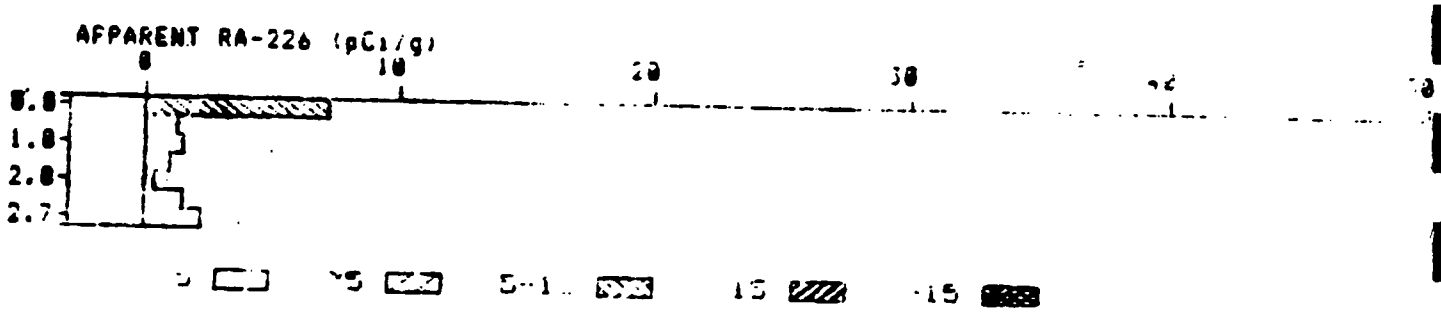
PROJECT: MEXICAN HAT, UTAH

START DATE: 840918

HOLE NUMBER: 164
LOCATION: 9697.8N 11613.8E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4272.7 FT.
AUGER HEIGHT: -31.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	484.0	7.3	1.4
0.5	242.0	1.[illegible]	1.[illegible]
1.0	185.0	1.5	1.3
1.5	156.1	1.0	1.[illegible]
2.0	137.2	0.[illegible]	1.[illegible]
2.5	117.0	1.[illegible]	1.[illegible]
2.7	146.3	[illegible]	1.[illegible]

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 165

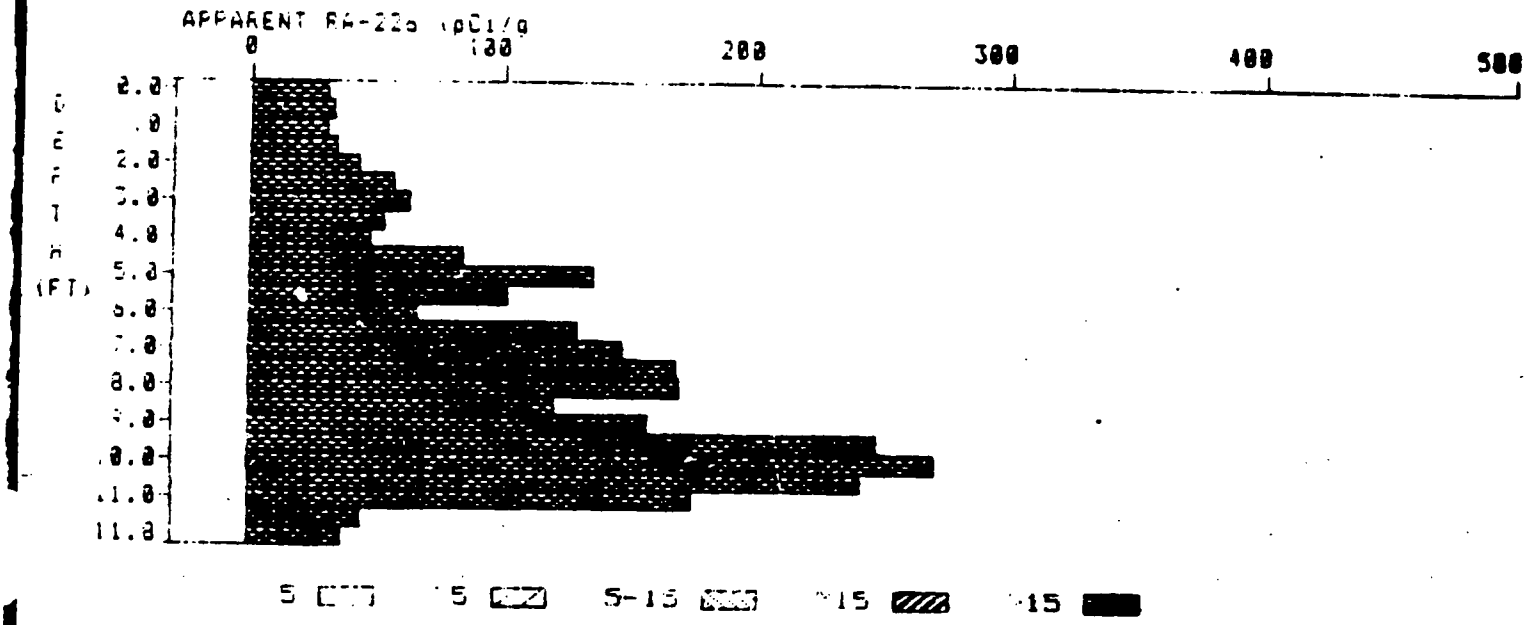
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 165
LOCATION: 9537.6N 11661.9E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840922
ELEVATION: 4271.8 FT.
AUGER HEIGHT: -44.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 BJO NO.: C-35729



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1727.5	30.5	2.5
0.5	1767.8	[illegible]	[illegible]
1.0	1588.4	[illegible]	[illegible]
1.5	[illegible]	33.6	[illegible]
2.0	1995.4	43.0	[illegible]
2.5	2561.9	[illegible]	4.[illegible]
3.0	2219.[illegible]	51.7	4.[illegible]
3.5	3037.0	51.7	4.6
4.0	[illegible]	48.[illegible]	4.7
4.5	4648.4	[illegible]	[illegible]
5.0	5276.7	[illegible]	11.0
5.5	5555.0	101.[illegible]	.4
6.0	4535.[illegible]	86.[illegible]	10.[illegible]
6.5	4467.9	[illegible]	7.7
7.0	[illegible]	146.[illegible]	11.[illegible]
7.5	6701.0	168.[illegible]	11.[illegible]
8.0	5676.0	158.[illegible]	12.0
8.5	7658.4	120.0	10.4
9.0	9189.3	156.[illegible]	11.6
9.5	12368.8	245.8	17.0
10.0	13406.9	268.2	17.3
10.5	12052.7	239.6	17.5
11.0	8274.0	173.5	18.5
11.5	2551.2	43.6	8.7
11.8	1726.9	36.6	4.8

This data generated by LOGCALL.BAS version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION

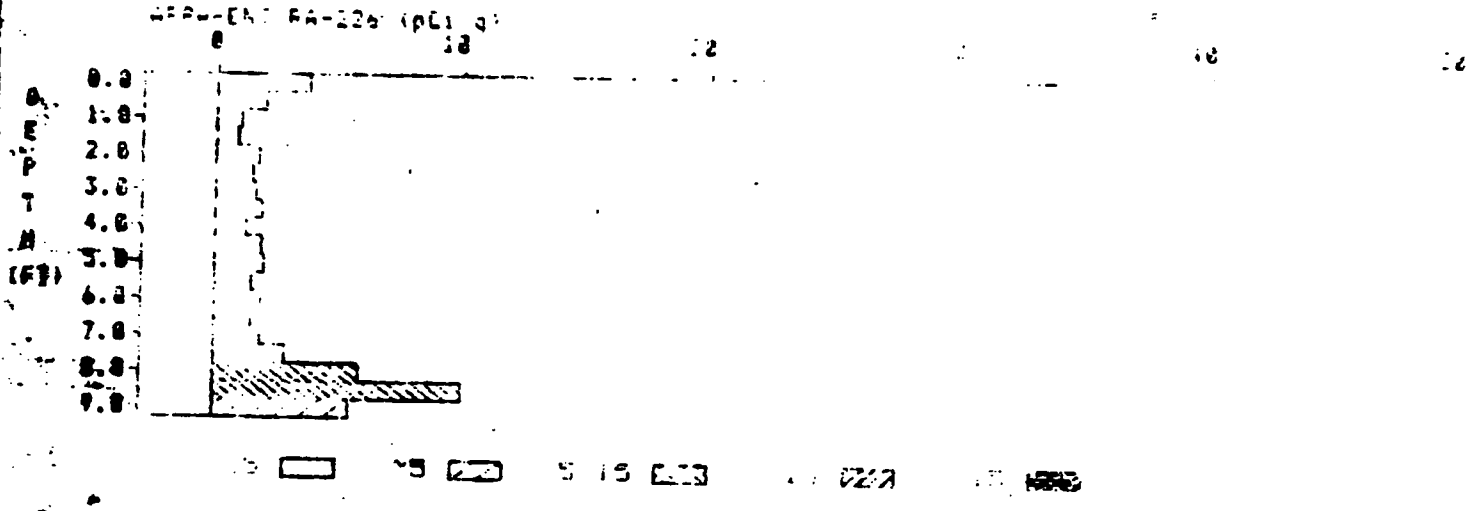
PROJECT: HAT01

START DATE: 840900

HOLE NUMBER: 166
LOCATION: 91N 114E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4300.0 FT.
AUGER HEIGHT: 9.0 IN.

INSTRUMENT TYPE: COMPULOG SERIAL NO. 231-03 GJO NO.: 1815



Depl (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	62.4	[illegible]	[illegible]
[illegible]	50.3	[illegible]	[illegible]
1.0	47.4	[illegible]	[illegible]
1.5	46.4	[illegible]	[illegible]
2.0	49.1	1.0	[illegible]
[illegible]	48.7	1.0	[illegible]
[illegible]	49.5	1.0	[illegible]
[illegible]	50.1	1.0	[illegible]
[illegible]	45.8	1.0	[illegible]
4.0	43.7	1.0	[illegible]
[illegible]	50.5	2.0	[illegible]
[illegible]	49.5	1.0	[illegible]
5.0	50.[illegible]	1.0	[illegible]
6.0	50.1	1.0	[illegible]
7.0	53.0	1.0	[illegible]
7.5	60.4	1.0	[illegible]
8.0	75.0	2.0	[illegible]
8.[illegible]	88.1	2.0	[illegible]
9.0	68.0	[illegible]	[illegible]

APPARENT RADIUM-226 CONCENTRATION 167

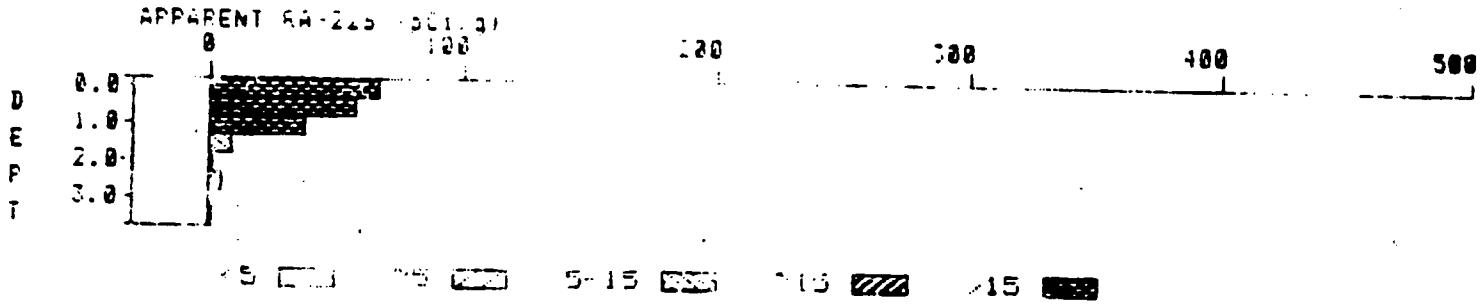
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 167
LOCATION: 9103.5N 11371.6E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 840923
ELEVATION: 4304.3 FT.
AUGER HEIGHT: -29.0 IN.

INSTRUMENT TYPE: FRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2 Sigma Uncertainty (pCi/g)
0.0	3619.8	65.8	4.8
0.5	3015.2	57.7	4.4
1.0	2030.0	37.8	3.0
1.5	862.5	8.7	2.2
2.0	370.6	1.5	1.0
2.5	231.3	0.1	1.5
3.0	144.5	0.6	1.4
3.5	170.7	1.5	1.2

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 168

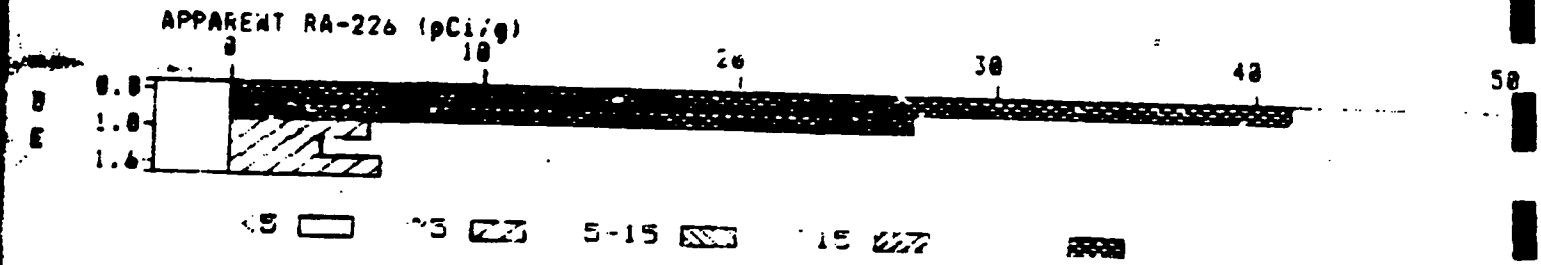
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 168
LOCATION: 8977.7N 11269.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4309.5 FT.
AUGER HEIGHT: -45.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2311.4	41.4	[illegible]
0.5	1505.1	26.7	[illegible]
1.0	575.3	9.5	[illegible]
1.5	274.7	3.6	[illegible]
1.6	301.3	6.0	[illegible]

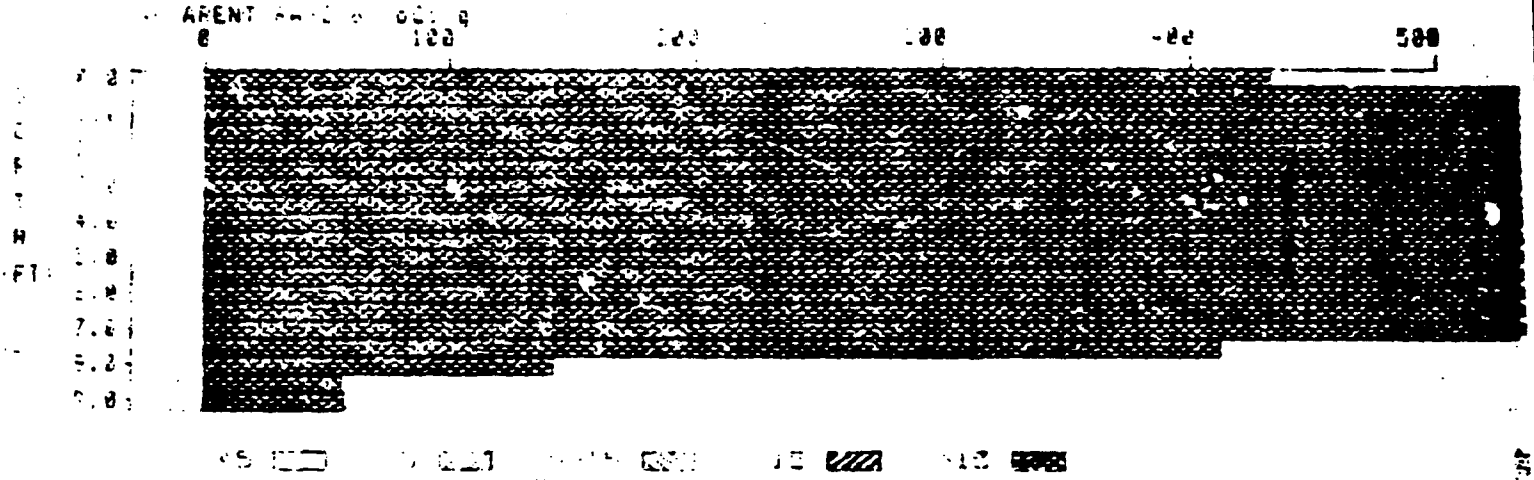
data generated by LOGCALC.BAS Version 1.1 [illegible]

APPARENT RADIUM-226 CONCENTRATION 169

PROJECT: HAT01 START DATE: 840906

HOLE NUMBER: 169 DATE DRILLED: 840923
LOCATION: 69N 110E ELEVATION: 4295.0 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: 9.0 IN.
PHASE: 2

INSTRUMENT TYPE: COMPULOG SERIAL NO. 271-03 GJO NO.: 1815



Depth (ft)	Observed Count Rate (cps)	Apparent Rad.ium 226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2694.9	433.1	12.4
0.5	4013.9	678.9	21.4
1.0	4995.5	826.3	24.0
1.5	5790.1	917.7	[illegible]
2.0	6864.1	%1164.7	32.5
2.5	7280.6	%1231.4	42.8
3.0	7745.3	%1[illegible].6	37.0
3.5	7327.7	%1189.9	41.5
4.0	6245.0	917.6	1.0.9
4.5	7741.6	%1748.4	110.4
5.0	9196.7	%1492.6	54.4
5.5	9479.7	%1543.8	44.7
6.0	9572.6	%1644.0	57.3
6.5	8435.4	%1456.2	48.3
7.0	6101.3	%1036.0	32.5
7.5	3114.4	411.7	28.1
8.0	1362.8	143.0	21.1
8.5	614.8	56.0	11.0
9.0	354.1	27.8	3.5

APPARENT RADIUM-226 CONCENTRATION 171

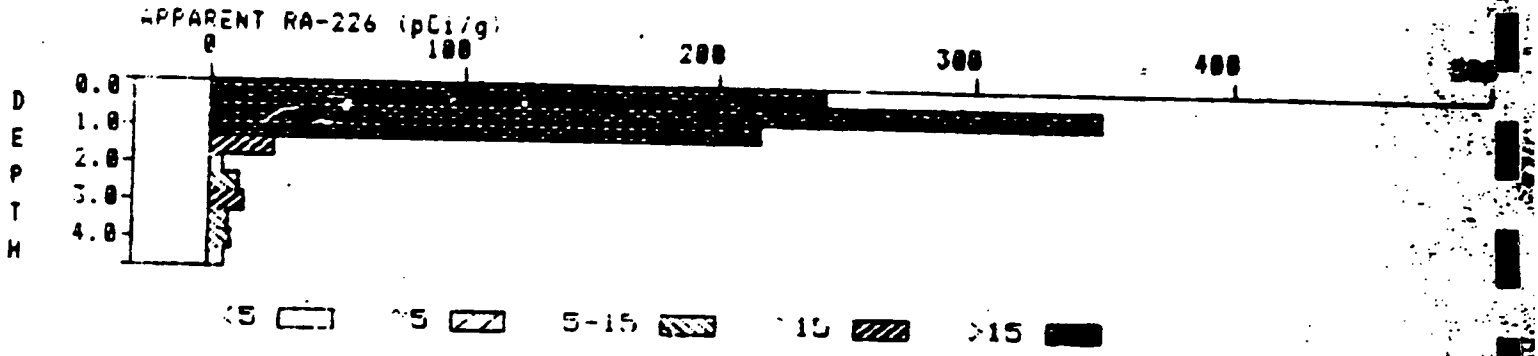
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 171
LOCATION: 8944.5N 10732.4E
FLUID LEVEL: 99.0 FT.
PHASE: 3

DATE DRILLED: 840923
ELEVATION: 4293.5 FT.
AUGER HEIGHT: -11.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	13050.0	241.7	16.7
0.5	15516.5	348.4	29.5
1.0	10664.2	215.9	15.9
1.5	3558.5	25.0	11.5
2.0	1234.1	5.3	4.7
2.5	832.0	10.9	1.7
3.0	770.3	13.9	1.7
3.5	550.1	7.0	1.5
4.0	367.3	8.3	1.8
4.5	332.9	6.2	1.5

This data generated by LOGCALC.BAS Version 1.1 S/N 002

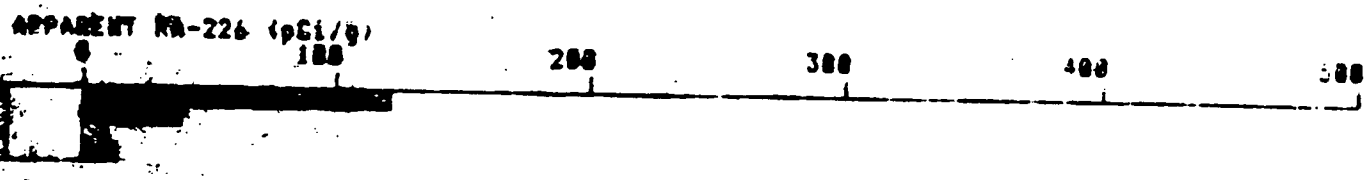
APPARENT RADIUM-226 CONCENTRATION 173

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 173
LOCATION: 8962.6N 10319.8E
WATER LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4284.5 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RADCAL SERIAL NO. 753 BJO NO.: C-3572S



<5 <5 5-15 >15 >15

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
[illegible]	10273.7	121.5	3.7
[illegible]	4758.6	41.0	4.5
[illegible]	1934.0	9.8	3.6
[illegible]	1296.7	13.8	1.3

Data generated by LOBCALC.BAS Version 1.1 S/N 002

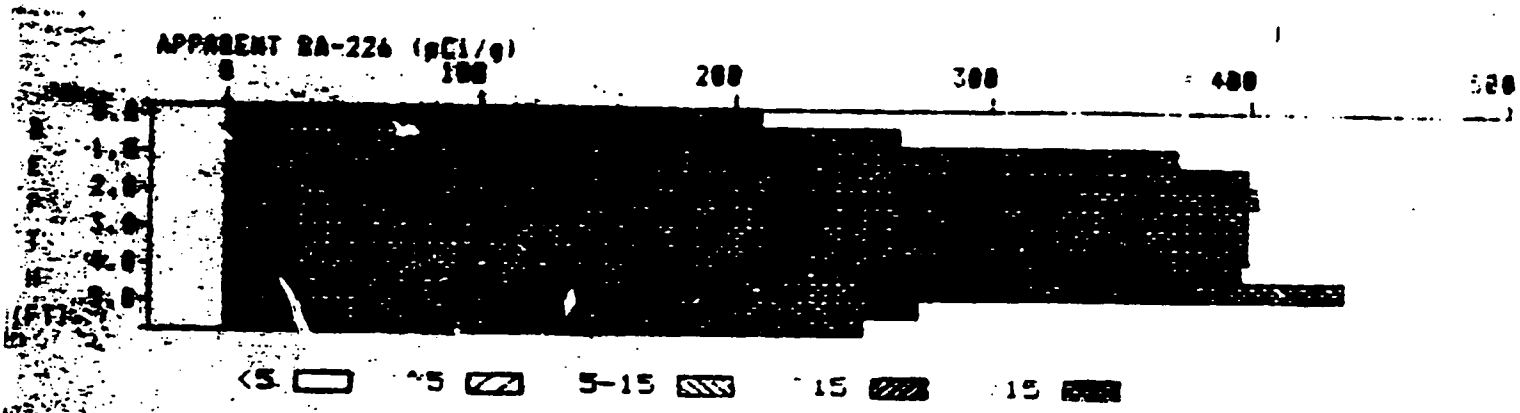
[illegible]MENT RADIUM-226 CONCENTRATION 174

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 174
LOCATION: [illegible].5N 10249.1E
FLUID LEVEL: 99.8 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4288.2 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RADCAL SERIAL NO. 753 BJO NO.: C-35725



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
[illegible]	17616.5	209.7	6.4
[illegible]	22761.7	263.4	6.4
[illegible]	29415.3	378.6	12.5
[illegible]	32437.1	398.9	12.5
[illegible]	33333.3	403.1	12.5
[illegible]	33333.3	398.3	12.1
[illegible]	33333.3	398.3	12.1
[illegible]	33333.3	399.3	12.1
[illegible]	33150.9	396.3	12.1
[illegible]	32927.6	436.1	17.9
[illegible]	24718.9	278.0	10.8
[illegible]	21884.6	258.3	7.6

[illegible] data generated by LOGCALC-BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 175

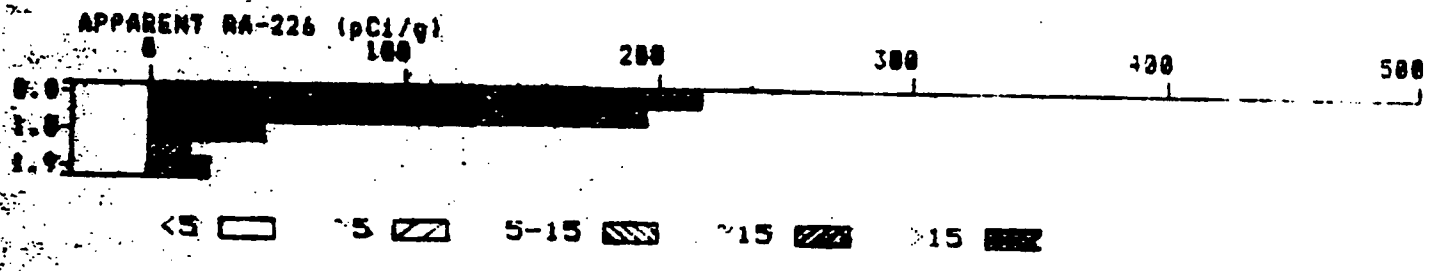
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 175
LOCATION: 8875.9N 18100.5E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4281.9 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



<5 ~5 5-15 ~15 >15

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	18150.9	216.1	6.4
0.5	14363.2	194.4	9.1
1.0	6108.8	45.5	7.6
1.5	2740.1	16.4	4.4
1.9	2132.5	23.8	1.4

data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 176

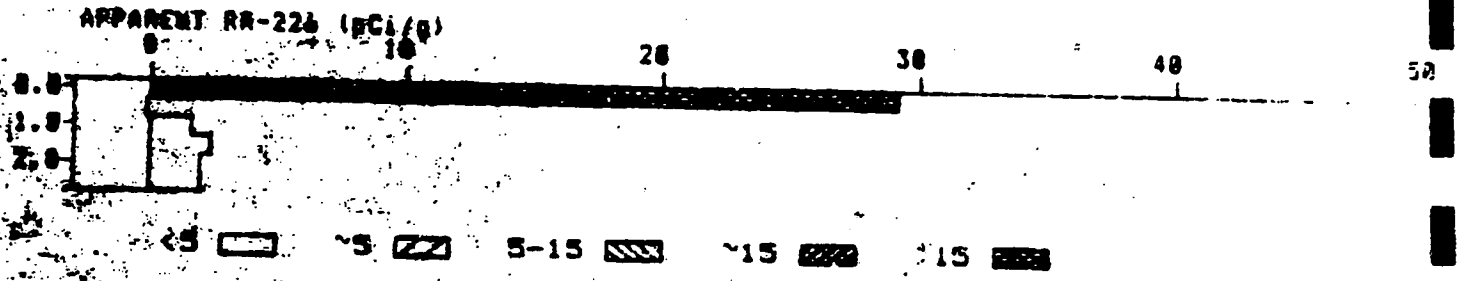
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 176
LOCATION: 8728.4N 9768.2E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840923
ELEVATION: 4289.7 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RADCAL SERIAL NO. 753 BJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2571.0	29.1	1.5
0.5	774.6	-0.1	2.5
1.0	416.2	1.6	1.4
1.5	356.5	2.4	1.2
2.0	329.0	2.0	1.2
2.1	315.8	2.0	1.2

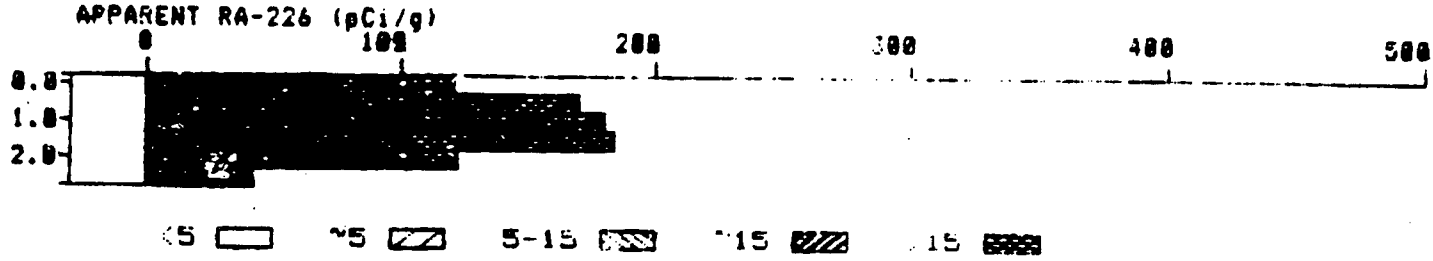
Data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM-226 CONCENTRATION 177

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 177 DATE DRILLED: 840924
LOCATION: 10105.1N 11302.1E ELEVATION: 4242.0 FT.
FLUID LEVEL: 99.0 FT. AUGER HEIGHT: 0.0 IN.
PHASE: 1

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	10281.6	121.6	3.9
0.5	13377.3	169.8	6.2
1.0	14401.1	179.5	6.1
1.5	13846.8	184.0	8.0
2.0	9614.4	122.9	4.8
2.5	3635.9	41.4	1.8

This data generated by LOGCALC.PAS Version 1.1 S/N 002

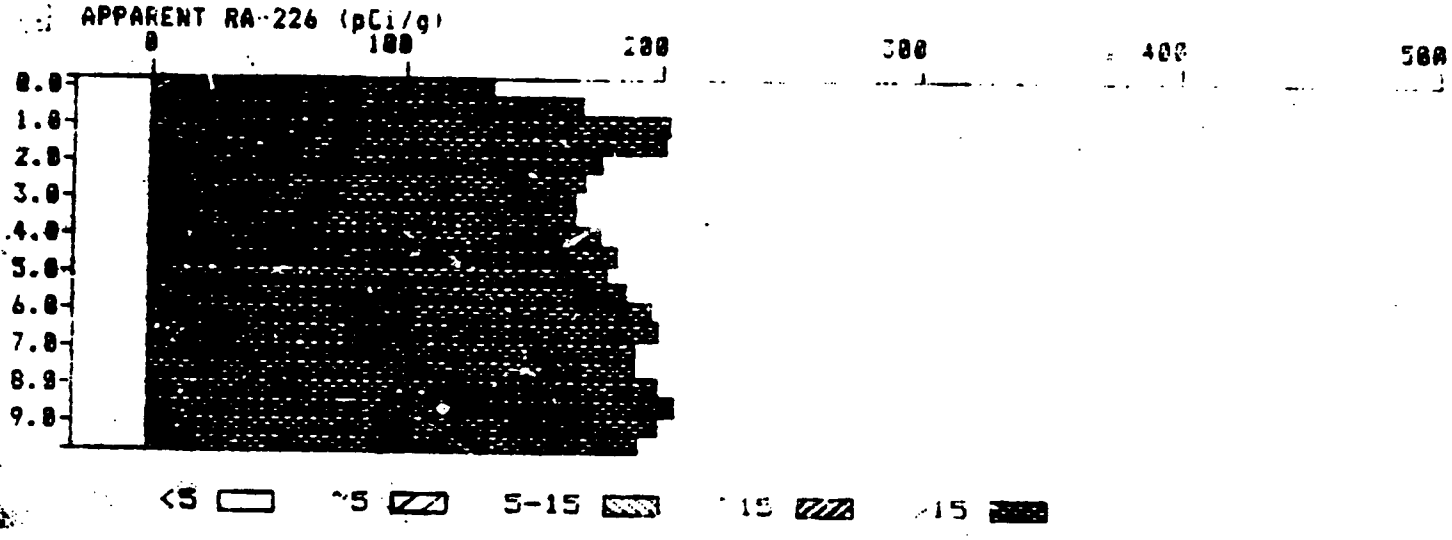
APPARENT RADIUM-226 CONCENTRATION 178

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 178
LOCATION: 9998.4N 11406.7E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840924
ELEVATION: 4239.9 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	11264.3	133.4	4.2
0.5	13972.0	168.8	5.4
1.0	16139.1	202.6	7.0
1.5	16313.7	201.3	6.6
2.0	15122.4	176.6	6.0
2.5	14487.3	170.4	5.4
3.0	14169.5	166.4	5.3
3.5	14211.7	166.1	5.3
4.0	14755.8	176.0	5.5
4.5	15180.6	182.4	5.7
5.0	15239.8	179.0	5.6
5.5	15699.5	185.7	5.8
6.0	16336.2	196.8	6.2
6.5	16498.4	199.0	6.2
7.0	16140.4	189.9	6.0
7.5	16162.0	189.7	6.0
8.0	16650.6	199.1	6.2
8.5	16937.6	204.7	6.4
9.0	16633.4	199.2	6.2
9.5	16087.6	191.3	5.9

This data generated by LOGCALC.BAS Version 1.1 S/N 002

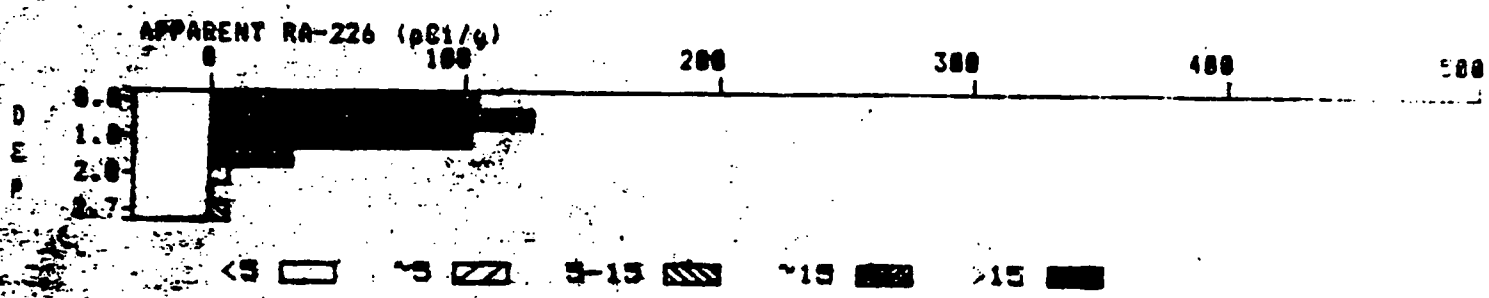
APPARENT RADIUM-226 CONCENTRATION 179

PROJECT: MEXICAN HAT, UTAH START DATE: 840910

HOLE NUMBER: 179
LOCATION: 10811.5N 11621.7E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 840922
ELEVATION: 4230.7 FT.
AUGER HEIGHT: -28.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	5732.7	105.2	7.4
0.5	6143.3	126.1	9.6
1.0	4950.0	102.6	8.0
1.5	2336.7	31.9	3.9
2.0	913.2	7.6	2.6
2.5	327.7	1.4	2.3
2.7	325.7	7.3	1.4

This data generated by LOGCALC.BAS Version 1.1 S/N 002

APPARENT RADIUM--226 CONCENTRATION 180

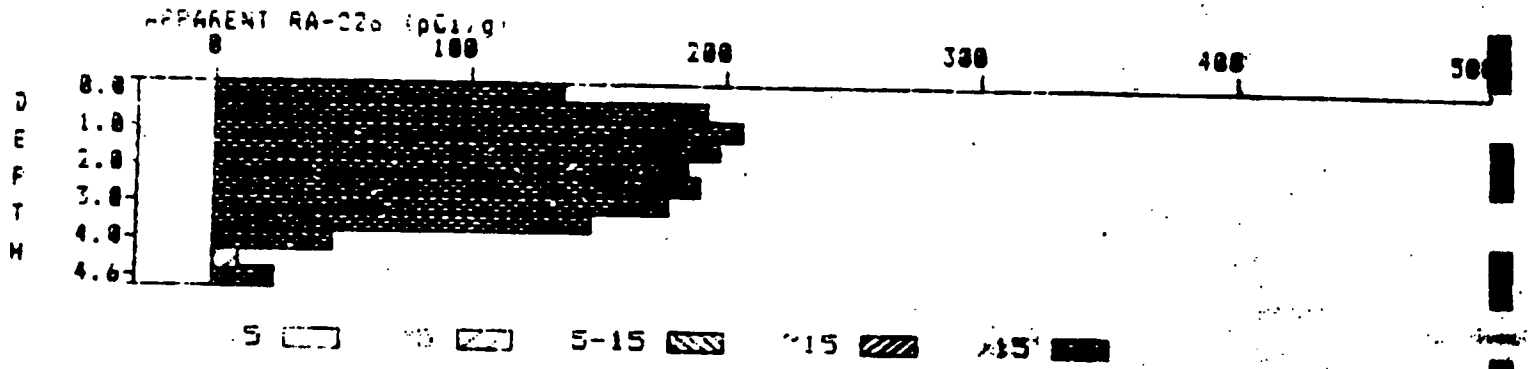
PROJECT: MEXICAN HAT, UTAH

START DATE: 840910

HOLE NUMBER: 180
LOCATION: 9956.6N 11511.4E
FLUID LEVEL: 99 [illegible] FT.
PHASE: 2

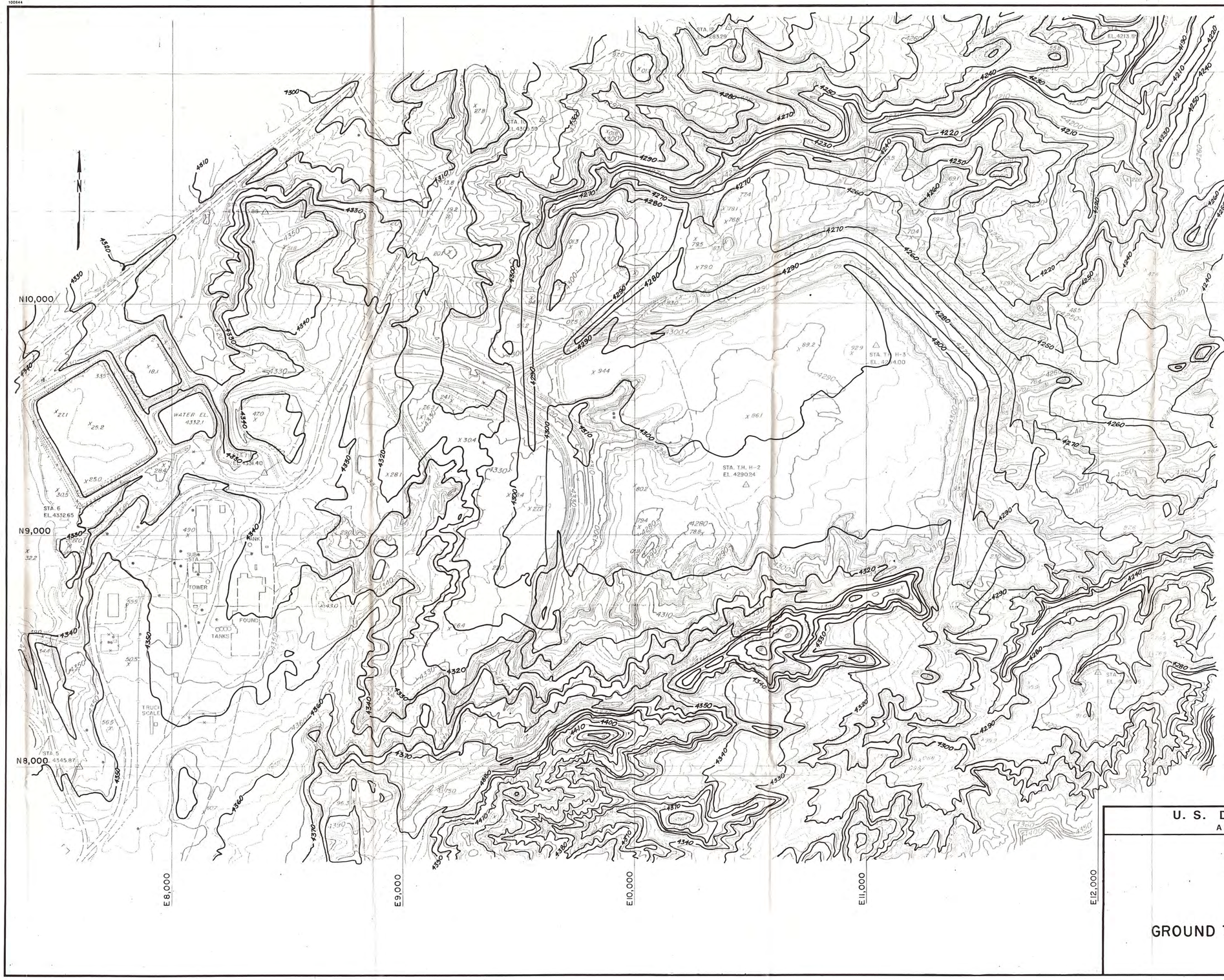
DATE DRILLED: 840924
ELEVATION: 4237.2 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: FRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-35728



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	11459.5	135.8	4.3
0.5	15125.7	192.5	5.9
1.0	16584.5	206.0	6.9
1.5	16302.9	196.9	5.[illegible]
2.0	15716.4	164.5	5.8
2.5	15511.0	170.4	6.2
3.0	14175.7	157.2	6.1
3.5	11777.8	147.6	6.4
4.0	52[illegible].1	46.7	4.7
4.5	[illegible]	[illegible].6	4.6
4.6	[illegible]	24.2	1.4

This data generated by [illegible]HLL.5HI Version 1.1 S/N 002



NOTES:

1. 1982 CONTOURS ARE AT 2 FT. INTERVALS
   1990 CONTOURS ARE AT 10 FT. INTERVALS

LEGEND:

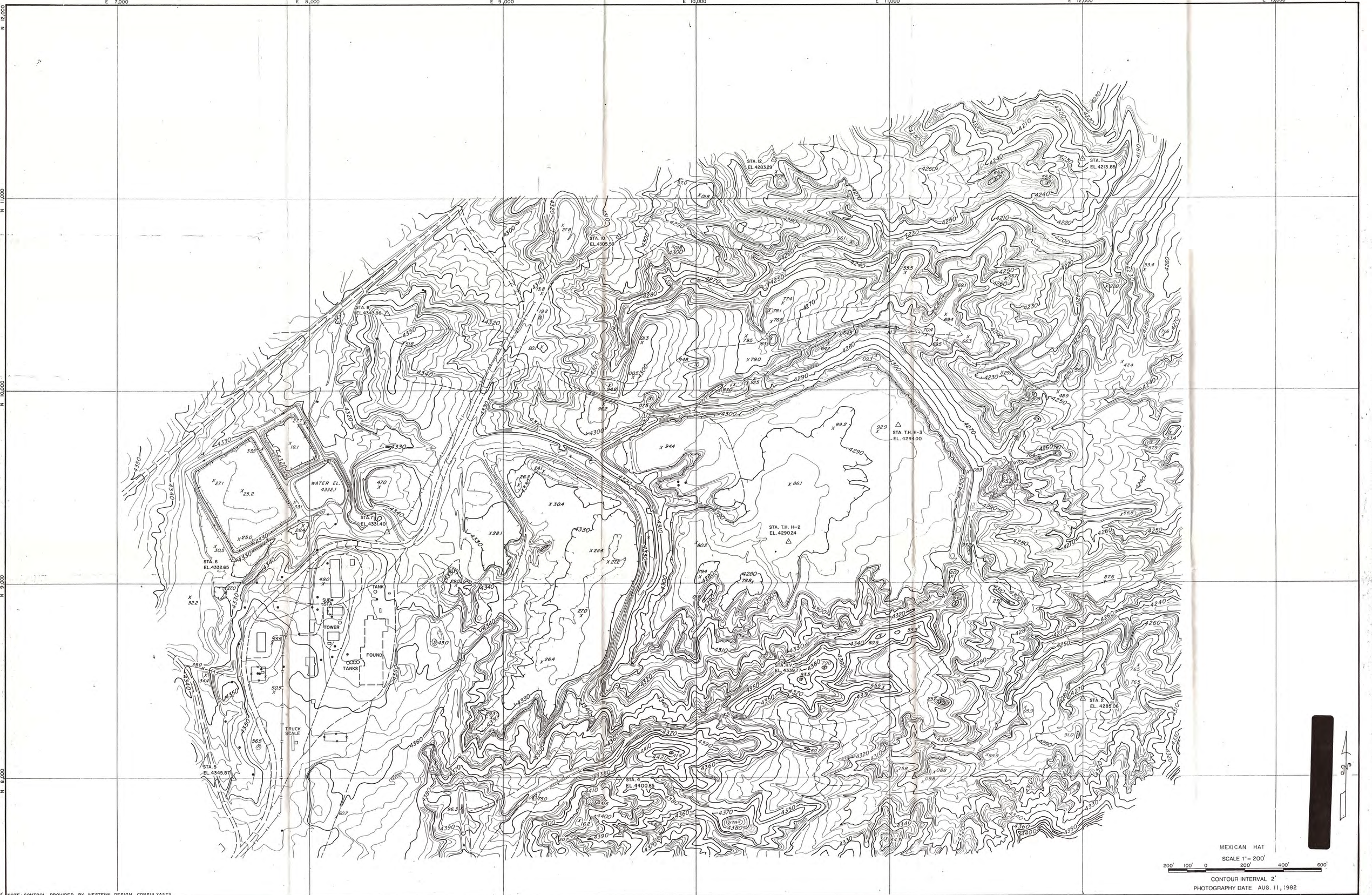
- 1982 CONTOUR LINES BEFORE ANY REMEDIAL ACTION
- 1990 CONTOUR LINES AFTER COMPLETION OF PHASE II SUBCONTRACT

200 0 200 400
SCALE FEET

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT SITE
MEXICAN HAT, UTAH

1982 AND 1990 GROUND TOPOGRAPHY COMPARISON

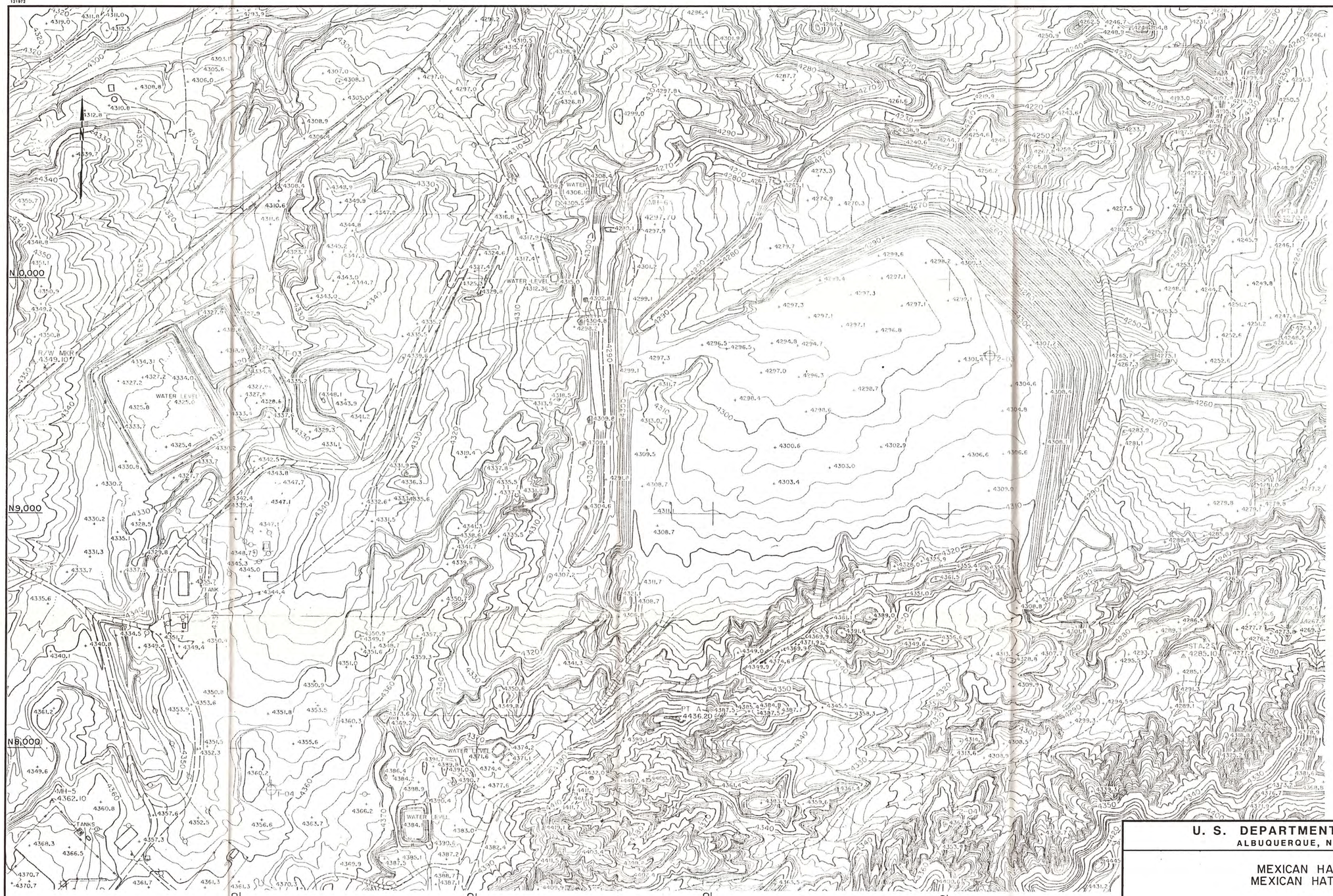


NOTE: CONTROL PROVIDED BY WESTERN DESIGN CONSULTANTS

Olympus AERIAL SURVEYS INC. 50 West 2950 South Salt Lake City, Utah 84115 – 2059-3199

NEW

121972



U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT SITE
MEXICAN HAT, UTAH

1990 CONTOUR LINES AFTER COMPLETION OF PHASE II SUBCONTRACT

B50251 | GD003800/JMTRAD

SURF008882

UNITED STATES DEPARTMENT OF ENERGY
Albuquerque, New Mexico

Box 1

Uranium Mill Tailings Remedial Action Project (UMTRAP)

Mexican Hat, Utah
Monument Valley, Arizona

Completion
Mexican Hat and Monument Valley

Remedial Action Completed During Phase I and Phase II Subcontracts

APPENDIX A

VOLUME II

August 1991

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

Box 2
mon 605.02.02
SMON 13.11

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MKE Document No. 5025-HAT-C-01-01146-00

Calculation Cover Sheet

Calc. No. 9-226-03-00

Contract No. 5025 Discipline ESCI No. of Sheets 25

Project

UMTRA - HAT

Feature

UPPER PILE TAILINGS EXCAVATION

Item

EXCAVATION LIMITS AND QUANTITY ESTIMATE

Sources of Data

1. On-Pile Volumes of Contamination at the Mexican Hat Site. Jacobs Weston Team. June 3, 1985. MKE Doc No 5025-HAT-I-04-00142-00.
2. US DOE, "Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at

~~Sources of Formulae & References~~

2. (Cont.) Mexican Hat, Utah," DRAFT, Feb. 1986. MKE DOC No 5025-HAT-R-03-00198-00.
3. Depth to Excavation and Hole Coordinates for Mexican Hat. MSRD Upper Pile Only, MKE DOC No 5025-HAT-X-04-00209-00
4. Topography Map - Based on Oct. 1, 1952 Aerial Photos. Produced by Towill Inc. MKE Doc No. 5025-HAT-M-09-00462-00.

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. 9-226-01

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	—	G. M. Blefgen	2-3-87	K. OHSIEK	6/23/87	A. [illegible]	6/26/87

Form 42-110

SUPERSEDES CALC NO 9-226-01 (preliminary design)
UMTRA, MEXICAN HAT
TAILINGS EXCAVATION
UPPER PILE EXCAVATION VOLUME

Calc. No 9-226-01 is superseded because topography based on 1952 aerial photos has since been received (Jan 13, 1987). The 1952 topo represents the ground surface prior to the Uranium Mill Tailings Mining operation. The 1952 topo is used in this calculation to more accurately define the tailings interface. In using the 1952 topo a revised excavation plan is developed. The excavation of the upper pile in the region of the final tailings embankment has also been modified to better represent the final tailings embankment configuration.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-HAT
Feature UPPER PILE TAILINGS EXCAVATION
Item EXCAVATION LIMITS AND QUANTITY EST.

Contract No. 5025
Designed GMB
Checked KLO

Sheet 1
File No.
Date 2-3-87
Date 6/23/87

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PURPOSE	1
DISCUSSION	1
METHOD	3
MSRD BOREHOLE DATA	4
EXCAVATION PLAN	10
1952 TOPOGRAPHY	11
QUANTITY ESTIMATE	12
CROSS-SECTIONS - UPPER PILE EXCAVATION	13

PURPOSE

The purpose of this calculation is to estimate the limit of excavation for the upper tailings pile and the subsequent excavation quantity. The excavation limits will be used as a guide in excavating the upper tailings pile and may be revised during construction if further contaminates are found.

DISCUSSION

The limit of contamination is estimated based on results of the drilling program conducted by MSRD (Mountain States Research and Development), 1982, and a recent study by BFEC (Ford, Bacon, and Davis), Ref 1. A topographic map based on photos of the site in 1952, prior to the mining operation at the Mexican Hat site, is also used to help estimate the limit of contaminates Ref. 2.

The MSRD boreholes are used to estimate the physical interface (tailings, and original ground) and the 15 pCi/g interface. Many of the boreholes were terminated at the physical interface and did not extend to the 15 pCi/g interface due to the low recovery of samples after encountering the hard

bedrock surface. The boreholes that reached the 15 pCi/g interface are used to obtain an average depth from the physical interface to the 15 pCi/g interface. This average depth is then added to the terminated boreholes to estimate a depth to the 15 pCi/g interface for each borehole (see Ref. 1).

The 1952 topography is used to estimate the limit of contamination in areas where no boreholes existed as well as to locate areas in which the estimated contamination limit based on the boreholes did not extend to the existing ground surface in 1952. In these cases, either the estimated contamination depth based on the borehole is in error or uncontaminated material was placed in these areas prior to the placement of the tailings. To be conservative, it is assumed that contamination extends to at least the ground surface in 1952. The estimated contamination limit is generally below the 1952 ground surface indicating the contamination has most likely permeated into the original ground surface.

METHOD

The boundries of the upper tailings pile are layed out based on the upper pile as defined in the DRAFT RAP (Ref. 2). The excavation depths (excavation contours) is estimated by superimposing the MSRD bore holes with the subsequent depth to the 15 pCi/g interface and the 1952 topography on the curent topography. From this, excavation contours are approximated so as to remove all contaminated material. In the region of the upper pile which will be covered by the final tailings embankment, the excavation does not extend to the bottom of the contaminated material to minimize over excavation. The excavation plan may be revised during construction if it is found that contamination extends beyond the contours shown.

The excavation quantity is estimated by the double-end-area method.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 4

Project UMTRA - HAT
Feature TAILINGS EXCAVATION
Item UPPER PILE

Contract No. 5C25 02 File No.
Designed GMB Date 1-23-86
Checked KLO Date 6/23/87

CONTAMINATION LIMIT-MSRD BOREHOLES (Ref. 1 + 3)

BORE HOLE	COORDINATES NORTH	COORDINATES EAST	SURFACE ELEVATION	DEPTH TO PHYSICAL INTERFACE	DEPTH TO 15 pCi/g INTERFACE	15 pCi/g ELEVATION	
M	9065	9720	4334.0	25.0	26.8 ✓	~~4303.2~~ 4307.2 ✓	KLO 6/23/
M	8470	9290	4330.0	12.4	14.2 ✓	~~4314.8~~ 4315.8 ✓	KLO 6/23/
A1	9120	8720	4333.5	5.1	6.9	4326.6	O.K. HM 6/26/
	9345	8640		N/A	N/A	—	
	9140	8605		N/A	N/A	—	
	9490	8755		N/A	N/A	—	
A5	9070	8840	4331.5	3.9	6	4325.5	
A6	9440	8845	4332.0	7.1	8.9	4323.1	
A7	9275	8780	4332.0	9.0	10.8	4321.2	
A8	9375	8990	4329.5	12.2	13.7	4315.8	
A9	9205	8925	4329.0	8.5	10	4319.0	
A10	9640	8825	4334.0	5.5	7.5	4326.5	
	9145	9075		N/A	N/A	—	
B12	9480	9205	4330.0	15.0	15.5	4314.5	
	8990	9060		N/A	N/A	—	
B14	9420	9355	4330.0	26.0	27.8	4302.2	
B15	8920	9150	4334.0	17.0	19.8	4314.2	
B16	9480	9550	4333.0	33.0	35	4298.0	
B17	8855	9290	4329.0	22.0	24	4305.0	
B18	9570	9415	4334.0	21.3	23.1	4310.9	
B19	8775	9470	4329.0	24.0	25.8	4303.2	
A20	9315	9145	4332.0	15.7	17.5	4314.5	
B21	8620	9415	4328.5	12.5	14	4314.5	
B22	9250	9280	4331.0	10.5	18.3	4312.7	
B23	8690	9220	4328.0	17.6	19.5	4308.5	
B24	9190	9430	4329.0	27.7	29.5	4299.5	
A25	8595	9010	4337.0	7.0	8.8	4328.2	
B26	9130	9570	4328.0	33.8	35.6	4292.4	
A27	8745	9070	4338.0	15.1	16.9	4321.1	
B28	8470	9130	4329.0	12.0	13.8	4315.2	
A29	8410	8945	4333.0	7.3	9.1	~~4324.9~~ 4323.9 ✓	KLO 6/23/8
B30	8960	9500	4328.5	30.0	31.8	4296.7	O.K. HM 6/26/
B31	9025	9360	4329.0	27.0	28.8	~~4300~~ 4300.2 ✓	KLO 6/23/8
B32	9295	9645	4330.0	37.5	39.3	4290.7	O.K. HM 6/26/8
B33	9085	9215	4332.0	19.0	22	4310.0	
B34	9635	9275	4334.0	23.0	24.8	4309.2	
B35	9340	9570	4330.0	29.4	31.2	4298.8	
A36	9685	9125	4336.0	21.6	23.4	~~4310.6~~ 4312.6	KLO 6/23/8
A37	9580	8985	4332.0	12.6	14.4	4317.6	OK HM 6/26/
	9710	8955		N/A	N/A	—	
B86	9170	9720	4332.0	38.0	39.8	4292.2	
B88	9000	9605	4330.0	35.0	36.8	4293.2	
B93	9420	9665	4334.0	34.6	35.5	4298.5	

See Sheets 5 THROUGH 9

KLO

UMTRA - HAT
UPPER PILE EXCAVATION
GMB 2-3-87
KLO 6/23/87
From Ref. 1

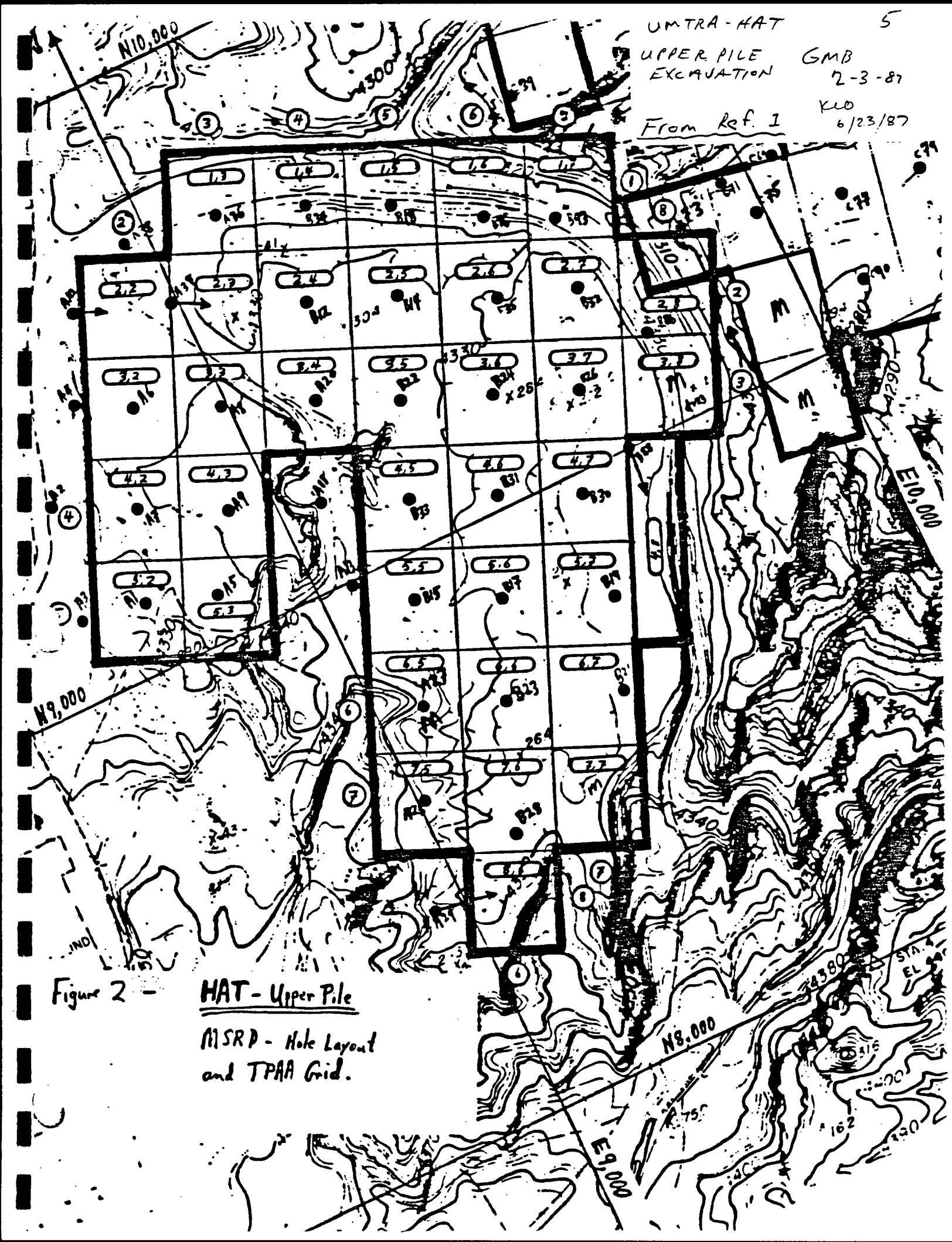

Figure 2 - HAT - Upper Pile

MSRP - Hole Layout and TPAA Grid.

DEPTHS TO EXCAVATION AND HOLE COORDINATES FROM MEXICAN HAT MEMO - UPPER PILE ONLY ALL VALUES SHOWN IN FEET.

MKE DOCUMENT NO. 5025-HAT-X-04-00209-00

XYL 32D.

35 pts

UMTRA-HAT UPPER PILE EXCAVATION

GMB 2-3-87
KLO 6/23/87.

From Ref. 3.

HOLE ID		EAST COOR	NORTH COOR	DEPTH TO 15pCi/g
A1	1	8720	9120	6.9
	2	8640	9345	N/A
	3	8605	9140	N/A
	4	8755	9490	N/A
A5	5	8840	9070	6
A6	6	8845	9440	8.9
A7	7	8780	9275	10.8
A8	8	8990	9375	13.7
A9	9	8925	9205	10
A10	10	8825	9640	7.5
	11	9075	9145	N/A
B12	12	9205	9480	15.5
	13	9060	8990	N/A
B14	14	9355	9420	27.8
B15	15	9150	8920	19.8
B16	16	9550	9480	35
B17	17	9290	8855	24
B18	18	9415	9570	23.1
B19	19	9470	8775	25.8
A20	20	9145	9315	17.5
B21	21	9415	8620	14
B22	22	9280	9250	18.3
B23	23	9220	8690	19.5
B24	24	9430	9190	29.5
A25	25	9010	8595	8.8
B26	26	9570	9130	35.6
A27	27	9070	8745	16.9
B28	28	9130	8470	13.8
A29	29	8945	8410	9.1
B30	30	9500	8960	31.8
B31	31	9360	9025	28.8
B32	32	9645	9295	39.3
B33	33	9215	9085	22
A34	34	9275	9635	24.8
B35	35	9510	9340	31.2
A36	36	9125	9685	23.4
A37	37	8985	9580	14.4
	38	8955	9710	N/A
B86	86	9720	9170	39.8
B88	88	9605	9000	36.8
B93	93	9665	9420	35.5

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MAY 05 1986
UMTRA-S.F.

UMTRA-HAT
UPPER PILE EXCAVATION

GMB 2-3-87
KLO 6/23/87

From Ref. 1

UPPER PILE

DEPTHS TO PHYSICAL INTERFACE TABLE

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
I = 1			21.6	23.8	21.3	33.8	34.6	
I = 2		5.5	12.6	15.8	26.8	29.4	37.5	38.8
I = 3		7.1	12.2	-1.8	16.5	27.7	33.8	25.8
I = 4		9.8	8.5		19.8	27.8	38.8	35.8
I = 5		5.1	3.9		17.8	22.8	24.8	
I = 6					-1.8	17.6	12.5	
I = 7					7.8	12.8	-1.8	
I = 8						7.3		

UMTRA-HAT
UPPER PILE EXCAVATION

upper pile

GMB 2-3-87
KLO 6/23/87

DEPTHS TO 15 pCi/g INTERFACE TABLE

From. Ref 1

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
I = 1			23.4	24.8	23.1	35.8	35.5	
I = 2		7.5	14.4	15.5	27.8	31.2	39.3	39.8
I = 3		8.9	13.7	17.5	18.3	29.5	35.6	26.8
I = 4		18.8	18.8		22.8	28.8	31.8	36.8
I = 5		6.9	6.8		19.8	24.8	25.8	
I = 6					16.9	19.5	14.8	
I = 7					8.8	13.8	14.2	
I = 8						9.1		

UMTRA-HAT
UPPER PILE EXCAVATION
GMB. 2-3-87
KCO 6/23/87

UPPER PILE

DEPTHS FROM PHYSICAL TO 15 pCi/g INTERFACE TABLE

From Ref. 1

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
= 1			1.8	1.8	1.8	2.8	8.9	
= 2		2.8	1.8	8.5	1.8	1.8	1.8	1.8
= 3		1.8	1.5	1.8	1.8	1.8	1.8	1.8
= 4		1.8	1.5		3.8	1.8	1.8	1.8
= 5		1.8	2.1		2.8	2.8	1.8	
= 6					1.8	1.9	1.5	
= 7					1.8	1.8	1.8	
= 8						1.8		

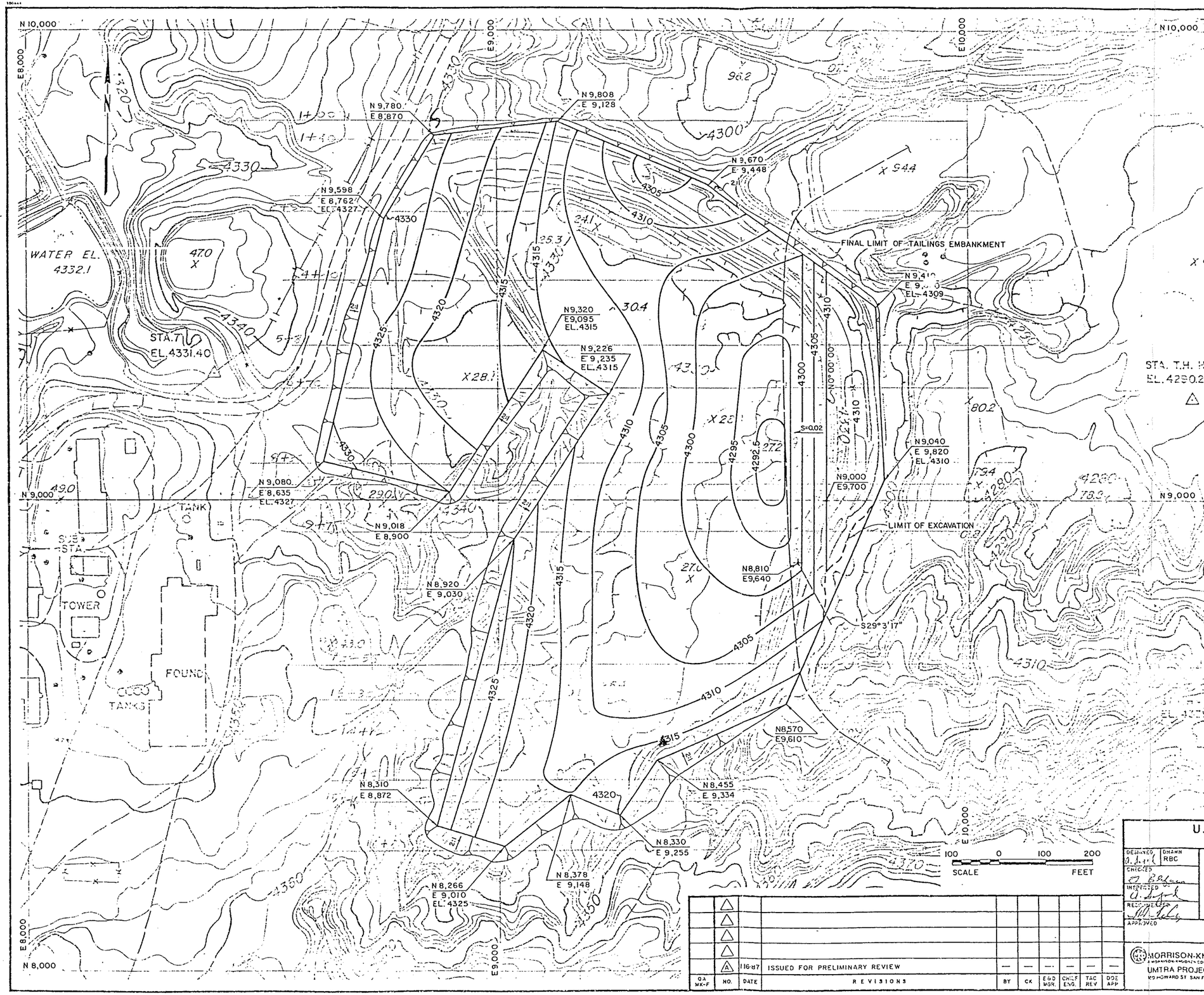
	ABOVE PHYSICAL INTERFACE	ABOVE 15 pCi/g INTERFACE
OTAL VOLUME (cy)	763580	834528
OTAL VOLUME (ftJ)	2.86167E+07	2.25322E+07
EPTH (ft)	19.4556	21.2633
OTAL ACTIVITY (Ci)	561.687	597.283
VERAGE ACTIVITY (pCi/g)	641.322	623.984

VERAGE DEPTH FROM PHYSICAL INTERFACE TO 15 pCi/g INTERFACE IS 1.80769 FEET (BASED ON 13 VALUES)

VERAGE PILE ACTIVITY PROFILE

DEPTH	ABOVE PHYSICAL INTERFACE		ABOVE 15 pCi/g INTERFACE		TOTAL PILE	
(FT)	VOLUME	ACTIVITY	VOLUME	ACTIVITY	VOLUME	ACTIVITY
0.0 - 2.5	98,119	430	98,119	430	98,119	430
2.5 - 5.0	96,952	479	98,119	476	98,119	476
5.0 - 7.5	89,633	503	95,899	487	98,119	485
7.5 - 10.0	79,556	712	86,785	665	98,119	592
10.0 - 12.5	75,896	719	77,768	710	98,119	576
12.5 - 15.0	63,751	728	71,678	687	98,119	523
15.0 - 17.5	54,952	775	60,989	718	98,119	453
17.5 - 20.0	46,779	782	53,151	715	98,119	487
20.0 - 22.5	42,324	778	47,283	756	98,119	373
22.5 - 25.0	33,944	869	40,120	837	98,119	372
25.0 - 27.5	27,849	720	31,945	694	98,119	244
27.5 - 30.0	20,791	577	25,058	584	98,119	184
30.0 - 32.5	15,911	503	19,110	512	98,119	127
32.5 - 35.0	12,092	869	15,911	893	98,119	157
35.0 - 37.5	5,384	1191	8,396	870	98,119	110
37.5 - 40.0	530	776	4,365	784	98,119	52
40 - 42.5	0	0	0	0	98,119	15
42.5 - 45.0	0	0	0	0	98,119	15

KLO 6/23/87



NOTES:

1. ALL EXCAVATED CUT SLOPES SHALL BE 2(H):1(V) MAXIMUM.
2. COORDINATES SHOWN ARE ESTIMATED LIMIT OF EXCAVATION. FINAL EXCAVATION LIMITS WILL BE DETERMINED BY THE CONTRACTOR DURING CONSTRUCTION
3. EXCAVATION WITHIN THE FINAL TAILINGS EMBANKMENT DOES NOT EXTEND TO THE BOTTOM OF THE TAILINGS. THE SUBCONTRACTOR SHALL EXCAVATE TO THE LIMITS SHOWN IN THIS AREA.

REFERENCE DRAWINGS:

LEGEND:

LIMIT OF CUT

PRELIMINARY REVIEW		
E & D MANAGER	CHIEF ENGINEER	QA MANAGER
	S.S. Smith	

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	TAC REV	DOE APP
	A	11-6-87	ISSUED FOR PRELIMINARY REVIEW	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED | DRAWN RBC | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE | DOE PROJECT ENGINEER | DATE

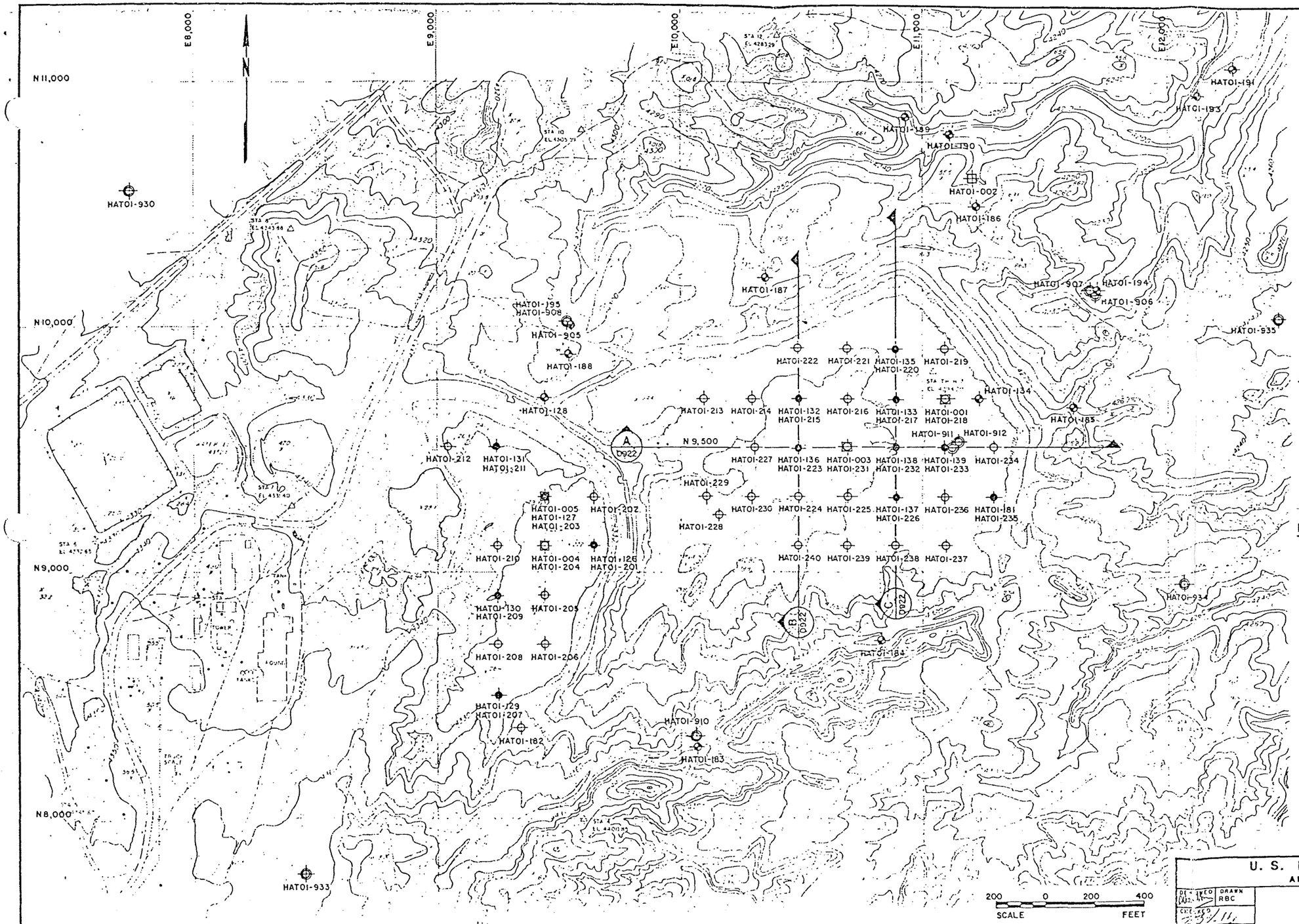
MEXICAN HAT SITE
MEXICAN HAT, UTAH
PHASE II CONSTRUCTION

UPPER TAILINGS PILE EXCAVATION PLAN

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. HAT-PS-10-0955 REV. A



NOTES:

1. GEOTECHNICAL INVESTIGATIONS WERE CONDUCTED BY DOE IN LATE 1984 AND EARLY 1985. A TOTAL OF 40 PIEZOCONE SOUNDINGS, 17 BORINGS AND FOUR TESTS PITS WERE MADE ON THE EXISTING TAILINGS PILES. ADDITIONAL 27 BORINGS AND ONE TEST PIT WERE MADE IN THE VICINITY OF THE PILES. FOURTEEN OF THE BORINGS WERE CASED AND COMPLETED AS MONITORING WELLS. THREE BORINGS AND FOUR MONITORING WELLS WHICH ARE LOCATED AWAY FROM THE TAILINGS PILE AREA ARE NOT SHOWN HERE. (REF. DOC. NOS. 5025-HAT-R-03-00198-00/SECT. 3.4 AND D4, 5025-HAT-X-09-00088-00, 5025-HAT-D-04-00080-00 AND 5025-HAT-C-09-00315-00).

REFERENCE DRAWINGS:

HAT-PS-10-0922 GEOLOGIC CROSS SECTIONS

LEGEND:

- PIEZOCONE SOUNDINGS
- BORINGS
- BORING AND PIEZOCONE SOUNDING IN SAME LOCATION
- TEST PITS
- TEST PIT AND PIEZOCONE SOUNDING IN SAME LOCATION
- TEST PIT, BORING AND PIEZOCONE SOUNDING IN SAME LOCATION
- MONITORING WELLS

PRELIMINARY REVIEW		
E & D MANAGER	CHIEF ENGINEER	QA MANAGER

QA MGR	NO	DATE	REVISIONS	BY	CK	E & D MGR	CHIEF ENG	TEC REV	DOE APP
	4	16-87	ISSUED FOR PRELIMINARY REVIEW	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT SITE
MEXICAN HAT, UTAH

BORING LOCATION PLAN

DRAWN RBC
CHECKED
INSPECTED
RECOMMENDED
APPROVED

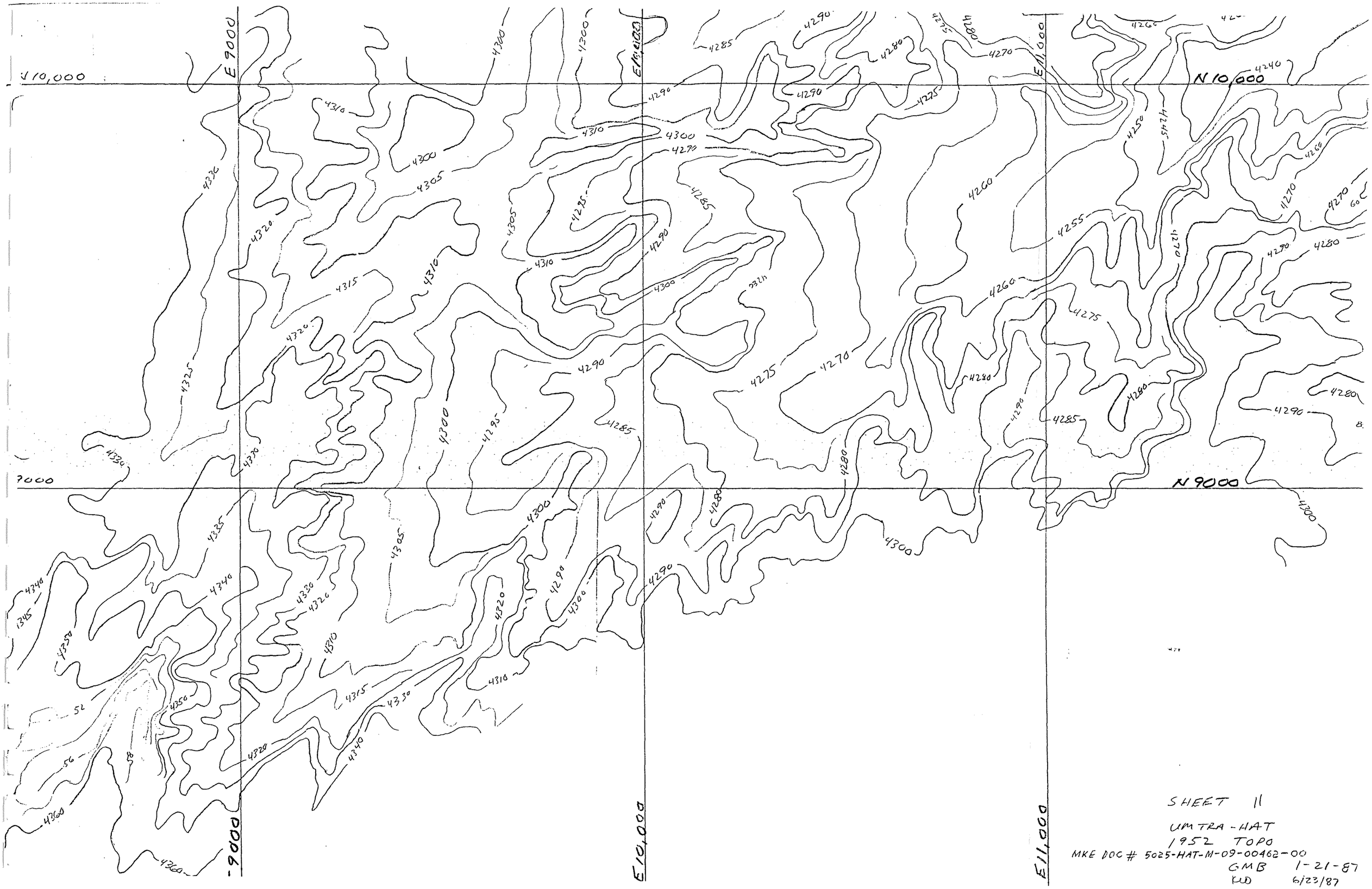
DATE

DOE PROJECT ENGINEER DATE

MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. HAT-PS-10-0921 REV 4



SHEET 11

UMTRA-HAT
1952 TOPO
MKE DOC # 5025-HAT-M-09-00462-00
GMB 1-21-87
KLD 6/23/87

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - HAT
Feature TAILING EXCAVATION
Item UPPER PILE - QUANTITY

Contract No. 5025
Designed GMB
Checked KLD

Sheet
File No.
Date 2-2-87
Date 6/23/87

QUANTITY ESTIMATE

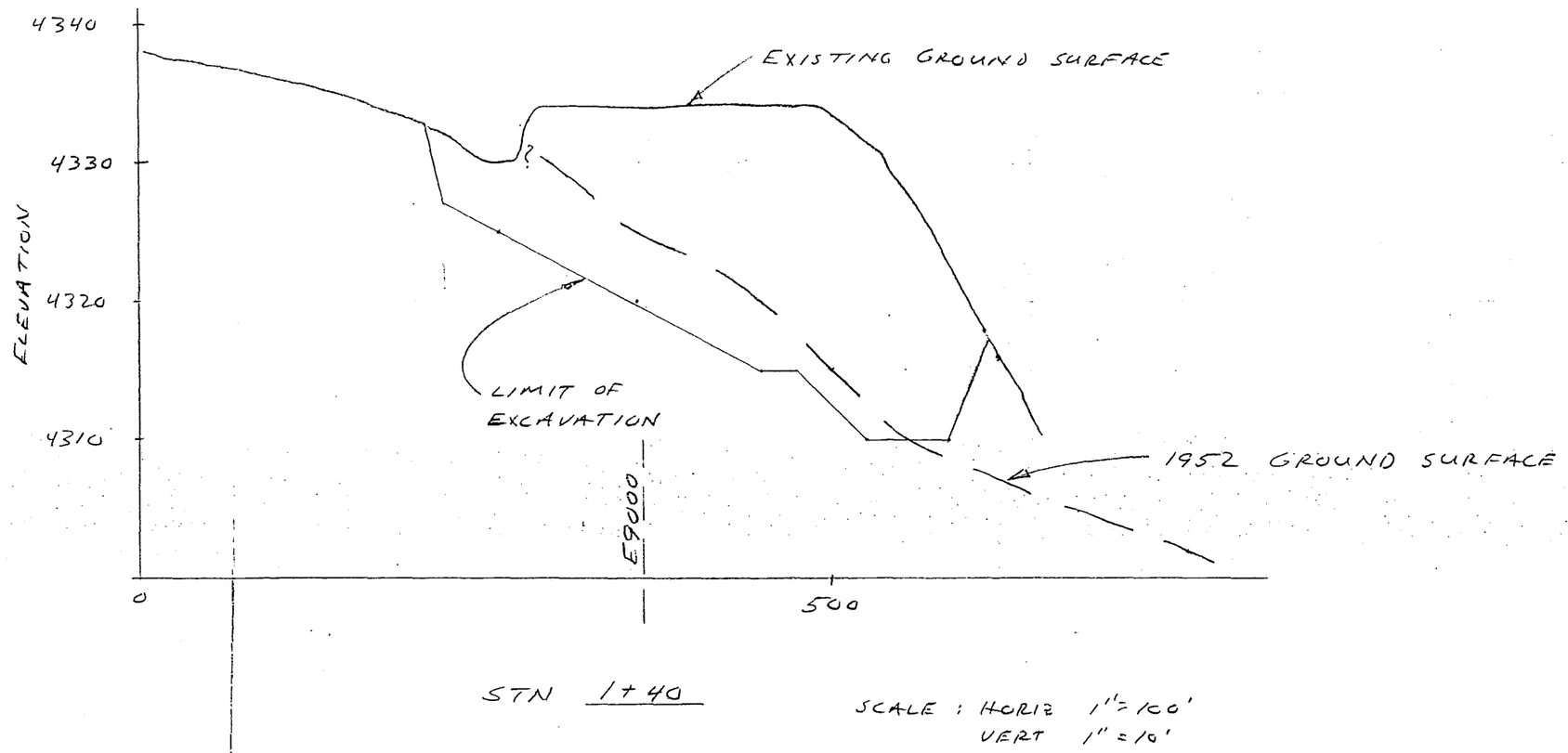
UPPER PILE TAILINGS EXCAVATION QUANTITY

STATION	DISTANCE (ft)	END AREA (sf)	DOUBLE END AREA (sf)	EXCAVATION VOLUME (cy)
1+00		0		
	40		5660	4190
1+40		5660		
	155		18,960	54,420
2+95		13,300		
	145		33,720	90,540
4+40		20,420		
	140		43,850	113,690
5+80		23,430		
	90		44,010	73,350
6+70		20,580		
	160		40,390	119,670
8+30		19,810		
	45		38,970	32,470
8+75		19,160		
	100		37,680	69,780
9+75		18,520		
	280		31,540	163,540
12+55		13,020		
	75		24,380	33,860
13+30		11,360		
	80		20,110	29,790
14+10		8750		
	90		15,480	25,800
15+00		6730		
	45		12,600	10,500
15+45		5870		
	105		5870	11,410
16+50		0		
			TOTAL	833,010 cy

SHEET 13

UMTRA-HAT
UPPER PILE
EXCAVATION

GMB 1-27-87
KLO 6/23/87



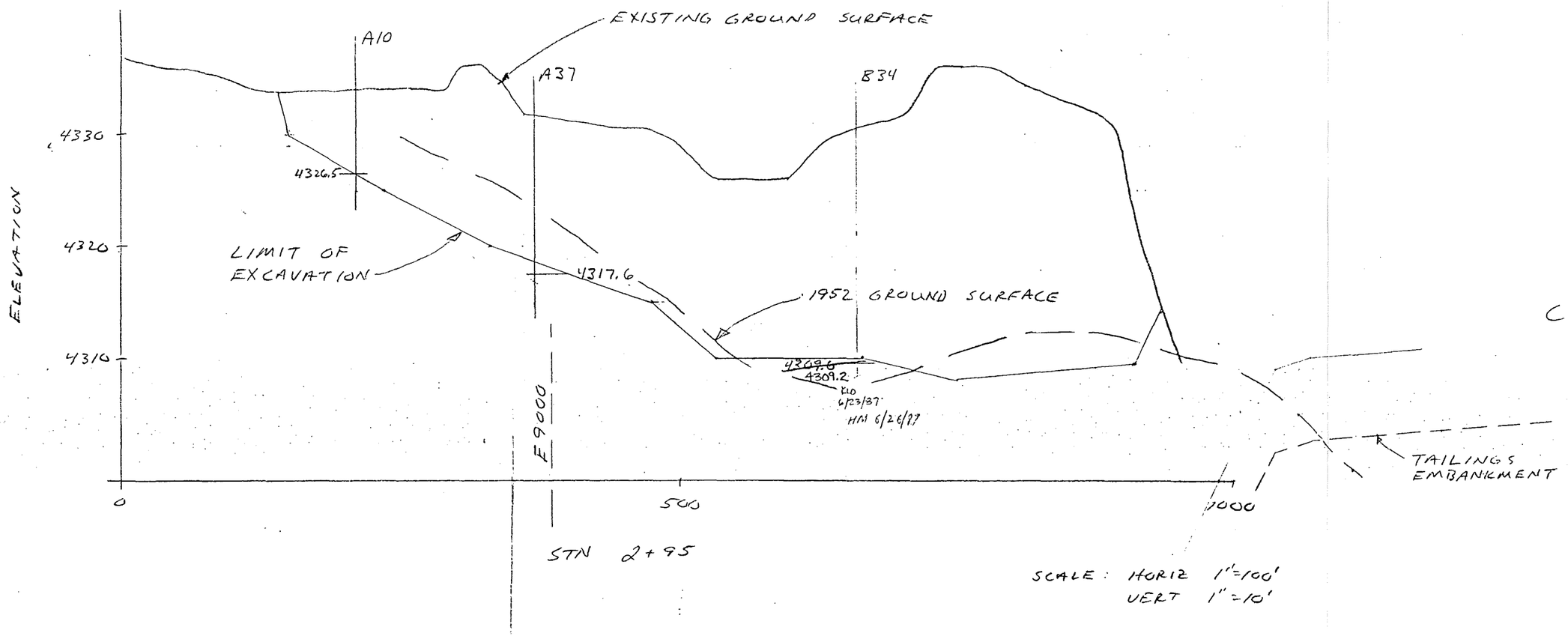
CUT = 5660 sf

STN 1+40

SHEET 14

UMTRA-HAT
UPPER PILE
EXCAVATION

GMB 1-27-87
KLO 6/23/87



CUT: 13,300 sf

LEGEND

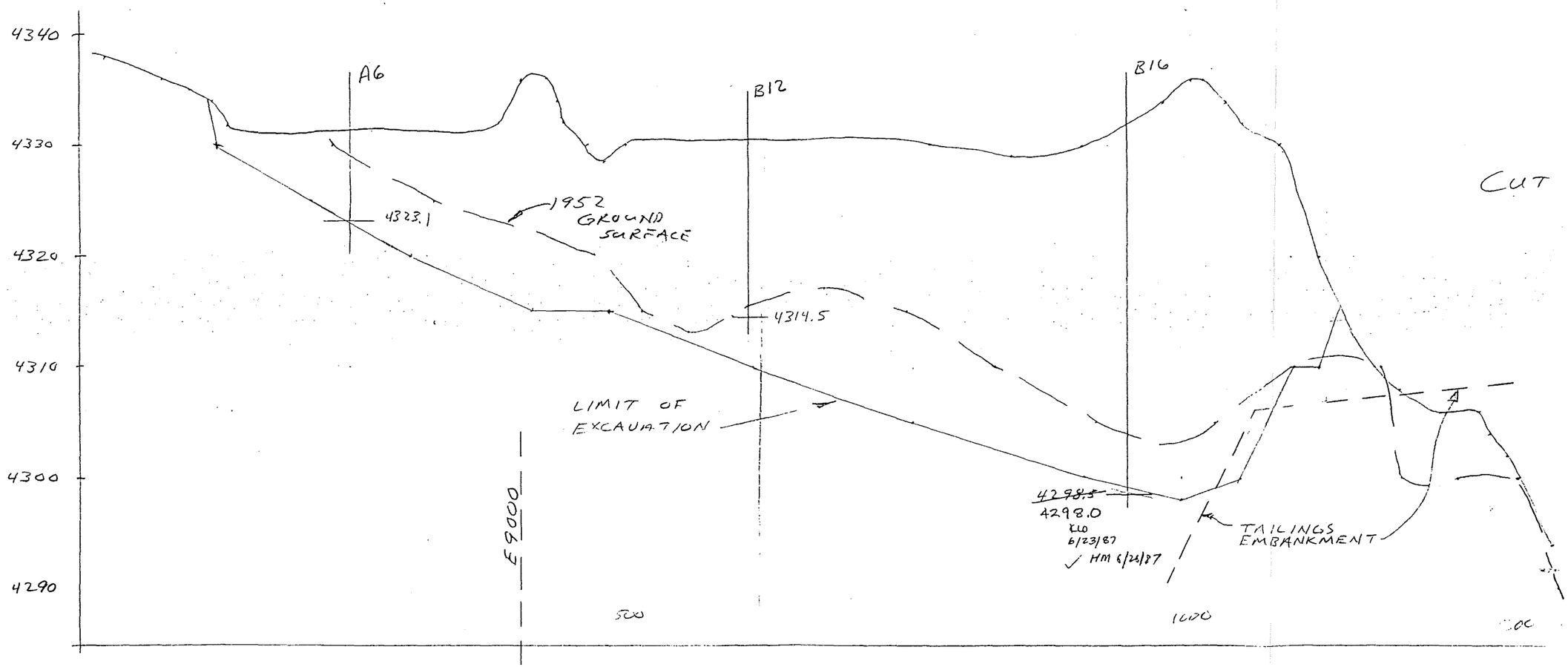
A10 BOREHOLE A10

4326.5 ELEVATION OF 15 pCi/g INTERFACE

STN 2+95

UMTRA-HAT
UPPER PILE
EXCAVATION

GMB 1-28-87
KLO 6/23/87
SHEET 15



CUT 20,420 sf

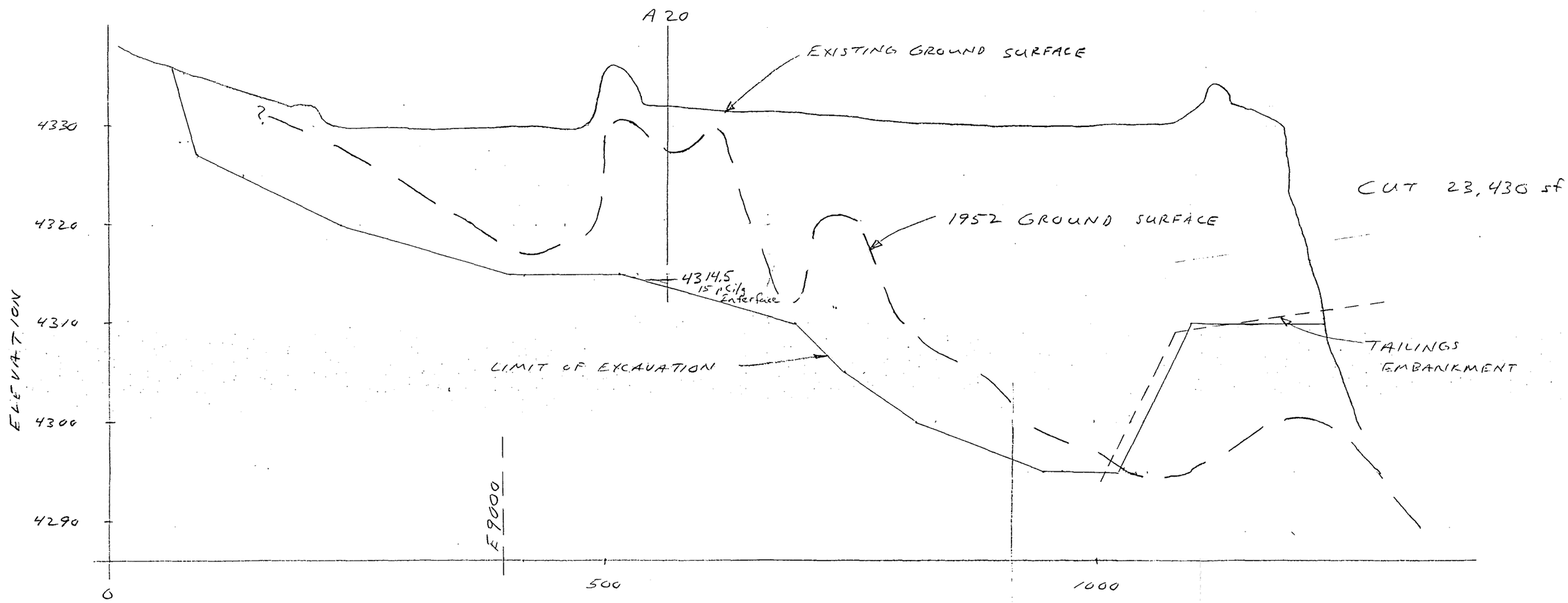
STN 4+40

SCALE: HORIZ 1" = 100'
VERT. 1" = 10'

STN 4+40

SHEET 16

UMTRA-HAT GMB 1-27-87
UPPER MILE KLO 6/23/87
EXCAVATION



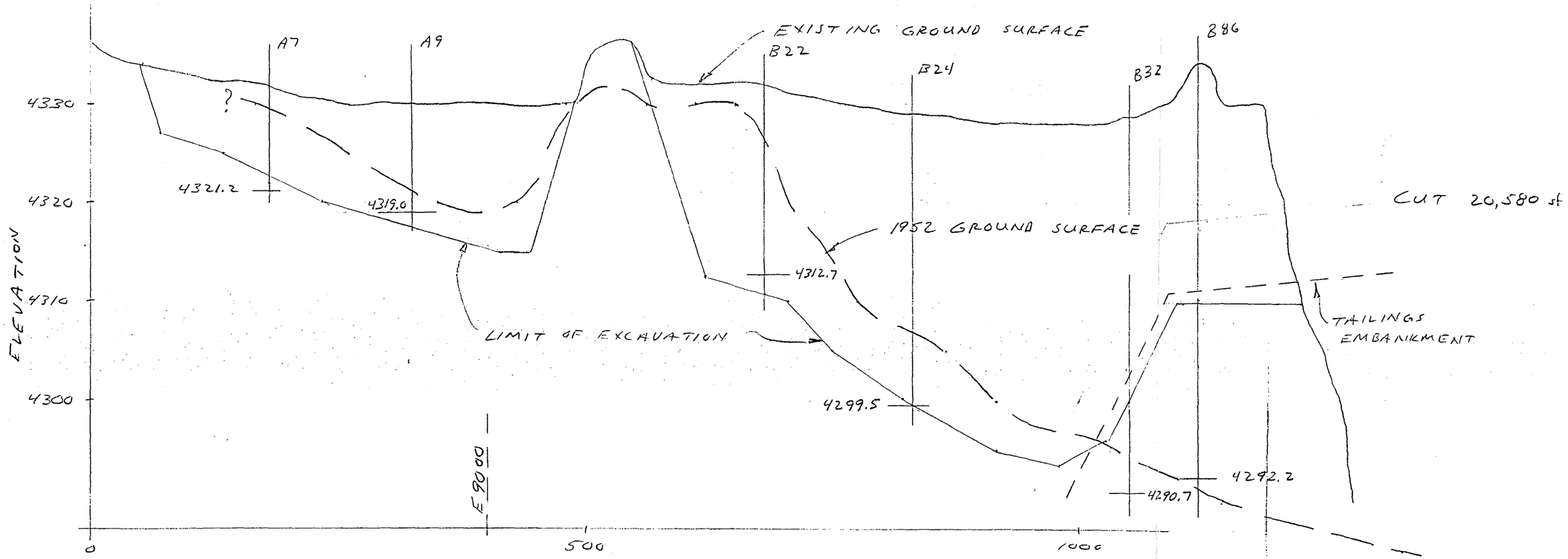
STN 5+80

SCALE: HORIZ 1" = 100'
VERT 1" = 10'

STN 5+80

UMTRA-HAT
UPPER PILE
EXCAVATION

SHEET 17
GMB 1-27-87
KWO 6/23/87



STN 6+70

SCALE: HORIZ 1" = 100'
VERT. 1" = 10'

STN 6+70

UMT 4812

9.13.1.1

UMTRA - DOE/AL -050509
.0000

United States Department of Energy

SURF008888

Remedial Action Plan for the Codisposal and Stabilization of the Monument Valley and Mexican Hat Uranium Mill Tailings at Mexican Hat, Utah

Bid Schedule
Special Conditions
Specifications
Subcontract Drawings

Final

February 1993

Appendix B of the
Cooperative Agreement
No. DE-FC04-83AL16258

Uranium Mill Tailings Remedial Action Project

MON605.02.02 Ex2
SMON131.1

UMTRA PROJECT - COMPLETION OF MEXICAN HAT, UT
AND MONUMENT VALLEY, AZ
SUBCONTRACT DOCUMENTS HAT-MON
FINAL DESIGN FOR CONSTRUCTION
AUGUST 1992

0170S/WP51
080392

NOTICE OF LIMITED DISTRIBUTION

THIS DRAFT DOCUMENT IS PART OF THE DELIBERATIVE PROCESS OF THE U.S. DEPARTMENT OF ENERGY (DOE) IN ITS DECISION-MAKING FUNCTION UNDER THE URANIUM MILL TAILINGS RADIATION CONTROL ACT OF 1978, THE NATIONAL ENVIRONMENTAL POLICY ACT, AND OTHER APPLICABLE LAW. IT IS PROVIDED TO THE RECIPIENT PARTICIPATING FEDERAL OR STATE AGENCY OR INDIAN TRIBE WITH THE EXPRESS UNDERSTANDING THAT IT IS ONLY TO BE USED FOR THE PURPOSE OF PROVIDING THE DOE WITH INPUT TO SUCH DECISION-MAKING PROCESS. THE RECIPIENT PARTICIPATING FEDERAL OR STATE AGENCY EXPRESSLY AGREES TO LIMIT DISTRIBUTION OF THIS DOCUMENT TO THOSE EMPLOYEES WHO WILL PROVIDE INPUT TO THE DOE.

UMTRA PROJECT

SUBCONTRACT DOCUMENTS HAT-MON

MEXICAN HAT, UTAH AND MONUMENT VALLEY, ARIZONA

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Section 00310, Rev. [1]* - Bid Schedule

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Section 00800, Rev. [1]* - Special Conditions

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01019, Rev. [1]* - Mobilization
01025, Rev. 0 - Measurement and Payment
01052, Rev. 0 - Layout of Work and Surveys
01300, Rev. [1]* - Submittals
01500, Rev. [1]* - Construction Facilities
01560, Rev. [1]* - Temporary Controls
01561, Rev. 0 - Construction Cleaning

DIVISION 2 - SITEWORK

Section 02050, Rev. [1]* - Demolition
02110, Rev. 0 - Site Clearing
02141, Rev. 0 - Dewatering and Drainage
02200, Rev. [1]* - Earthwork
02228, Rev. [1]* - Radon Barrier
02278, Rev. [1]* - Erosion Protection
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* P.I.D. 09-S-15

SUBCONTRACT DRAWINGS

Drawing No.	Title
General	
H/M-GE-10-0201, Rev. 0	Title Sheet
H/M-GE-10-0202, Rev. [1]*	Vicinity Maps, Location Map and List of Drawings
H/M-GE-10-0203, Rev. 0	Haul Road Corridor and Borrow Area Locations
H/M-GE-10-0204, Rev. [1]*	Riprap Borrow Areas
H/M-GE-10-0205, Rev. 0	Radon Barrier Material Borrow Areas and Gypsum Wash Crossing
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H/M-DS-10-0211, Rev. 0	HAT - Contaminated Material Excavation Plan
H/M-DS-10-0212, Rev. 0	Tailings Embankment Plan
H/M-DS-10-0213, Rev. 0	Tailings Embankment Plan and Ditch Sections and Details
H/M-DS-10-0214, Rev. 0	HAT - Final Site Grading Plan
H/M-DS-10-0215, Rev. [1]*	Tailings Embankment Sections and Details (Sheet 1 of 2)
H/M-DS-10-0216, Rev. [1]*	Tailings Embankment Sections and Details (Sheet 2 of 2)
H/M-DS-10-0217, Rev. [1]*	HAT - Site Drainage Sections and Details (Sheet 1 of 2)
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H/M-DS-10-0219, Rev. 0	HAT - Erosion Protection Plan and Sections

* P.I.D. 09-S-15

SUBCONTRACT DRAWINGS (cont'd.)

Drawing No.	Title
H/M-DS-10-0220, Rev. 0	HAT - Gully Details
H/M-DS-10-0221, Rev. 0	HAT - Boring Location Plan
Monument Valley	
H/M-PS-10-0230, Rev. 0	MON - Site Plan
H/M-PS-10-0231, Rev. 0	MON - Construction Facilities and Site Drainage
H/M-PS-10-0232, Rev. 0	MON - Contaminated Material Excavation Plan (Sheet 1 of 2)
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H/M-PS-10-0234, Rev. 0	MON - Final Site Grading and Drainage (Sheet 1 of 2)
H/M-PS-10-0235, Rev. 0	MON - Final Site Grading and Drainage (Sheet 2 of 2)
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Bid Schedule

SECTION 00310

BID SCHEDULE

Name of Bidder _____ Date: _____

Following are the prices bid for completion of the Work as required by the Subcontract Documents:

Item No.	Spec. Section	Description*	Unit	Estimated Quantity	Unit Price	Amount
000 - MOBILIZATION						
[001H	01019	Phase I Mobilization - HAT	L.S.	100%	N/A	_____
001M	01019	Phase I Mobilization - MON	L.S.	100%	N/A	_____
002H	01019	Phase II Mobilization - HAT	L.S.	100%	N/A	_____
002M	01019	Phase II Mobilization - MON	L.S.	100%	N/A	_____
003H	01019	Phase III Mobilization - HAT	L.S.	100%	N/A	_____
003M	01019	Phase III Mobilization - MON	L.S.	100%	N/A	_____
004H	01019	Demobilization - HAT	L.S.	100%	N/A	_____
004M	01019	Demobilization - MON	L.S.	100%	N/A	_____]**
005	00800	Payment for Bond Premium	L.S.	100%	N/A	_____
200 - SITE PREPARATION						
[201H	01500	Temporary Offices - HAT	L.S.	100%	N/A	_____
201M	01500	Temporary Offices - MON	L.S.	100%	N/A	_____]**
202	01500	Temporary Roads including Monument Valley Bypass Road and Parking Areas	L.S.	100%	N/A	_____

** P.I.D. 09-S-15

Item No.	Spec. Section	Description*	Unit	Estimated Quantity	Unit Price	Amount
[203H	01500	Temporary Sanitary Facilities - HAT	L.S.	100%	N/A	_____
203M	01500	Temporary Sanitary Facilities - MON	L.S.	100%	N/A	_____
204H	01500	Temporary Electric Power - HAT	L.S.	100%	N/A	_____
204M	01500	Temporary Electric Power - MON	L.S.	100%	N/A	_____
205H	01500	Temporary Water - HAT	L.S.	100%	N/A	_____
205M	01500	Temporary Water - MON	L.S.	100%	N/A	_____
206H	01500	Decontamination System - HAT	L.S.	100%	N/A	_____
206M	01500	Decontamination System - MON	L.S.	100%	N/A	_____
207H	01500	Janitorial Services - HAT	Month	30	_____	_____
207M	01500	Janitorial Services - MON	Month	30	_____	_____]**
208	01500	Gypsum Wash Crossing	L.S.	100%	N/A	_____
209	02050	Demolition and Disposal of Structures	L.S.	100%	N/A	_____
210	02050	[Removal and Disposal of Rubble and Ore in Embankment]**	L.S.	100%	N/A	_____

[Text Deleted]**

<u>400 - TAILINGS PILE</u>

401	02200	Placement in the Tailings Embankment of all Contaminated and Other Materials Including Demolished Materials, Debris, Rubble and Vicinity Property Materials	C.Y.	1,096,000	_____	_____

** P.I.D. 09-S-15

Item No.	Spec. Section	Description*	Unit	Estimated Quantity	Unit Price	Amount
402	02200	Fine Grading of Existing Side Slopes of the Tailings Embankment	Acre	12	_____	_____
403	02200	Cleanup of Rock Surfaces at the Mexican Hat and Monument Valley Sites	Acre	74	_____	_____
404	02200	Furnish and Install New Displacement Monuments	Each	3	_____	_____
500 - COVER						
501	02228	Furnish and Place Radon Barrier Material	C.Y.	224,800	_____	_____
502	02228	Furnish Bentonite	Ton	33,600	_____	_____
600 - EROSION PROTECTION						
601	02278	Furnish and Place Riprap Material, Type A	C.Y.	47,000	_____	_____
602	02278	Furnish and Place Riprap Material, Type B	C.Y.	50,500	_____	_____
603	02278	Furnish and Place Riprap Material, Type C	C.Y.	12,000	_____	_____
604	02278	Furnish and Place Bedding Material	C.Y.	60,600	_____	_____
800 - SITE RESTORATION						
801	02200	Rock Excavation for Finish Grading of the Mexican Hat Site Including Ditches and Gullies and Grinding or Planing of Rock Adjacent to the North Ditch	C.Y.	4,700	_____	_____
802	02200	Uncontaminated Material Fill for Finish Grading of the Mexican Hat and Monument Valley Sites	C.Y.	53,500	_____	_____

Item No.	Spec. Section	Description*	Unit	Estimated Quantity	Unit Price	Amount
803	02200	Rockfill Selected by Contractor for Finish Grading of Mexican Hat Site	C.Y.	1,500	_____	_____
804	02935	Seeding of Final Grades	Acre	43	_____	_____
[PART B - VICINITY PROPERTY MH-024						
1.0	-	Machine Excavation	C.Y.	433	_____	_____
1.1	-	Hand Excavation	C.Y.	20	_____	_____
3.0	-	Safety Barricades, Netting	L.S.	1	_____	_____
24.1	-	Temporary Access Road Mobilization	L.S.	1	_____	_____
24.2	-	Temporary Access Road Demobilization	L.S.	1	_____	_____

(Part B - Applicable Technical Specifications:

Section 02110 - Clearing and Grubbing, Revision 0
Section 02130 - Contaminated Material Removal, Revision 0
Section 02200 - Excavation and Backfill, Revision 0
Section 02480 - Landscaping, Revision 0)]**

TOTAL SUBCONTRACT PRICE $_____

* For complete description of a Bid Item and measurement and payment provisions, see Part 4 of the Specification Section cited.

END OF SECTION 00310

** P.I.D. 09-S-15

SECTION 00800

SPECIAL CONDITIONS

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SC-4	SITE LOCATION AND ACCESS
SC-5	COORDINATION OF WORK
SC-6	CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
SC-7	CONSTRUCTION ENVIRONMENT, SAFETY AND HEALTH
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SC-20	MEASUREMENT AND PAYMENT
SC-21	WORK HOURS
SC-22	CONTAMINATED MATERIALS HAUL INSURANCE REQUIREMENTS
[SC-23	BULLETIN BOARDS]*

* P.I.D. 09-S-15

SC-1 DEFINITIONS

A. Wherever used in the Subcontract Documents the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

1. Access Control Area - Access control area shall include the areas occupied by and in the immediate vicinity of the access gates and including, but not limited to, Contractor's and Subcontractor's office trailers, access control trailer, sanitary facilities, decontamination pad and its contaminated water collection sump, equipment and materials laydown and storage area, employee and service vehicle parking area, roadway connecting vehicular gate to decontamination pad.

2. Addenda - Written and/or graphic instruments issued prior to opening of Bids which clarify, correct or change the bidding documents.

3. ALARA - The designation 'ALARA' is an acronym for "as low as reasonably achievable".

4. Bid - The offer or proposal of the bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

5. Bonds - Bid, performance and payment bonds.

6. Construction Facilities - Construction facilities shall include temporary facilities required during construction phase of the permanent facilities. These facilities are specified in Section 01500.

7. Contaminated Materials - Tailings and other materials having radioactive contamination levels greater than specified in the applicable US Environmental Protection Agency Standards, or limits specified for free release of demolished materials and debris. Contamination levels, which may be based on radium, thorium or other radionuclides, shall be as determined by the Contractor. These standards are presented in the Federal Register, 48FR602, January 5, 1983: "Standards for Remedial Actions at Inactive Uranium Processing Sites" and for demolished materials and debris, in applicable limits available from the Contractor.

8. Controlled Area - Areas of elevated gamma, surface contamination and/or airborne radionuclide levels. These areas are generally radiologically posted and

require restricted access, some may have localized restrictions; as determined by the Contractor.

9. Day - Day shall mean a calendar day of 24 hours.

10. Fiscal Year - October 1 through September 30.

11. General Requirements - Division 1 of the Specifications.

12. Hazardous Waste - Any material, alone or mixed with other materials, which has no commercial use or value, or which is discarded or is to be discarded by the possessor thereof, either of which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or to the environment when improperly treated, stored, transported, disposed of, or otherwise managed. The term does not include: discharges which are point sources subject to permits under Section 402 of the "Federal Water Pollution Control Act:, as amended; source, special nuclear, or byproduct material as defined by the Federal "Atomic Energy Act of 1954", as amended; agricultural waste from the raising of crops or animals, including animal manures, which are returned to the soils as fertilizers or soil conditioners; domestic sewage; irrigation return flows; inert materials deposited for construction for fill or topsoil placement in connection with actual or contemplated construction at such location or for changes in land contour for agricultural and mining purposes; or any waste or other materials exempted or otherwise not regulated as a hazardous waste under the federal act.

13. Lower-Tier Subcontractor/Other Subcontractor:

    a. Lower-tier Subcontractor - An individual firm or corporation having a direct contract with the Subcontractor.

    b. Other Subcontractor - An individual firm or corporation (other than the Subcontractor) having a direct contract with the Contractor for other work on the Project.

14. Notice of Award - The written notice by Contractor to the apparent successful bidder stating that upon compliance by the apparent successful bidder with the

conditions precedent enumerated therein, within the time specified, Contractor will sign and deliver the Agreement.

15. Notice to Proceed - A written notice given by Contractor to Subcontractor fixing the date on which the Subcontract Time will commence to run and on which Subcontractor shall start to perform Subcontractor's obligations under the Subcontract Documents.

16. Permanent Facilities - Permanent facilities shall include permanent features of the Project including, but not limited to, the following: demolition of structures and disposal of demolished materials and debris; abandonment and relocation of existing utilities; construction of tailings embankment; construction of permanent drainage ditches; finish grading; and seeding.

17. Project - The total construction of which the Work to be provided under these Subcontract Documents is a part as indicated elsewhere in the Subcontract Documents.

18. Project Site/Site/Jobsite: The Project Site or Site shall include the areas occupied by Monument Valley tailings site, Arizona including windblown outside of the site and tailings embankment (disposal) site at Mexican Hat, Utah including windblown and waterborne areas outside of the existing fence.

19. Shop Drawings - All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for Subcontractor to illustrate some portion of the Work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a Supplier and submitted by Subcontractor to illustrate material or equipment for some portion of the Work.

20. Site Manager - The authorized representative of the Contractor who is assigned to the site or any part thereof.

21. Specifications - Those portions of the Subcontract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

22. Subcontract Change Notice/Change Order - A document signed by Subcontractor and Contractor authorizing an addition, deletion, revision, or clarification of the

Work, modified in writing and issued on or after the Effective Date of the Agreement.

23. Subcontract Drawings - The drawings which show the character and scope of the Work to be performed and which are referred to in the Subcontract Documents.

24. Subcontract Modification - A document issued to incorporate Subcontract Change Notices/Change Orders and adjustments in the Subcontract Price or Subcontract Time or to modify Subcontract.

25. Subcontract Price - The moneys payable by Contractor to Subcontractor under the Subcontract Documents as stated in the Agreement.

26. Subcontract Time - Duration of time specified in the Subcontract Agreement Form for the completion of the Work under the Subcontract. The time shall commence from the date or the day specified in the written Notice to Proceed, and may be specified in terms of number of calendar days available to complete the Work.

27. Tailings Embankment - See Section 02200, Article 1.4.

28. Temporary Facilities - See Construction Facilities in Paragraph 6 above.

29. Temporary Roads - Improvements to existing roads and construction of new roads including, but not limited to, the following; and improvements to existing roads and construction of new roads, if any, for the Subcontractor's convenience in the performance of the Subcontract.

    a. Access/haul road along existing Indian Service Route 6440 connecting Monument Valley and Mexican Hat sites.

    b. Maintain a Bypass Road at Monument Valley site as shown on the Subcontract Drawings.

    c. Maintain a Bypass Road at Halchita as shown on the Subcontract Drawings.

30. Uncontaminated Materials - All materials having radioactive contamination levels less than specified in the applicable US Environmental Protection Agency Standards, or limits specified for free release of demolished materials and debris. Contamination levels which may be based on radium, thorium or other

radionuclides shall be as determined by the Contractor. These standards are presented in the Federal Register, 48FR602, January 5, 1983: "Standards for Remedial Actions at Inactive Uranium Processing Sites" and for demolished materials and debris, in applicable limits available from the Contractor.

31. Uncontrolled Hazardous Waste Site - An area where an accumulation of hazardous substance creates a threat to the health and safety of individuals or the environment or both. Uranium mill tailings that have a total specific activity above 2000 pCi/g are classified as a Hazardous Substance by the Department of Transportation.

32. Work - The entire completed construction required under the Subcontract Documents. Work is the result of performance of services, furnishing labor and furnishing and incorporating materials and equipment into the construction, all as required by the Subcontract Documents.

B. The other terms such as Contractor, Subcontractor, Government, DOE, Subcontract Administrator, Subcontract Documents, MK-F and Site of Work are defined in Article GP-2 of General Provisions.

SC-2 HOLIDAYS

A. The following days will be observed as holidays by MK-Ferguson Company, and shall be observed by the Subcontractor and lower tier subcontractors:

Navajo Memorial Day
Pioneer Day
New Year's Day
Presidents' Day
Memorial Day
Independence Day
Labor Day
Veteran's Day
Thanksgiving Day
Christmas Day

B. Holidays occurring on Friday, Saturday or Sunday will be observed on a day designated by the Contractor.

SC-3 CONSTRUCTION RESTRAINTS

A. Concurrent Work: MK-Ferguson Company (Contractor) and other subcontractors may be engaged in work in the general areas covered by the Work under this Subcontract. Such personnel will have access to the areas and to the utilities. The Subcontractor shall cooperate and coordinate his work to best utilize the available areas, roadways and facilities. Coordination shall be through the Contractor.

B. During the course of this Subcontract, the Contractor, and possibly Navajo Nation personnel, will perform radiological surveys for excavation control, and will conduct tests on excavated areas to determine whether additional contamination remains to be excavated. Results of such tests of contaminated material are generally available within four hours during normal work hours; however, test equipment constraints may increase the testing time. This does not relieve the Subcontractor of his contractual obligation to place all contaminated material in the cell if additional contaminated material is found at a later date.

C. Upon apparent completion of contaminated material excavation in a distinct area, the Contractor will conduct a radiological verification survey to confirm final removal of contamination to EPA standards. This survey may take up to seven work days. The Subcontractor shall plan his work accordingly.

D. Radiological and Nuisance Dust:

1. Proactive Dust Suppression Plan: Prior to the start of any work on the Processing and (or) Disposal Site(s) the Subcontractor shall have a Contractor-approved "Proactive Dust Suppression Plan" for the entire site(s) including borrow areas and haul roads. This plan shall include listing of specific pieces and quantity of equipment to be used, water sources, additives, days and hours of operation which demonstrate the Subcontractor's understanding of the importance of dust suppression requirements. It shall be adequate for all areas within the site boundaries, work areas and nonwork areas, radiological and non-radiological areas, borrow areas and haul roads. Approval of this plan does not relieve the Subcontractor of any responsibilities regarding the control of dust under the terms of the Subcontract.

2. Work Stoppage in Case of Excessive Radionuclides: The Contractor will monitor construction activities and will shut down the work or require modifications of the Subcontractor's activities in the event that gaseous or

particulate radionuclides exceed limits or airborne particulates are visible. Any shutdown will be a last resort response to such conditions. Watering, vehicle speed reduction, voluntary partial shutdowns, respiratory protection and covering of materials emitting radon gas are some actions which shall be taken.

3. Work stoppage in case of Excessive and/or Visible Dust: The Contractors and Subcontractor's actions regarding dust emissions in nonradiological areas within the site boundary shall be as stated above and in accordance with any permits provided by the Contractor. The amount or type of dust suppression equipment in operation shall not prevent the Contractor from stopping work if there is excessive dust. If work stoppages occur due to excessive dust, the Subcontractor shall not recommence work without approval of the Contractor.

E. Site speed limit shall be posted in accordance with Subcontractor's approved submittal and shall be observed at all times by all construction personnel and equipment operators. Safe speed limits shall be observed at all times.

F. The Subcontractor shall not be permitted to bring explosives or firearms to the sites under any circumstances without the prior approval of the Contractor.

G. The Subcontractor shall maintain the exhaust systems of all vehicles and equipment to protect against excessive noise and air pollution in compliance with the applicable local, state and federal requirements. The trucks shall be equipped with sound-dampening features. Tailgate chains shall be rubber-insulated and latches shall be adequately secured. Noise surveys will be conducted on all equipment by a Contractor's representative.

H. No surface-disturbing activities shall be permitted at any archaeological site that has been declared eligible for the National Register of Historic Places, unless and until the archaeological resources from such a site have been tested and recovered by a qualified archaeologist.

I. If the Subcontractor uncovers any archaeological artifacts or human remains during the term of the Subcontract, the Subcontractor shall immediately halt operations in the immediate vicinity of such a discovery and notify the Site Manager. Further work in these areas shall not resume until a qualified archaeologist has inspected the site and completed all resource recovery work.

J. Placement of radon barrier material and production of erosion protection materials shall not begin prior to March 1 of the year the work is scheduled.

SC-4 SITE LOCATION AND ACCESS

A. Location:

1. The Work under the Subcontract involves operations at two different sites:

a. Monument Valley Processing Site

b. Mexican Hat Disposal Site

2. The locations of these sites are specified in Specification Section 01010.

B. Access: The liability insurance dictates mandatory enforcement by the Contractor of the following restraints to all persons seeking construction site access:

1. Private, personal or agency vehicles not used for authorized construction purposes will not be allowed in the controlled site areas.

2. Parking of private, personal or agency vehicles shall be in a restricted area outside of the controlled site areas as designated by the Site Manager or his representative.

SC-5 COORDINATION OF WORK

The Subcontractor shall carefully coordinate all construction activities with the Site Manager to avoid conflicts and unnecessary delays in construction.

SC-6 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

A. Unless otherwise specified elsewhere in the Subcontract Documents, the Subcontractor shall furnish and assume full responsibility for the following facilities and incidentals which are necessary for the furnishing, performance, testing, start-up and completion of the Work as shown on the Subcontract Drawings and as specified in the Specifications:

1. All materials, equipment, plant, labor, transportation, construction equipment and machinery, tools, appliances,

fuel, power, light, heat, telephone, water, sanitary facilities, decontamination facilities and all other facilities and incidentals as specified in Section 01500.

2. Temporary controls including, but not limited to, dust control, erosion control, noise control, pollution control, surface water control and access and traffic control as specified in Section 01560.

B. Subcontractor shall be responsible for installing, constructing, maintaining, operating, removing and disposing of the construction facilities and temporary controls through the term of the Subcontract.

SC-7 CONSTRUCTION ENVIRONMENT, SAFETY AND HEALTH

A. Contractor Safety Program:

1. The Subcontractor shall comply with the Construction Environment, Safety and Health Management Program (Document No. MK-UMTRA-4). A condensed version of this document is provided at the end of this Section.

2. The successful bidder will be issued a copy of the Construction Environment, Safety and Health Management Program Document with the Notice to Proceed by the Contractor's Subcontract Administrator.

3. A table of contents for the Construction Environment, Safety and Health Management Program is listed below:

CONSTRUCTION ENVIRONMENT, SAFETY AND HEALTH MANAGEMENT PROGRAM

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4. The Subcontractor shall comply with radiological programs and procedures required in the current revisions of the RAC/MK-F Health Physics Procedures, Health Physics Monitoring Plan, the Site Specific Health Physics Monitoring Plan, and/or DOE Orders as applicable.

B. Construction Environment, Safety and Health Initial Indoctrination and Training:

[1. All construction personnel working on the site shall receive the basic Construction Environment, Safety and Health Initial Indoctrination and Training. The Indoctrination and Training will cover such matters as first aid and medical responsibilities, emergency actions, etc. The indoctrination may be oral or written, and/or audio visual (approximately 2 hours in length). It will be presented to construction personnel either individually or on a group basis and at the Subcontractor's convenience. The indoctrination will be presented to all personnel upon request at the site office between the hours of 8:00 a.m. and 4:00 p.m., Monday through Thursday (holidays excluded). No construction personnel will be permitted to work without having received this basic indoctrination.]*

2. The use of respirators for radiological protection may be necessary on this Project. Respirators for any other kind of protection shall be furnished by the Subcontractor. If respirator use becomes necessary, for radiological protection, the respirators will be provided by the Contractor with training in the proper use to perform specific tasks. This instruction is approximately two hours long and will be provided to the Subcontractor at no extra cost. The Subcontractor shall notify the Contractor's Representative at least one (1) week in advance of the time that the training is desired. Note, that individuals with beards or facial hair that interferes with a proper respirator seal will not be accepted for respirator training. Training for respirators and for any other type of protection, other than radiological, shall be provided by the Subcontractor.

3. No payment will be made to the Subcontractor for the Subcontractor's employees' attendance at Safety and Health Initial Indoctrination and Training Program or respirator training provided by the Contractor. Full compensation for such costs will be considered incidental to the Work of this Subcontract.

* P.I.D. 09-S-15

4. All employees not subject to the medical surveillance requirements of OSHA Standard 29 CFR 1910.120 shall have a written medical qualification to wear a respirator before they can perform work which requires the use of a respirator. If respirator use becomes necessary, for radiological protection, the respirators will be provided by the Contractor with training in the proper use to perform specific tasks. Based upon requirements in OSHA 29 CFR 1910.134 and criteria established by the Contractor's Medical Director, and upon recommendations listed in the American National Standards Institute, ANSI 288.2-1980, "Practices for Respiratory Protection", all employees who will or may be required to wear respirators on this project shall complete a medical questionnaire and will be given pulmonary function and blood pressure tests by the Contractor before initial assignment and annually thereafter. This information will be evaluated by the Contractor's Medical Director between the hours of 8 a.m. and 4 p.m., Monday through Thursday, and if it is determined to meet specific criteria, a written qualification to safely wear a respirator will be issued to the employee within 24 hours, upon receipt of the information. If a written qualification is not issued by the Contractor's Medical Director, the Subcontractor is responsible for scheduling and payment of any additional medical evaluations, and shall submit to the Site Manager a written medical release for their employees' use of respirators.

C. Electrical Precautions:

1. Personnel Ground Fault Protection: All electrical conductors used in construction, operating on single phase, 120 VAC, 15 or 20 amperes circuits, shall be equipped with UL listed Ground Fault Circuit Interrupters set at five (5) milliamperes plus (+) or minus (-) one (1) milliampere. All electrical conductors, portable electric tools and their identification, installation and usage shall be in compliance with applicable OSHA standards set forth in Section 29 CFR 1926.404 of the OSHA 2207 construction industry publication.

2. Electrical Clearance Requirement: All electrical circuit connections shall be made on de-energized systems. Working clearance for energized systems shall be 3 feet for 0 to 150 volts and 4 feet for 151 to 600 volts. The work shall be performed by a qualified journeyman electrician or by an apprentice electrician under the direct supervision of a qualified journeyman electrician.

D. Smoking, Drinking, Eating and Chewing Restrictions: No smoking will be permitted in the immediate vicinity of any flammable liquids, gases or highly combustible material, or in any area posted as a non-smoking area. No smoking, drinking, eating or chewing will be permitted in any controlled area.

E. Ladders, Scaffolds, Man Lifts and Stairways: All man-lift equipment, ladders, scaffolding and stairways shall be in compliance with applicable OSHA (29 CFR 1926) standards and be subject to inspection by the Contractor prior to and during its use.

F. Trench/Excavation Barricades:

1. Trenching, excavation, shoring, bracing, and barricading requirements shall be in accordance with OSHA standard, 29 CFR 1926, Subpart P, revision effective January 2, 1990.

2. The following forms of protection shall be required for open trenches/excavations adjacent to occupied buildings, crossing pedestrian crosswalks and paths, at street intersections, and crossing or adjacent to sidewalks and driveways:

a. Barricades shall be positioned on each side of the trench and stationed at a maximum of ten (10) foot intervals. Spacing on each side of the trench shall alternate to show that a front view depicts barricades at five (5) foot intervals.

b. Whenever possible, each barricade shall be positioned at least two (2) feet away from the open trench or excavation.

c. Each barricade shall be equipped with a yellow flasher of at least seven (7) inches in diameter. (NOTE: Temporary barricades used during daylight operations do not require flashers.) Street side flashers shall be directed parallel with the street, curb side flashers and flashers along pedestrian routes shall be facing in the direction of pedestrian traffic.

d. When continuous solid barricades are not provided, interconnecting ropes or tape shall be attached to all barricades. When rope is used, streamers shall be attached at 2-3 foot intervals.

e. Walkways and/or bridges with standard guard rails, shall be provided at all pedestrian crossing points except for trench width 2'-0" and less where a barricade straddling the trench on either side of the walkway may be used.

f. Where vehicle traffic must cross trenching operations, metal plate covers shall be provided to support all motor vehicles.

g. Where trenches or excavations interrupt a doorway, ramp, or other exits/entrances to buildings, the doors shall be locked or blocked and a sign displayed to indicate the condition that exists.

[G. Notification of Occurrences: In accordance with the requirements of DOE Order 5000.3A, the Subcontractor shall report to the Contractor immediately upon occurrence of any non-routine events, occurrences, incidents, truck spills of contaminated materials, or accidents, etc., particularly in situations such as lost time accidents and ambulance calls.]*

H. Responsibility:

1. Subcontractor Safety Responsibility:

a. The Subcontractor shall designate in writing a qualified person to implement at all times the Construction Environment, Safety and Health Management Program at the work site. The designated person shall have authority for actions and for control of work activity to prevent accidents. The Subcontractor's safety representative shall be a full-time, on site employee whose only responsibility is to implement the Construction Environment, Safety and Health Management Program and who reports directly to the Subcontractor's management. The Contractor reserves the right to reject any safety person designated by the Subcontractor and considered unqualified by the Contractor. At times when the Subcontractor's designated Safety Representative is not available (sick, vacation, day-off, seminar, etc.), an alternative representative acceptable to the Contractor shall fulfill all the responsibilities of the Safety Representative.

* P.I.D. 09-S-15

b. The Subcontractor's Safety Representative shall make daily work area safety and health inspections when any work is ongoing. Such daily inspections shall be documented in writing and shall include a brief description of the inspection findings, deficiencies noted and actions taken or implemented as a result. Copies of the documented inspections shall be submitted to the Contractor on a weekly basis.

c. The Subcontractor shall submit at the preconstruction meeting a copy of the Subcontractor's company's safety plan.

[d. The Subcontractor shall provide an on-site full time Emergency Medical Technician (EMT).]*

2. Contractor Safety Responsibility:

a. Contractor Safety Department personnel or designated representatives will make regular continuing inspections of all facilities and operations within the scope of the Subcontract. These inspections will include the facilities and all operations of the Subcontractor, but do not in any way relieve the Subcontractor of responsibility for compliance with the provisions of the Construction Environment, Safety and Health Management Program.

b. Daily work area safety and health inspections will be made by Contractor personnel.

I. Galvanized Materials: Personal respiratory protection or ventilation is required if a heat process takes place with galvanized materials.

J. Back-Up Alarms: All construction equipment shall have functioning audible back-up alarms while in use on an UMTRA project.

K. Unidentified Waste Materials: Unidentified wastes will be identified by the Contractor through laboratory analysis. If the materials are identified as hazardous, the Subcontractor shall comply with the applicable standards for personnel safety and health protection.

* P.I.D. 09-S-15

L. Industrial Hygiene:

1. Noise:

a. The UMTRA Project shall comply with the OSHA Construction Occupational Noise Exposure Regulation 29 CFR 1926.52. Sound level surveys and noise dosimetry will be conducted by the Contractor for both the Contractor and Subcontractor personnel. Noise monitoring data will be available to the Subcontractor for evaluation. Hearing protection is required for any personnel exposed to 85 dB(A) or above. Limit applies for an 8-hour time weighted average.

b. The Subcontractor shall provide baseline and annual audiometric testing (hearing tests) if it is possible to track employees, and shall provide training to any employee exposed above 85 dB(A) 8-hour Time Weighted Average (TWA), as required to have an effective hearing conservation program. The baseline audiometric test shall be given to employees within 6 months of hire date. Costs of audiograms and training shall be funded by the Subcontractor without cost to the employee. Subcontractors or their individual employees, who work on an UMTRA site for less than 6 months are not required to perform audiometric tests for purposes of this Subcontract.

c. The Contractor will monitor Subcontractor compliance with the OSHA 29 CFR 1926.52 regulation by reviewing Subcontractor records and interviewing Subcontractor employees as necessary.

d. Trucks engaged in hauling activities shall not use engine brakes except in emergencies.

2. Dust: Subcontractor's dust control provisions shall be adequate to prevent personnel from potential inhalation exposure to Silica or Nuisance Particulates. Contractor's Safety Department will conduct ongoing dust monitoring and will keep the Subcontractor informed about the need for respiratory protection. The Subcontractor shall provide dust masks or the necessary respiratory protection for silica where radiological contamination is not present.

3. Prior to confined space entry, the Subcontractor shall read and comply with the confined space entry procedures developed by the Contractor. The procedures require

that a permit be completed and kept at the work place. Atmospheric testing will be performed prior to confined space entry for percent Oxygen, Carbon Monoxide, Combustibles and Hydrogen Sulfide. Testing will be done using a direct reading instrument assigned to the Contractor's Health and Safety personnel.

4. Hazard Communication: The Subcontractor shall comply with the OSHA Hazard Communication Program for the Construction Industry. The required compliance activities include but are not limited to:

   a. Current Chemical Inventories

   b. Material Safety Data Sheets for all Chemicals

   c. Proper labeling of all chemical containers.

   d. Complete written program available to all work place employees.

   e. Appropriate training to all employees on hazards of the workplace as required in OSHA 29 CFR 1926.59.

   f. The Subcontractor shall submit to the Contractor a generic Hazard Communication Program at the preconstruction meeting. The Subcontractor shall submit a site specific Hazard Communication Program for approval within 30 calendar days after the Notice to Proceed. This plan shall be updated as new materials are utilized on site.

5. General Hazards: The Subcontractor shall be responsible for controlling general hazards as identified. General hazards include heat stress, ultra violet radiation, chemical exposures and biological agents with potential to cause illness or injury to site personnel.

M. Construction Motor Vehicles, Heavy Equipment and Machinery Inspections and Maintenance:

1. Construction Motor Vehicles:

   a. Vehicles that are in operation within an offhighway jobsite shall comply with 29 CFR 1926.601.

   b. Vehicles that operate on highways or any public roads shall comply with the North American Uniform Out-of-Service Criteria (which the Subcontractor is responsible for obtaining). In addition, the Subcontractor shall implement and comply with all

requirements of the Contractor's Truck Inspection Plan. The truck inspection frequency shall be every two weeks. This frequency supersedes Section 3, Article 3.6 of the Truck Inspection Plan. All other requirements in Section 3 of the Plan apply. If conditions exist, in the Contractor's opinion, due to safety concerns, the inspection frequency may be increased to once weekly.

c. Inspection reports and repair records shall be submitted to the Contractor's Site Manager prior to the initial use of all Motor Vehicles. Any additional inspection reports or repair records as required by the Truck Inspection Plan shall also be submitted to the Site Manager.

d. Truck Information: All haul unit vehicles shall be equipped with a system that will:

   1) Monitor driver trends, habits, routes and equipment. Identify high risk driver activity. Identify when vehicle exceeds operating parameters.

   2) Monitor fuel economy, speed, idle time and RPM's.

   3) Present data in a clear, user friendly report format that separates driver and vehicle information.

   Any and all data shall be provided to the Contractor within 24 hours upon request.

e. All trucks carrying contaminated materials shall be connected to a radio communications system.

2. Heavy Equipment and Machinery:

   a. The Subcontractor shall designate a competent person to inspect the operating safety conditions of all construction Heavy Equipment and Machinery. The Heavy Equipment and Machinery shall be inspected prior to their use and frequently during their use to make certain that they are in safe operating condition. All deficiencies shall be repaired and defective parts replaced before continued use of the equipment or machinery. Records of inspections and repairs shall be maintained by the Subcontractor and be submitted weekly to the Contractor.

b. A thorough annual inspection of the hoisting machinery shall be made by a competent person or by a government or private agency recognized by the U.S. Department of Labor, and inspection reports shall be maintained.

c. Inspection reports and repair records shall be submitted to the Contractor's Site Manager prior to the use of such construction vehicles, machinery and equipment on the Project.

d. Material handling Heavy Equipment shall comply with 29 CFR 1926.602.

N. Hazardous Waste Operations (OSHA Standard 29 CFR 1910.120):

1. Training Requirements:

a. All Subcontractor employees who are expected to work full-time, part-time or routinely on-site, and are exposed to hazardous substances (i.e. uranium mill tailings above 2000 pCi/g total specific activity), or other health and safety hazards shall complete 40 hours or equivalent of initial training prior to working on-site. These employees shall be provided with an additional three days of on-the job training by a trained supervisor.

b. The Contractor will provide all Subcontractor employees affected by Subparagraph a with approximately eight (8) hours of site specific safety and health training. This 8 hours of training is considered "equivalent training" and is applicable to the 40-hour training requirement. The Subcontractor shall apply this 8 hours of training towards the required 40-hour training for each affected employee. The general contents of the 8 hours of training include:

1) Initial ES&H Indoctrination - which addresses site rules and requirements: One (1) hour.

2) Hazard Communication Training - in compliance with OSHA 29 CFR 1926.59: One (1) hour.

3) Respiratory Protection Training - for air-purifying respirators as required by OSHA 29 CFR 1910.134: Two (2) hours.

4) Radiation Protection Worker Training - which addresses radiation safety, effects of

exposure, health risks, dose, protection measures, instrumentation, decontamination, emergency procedures, and responsibilities: Four (4) hours.

c. In addition to the 40 hours of initial training, the Subcontractor shall provide 8 hours of supervisor training to all management and supervisory personnel.

d. The Subcontractor shall provide all employees specified in paragraphs 1.a and 1.b with 8 hours of refresher training annually. This training is required on or before the anniversary date of the initial training.

e. All training required by this Special Condition shall comply with the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910.120 entitled "HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE".

f. Should the Subcontractor perform work on-site with employee(s) who are not appropriately trained, a written submittal shall be provided to the Contractor for approval prior to commencement of this work. This submittal shall provide details as to the type and duration of the work, and certify that the work is to occur in a non-exclusion area that is free of exposures to hazardous substances, health hazards, or safety hazards.

g. Site visitors, vendors, auditors and others who are not full-time, part-time, or routine site workers will not be required to complete training as required in OSHA Standard 29 CFR 1910.120 provided they are escorted on-site at all times by project personnel who are knowledgeable of the exclusion and non-exclusion areas, and provided they are not exposed to hazardous substances, health hazards or safety hazards. All site visitors, vendors, auditors and others shall be given initial ES&H indoctrination training by the Contractor prior to site entry.

2. Medical Surveillance Requirements:

a. The Subcontractor shall provide medical surveillance for all Subcontractor employees who: 1) are or may be exposed to a hazardous substance (i.e. uranium mill tailings above 2000 pCi/g total

specific activity), or health hazards at or above the permissible exposure level (PEL), or, if there is no PEL, above the published exposure levels for these substances, without regard to the use of respirators, for thirty days or more a year; or 2) who wear a respirator for thirty days or more a year; or 3) who are injured due to overexposure from an emergency incident involving hazardous substances; or 4) who are members of a HAZMAT Team. The Subcontractor shall submit to the Contractor a written explanation which provides justification for any employees who are not included in the medical surveillance program.

b. The Subcontractor shall provide employees who require medical surveillance with examinations at the following times: 1) before initial assignment; 2) every twelve months unless the attending physician believes a shorter or longer interval is appropriate (in no case shall the surveillance duration be greater than every two years); 3) at termination of employment from the Uranium Mill Tailings Remedial Action Program unless an examination has occurred within the last six months; 4) immediately when an employee develops symptoms of overexposure to a hazardous substance or health hazard, or is injured or exposed above accepted levels in an emergency situation.

c. The Subcontractor shall ensure medical examinations are either provided or supervised by a qualified licensed physician. The Subcontractor shall provide, at a minimum, the following information to the attending physician: 1) A copy of OSHA Standard 29 CFR 1910.120; 2) A description of the employee's duties as they relate to the employee's exposure; 3) A copy of the employee's actual or potential exposure levels; 4) A description of the types of personal protective equipment (PPE) used on-site, including respiratory protection; 5) A copy of the employee's past medical examination if requested by the physician.

d. The physician shall perform, at a minimum, a medical and work history, and an examination that is representative of the site hazards including fitness for duty with an emphasis on the ability of the employee to wear an air-purifying respirator and other PPE under stressful conditions such as hot weather and physical work.

e. The physician shall provide the Subcontractor with a written statement in compliance with OSHA Standard 29 CFR 1910.120 that qualifies or disqualifies the employee on their ability to work on-site. This qualification statement shall specifically address the employee's ability to wear an air purifying respirator. The Subcontractor shall provide a copy of this written statement to the employee and to the Contractor. Employees not qualified to work under the conditions considered in the examination will not be allowed to perform job duties on-site.

f. The Subcontractor shall comply with all provisions of OSHA Standard 29 CFR 1910.120, unless more stringent requirements are described or referenced in this document. The Contractor will determine on-site exclusion and non-exclusion areas.

g. The Subcontractor shall submit for Contractor approval a site specific Hazardous Waste Operations, Site Safety and Health Plan in accordance with 29 CFR 1910.120. This plan shall be submitted 10 calendar days prior to any work in a controlled area.

3. Record Keeping Requirements:

a. The Subcontractor shall submit to the Contractor, on the first business day of every month, a complete roster of personnel which lists the following information and accomplishments which comply with OSHA Standard 29 CFR 1910.120, if applicable:

- Name
- Social Security Number
- Site Name
- Date of Initial 40-Hour Training Course
- Date of Annual 8-Hour Refresher Training Course
- Date of 8-Hour Supervisor Course
- Date of Initial Medical Examination
- Date of Annual Medical Examination
- Date of Exit Medical Examination
- Date of Three Day On-The-Job Training
- Date of Employment Termination

b. The Subcontractor shall issue a card to all employees which certifies that they are currently

trained and are qualified under the medical examination requirements. The Subcontractor shall ensure each employee has this card readily available for Contractor compliance audits.

4. Responsibility: The Subcontractor is responsible for providing all scheduling and implementation activities related to OSHA Standard 29 CFR 1910.120 and Special Conditions Article SC 7.0. This ensures that employees are trained and medically qualified prior to job assignment. These activities are incidental to the work and there will be no separate payment. In addition, prior costs related to these training and medical examinations which were determined to be unnecessary are not recoverable.

SC-8 HEALTH PHYSICS

Portions of the Subcontract work area are radiologically controlled areas. All work shall be governed by the essential requirements given in the following paragraphs:

A. Health Physics (HP) Personnel: The Site Manager will monitor the construction work through HP personnel employed by the Contractor. The HP personnel will provide radiological surveillance over construction activities and advise supervision on matters concerning radiation safety as related to activities or conditions affecting the construction work.

B. Radiologically Controlled Areas:

1. Radiologically controlled areas shall be established as needed at the discretion of the Site Manager. They will normally include areas where radioactive contamination levels exceed 10 times the applicable limits or where airborne radioactive material concentrations or external radiation dose exceed the applicable limits.

2. The Contractor will provide HP personnel to control access to radiologically controlled areas.

3. The Subcontractor shall provide access control facilities as specified in Section 01500.

4. All personnel will be required to sign in and sign out of radiologically controlled areas, including but not limited to name, time and areas where they worked.

5. No eating, drinking, smoking, or chewing will be allowed in a radiologically controlled area. Personnel found to be in violation of this rule may be restricted from the controlled area, and/or have their training certification revoked. Repeated violations may result in permanent restriction from UMTRA sites.

6. All personnel will be required to self-monitor (frisk) for radioactive contamination upon leaving the controlled area. Personnel will be instructed in self-monitoring procedures as a part of the Radiation Worker Training.

7. The Subcontractor shall observe controlled area restrictions and shall take applicable precautions.

8. Dust suppression techniques are required to limit exposure to airborne radionuclides.

C. Protective Clothing for Contamination Control:

1. Protective clothing will be utilized for contamination control at the discretion of the Contractor.

2. When required, protective clothing may consist of coveralls, gloves, rubber boots, shoe covers, and/or respirators in any combination. At a minimum, all personnel shall wear rubber boots within the controlled area (unless this is determined to be unnecessary by the Site HP Manager).

3. Protective clothing will be provided to the Subcontractor at no charge on a loan basis.

4. Protective clothing will be issued by Contractor personnel at the access control area. Protective clothing shall be put on and removed at the access control area or radiologically controlled area boundary. Personnel will be required to change out of the protective clothing prior to leaving the controlled area.

5. The Contractor will determine when respiratory protection is required during certain construction activities when the potential for airborne radiological limits could be exceeded. The Contractor's HP Site Manager will specify when and where respirators are required.

6. The Subcontractor shall ensure that protective clothing items are stored in the workers' change and storage

trailers located inside the controlled area boundaries and that storage areas are maintained in proper order. Access control trailers specified in Section 01560 may be used for storage of protective clothing.

7. Compliance with required protective clothing standards is mandatory.

D. Training Requirements:

1. All personnel whose job assignment requires work on, with, or in the proximity of radioactive materials (mill tailings) will be trained as Radiation Workers.

[2. The Radiation Worker training course is approximately six hours long.]*

3. The Radiation Worker training course is available to Subcontractor personnel at no cost for the instruction. The Subcontractor shall notify the Contractor's representatives at least one day in advance when training is desired.

4. A test will be given to all personnel at the conclusion of training to establish qualifications as a Radiation Worker. Personnel must pass this test to work within the radiation control area.

5. Training in the proper use of respirators for performing specific tasks may be required. For respirator training and employee requirement, see Articles SC-7.B.2 and SC-7.B.4.

E. Radiation Exposure Limits and Dosimetry:

1. Radiation exposure on the UMTRA Project is expected to be well within allowable radiation exposure limits.

2. Each employee shall provide prior radiation exposure records as applicable.

3. Whole body radiation exposure shall be determined by the use of Personal Thermoluminescent Dosimeters (TLD). The Contractor will provide TLDs as required.

4. While working at the construction site, each employee who is issued a TLD is required to wear that TLD. TLDs will be issued and collected upon entrance to and exit from the controlled area.

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5. No one under the age of 18 shall be permitted to enter or work in the controlled area.

F. Bioassay (Urine and/or Fecal Samples):

1. Employees working in radiation control areas may be required to submit an initial, quarterly, and termination bioassay sample.

2. Employees may be required to submit additional bioassay samples on an occasional basis, to ensure that applicable radionuclide exposure standards are being met.

3. It is the Subcontractor's responsibility to ensure that each employee submits bioassay samples as required by the Subcontract.

4. The Contractor will notify the Subcontractor of any employee who fails to provide a required bioassay sample. The communication will state that urine sample submittal to the Contractor representative is a subcontract requirement. If the issue is not resolved, the Contractor's Subcontract Administrator will notify the Subcontractor, by written communication, that the employee will be restricted from all radiologically controlled areas.

5. Employees who fail to provide a bioassay sample will not be permitted on the site.

6. In the unlikely event that an employee has a confirmed positive bioassay result, he may be temporarily restricted from the controlled area for radiological evaluation.

7. The Subcontractor shall notify the Contractor of any personnel terminations or transfers as early as possible, but no later than two working days in advance of such terminations or transfers. This notification will allow sufficient time to collect a termination bioassay sample.

8. The Contractor shall be notified of the termination of any employee so that a final bioassay sample may be collected. This final sample is crucial to the overall radiation protection program.

G. Warning Signals: Certain circumstances such as unusual or unanticipated radiation levels, presence of toxic substances, or unsafe working conditions may prompt the Contractor to give verbal information or directions, as

Warning Signals, directly to the Subcontractor and the Subcontractor's employees. The Subcontractor and the Subcontractor's employees shall take required actions as directed by the Contractor. The Subcontractor shall obtain the name and title of the Contractor's representative providing such information.

H. Decontamination and Monitoring of Vehicles and Equipment:

1. Vehicles, equipment and tools that are to be removed from radiologically controlled areas (free release) shall be cleaned of all potentially contaminated soils and will be monitored for radioactive contamination by the Contractor prior to removal from the area.

2. When vehicles are decontaminated for release from one radiologically controlled area to another (controlled release), they will be monitored for contamination by the Contractor. The Contractor will initially monitor 100 percent of the vehicles for contamination. As experience begins to indicate that the decontamination process is being performed adequately, the percentage of vehicles that are monitored may be reduced to as few as 10 percent. Monitoring may be increased as contamination levels increase.

3. Vehicle decontamination facilities will be provided as specified in Section 01500, Article 1.15.

4. During snowfall or icing conditions complete removal of snow or ice may be required prior to verifying decontamination.

5. Equipment will normally be decontaminated prior to any maintenance other than routine servicing.

I. Tailings Leakage in Uncontrolled Areas:

1. Leakage of tailings or contaminated materials will not be allowed in uncontrolled areas.

2. The Contractor will perform baseline surveys of all haul routes outside of controlled areas.

3. The Contractor will periodically monitor the haul route and compare the data against baseline to detect spills of contaminated material. The Subcontractor shall clean up any contaminated material leaked or spilled outside of the controlled area, and the area shall be restored as required by the Contractor.

J. Disposition of Contaminated Equipment, Tools and Material:

1. The Subcontractor shall use his own or rental equipment in performing the required work under this Subcontract. All tools, vehicles, equipment and material will be inspected for radioactive contamination by the Site Manager or his designee prior to removal from the construction area.

2. Should the Subcontractor's tools, material, or equipment become contaminated, they will have to be decontaminated before removal from the area. If decontamination becomes necessary, the Site Manager will provide instructions for decontamination by the Subcontractor's employees. Decontamination may consist of steam cleaning, dry brushing, or washing with appropriate liquids. Decontamination required beyond these described will be handled under Article GP-52, "CHANGES", of the General Provisions. All releases shall be on an ALARA (As Low As Reasonably Achievable) basis as determined by the Contractor.

3. If decontamination proves impracticable or impossible, the tools, material, or equipment in question will be retained by the Contractor and an equitable adjustment for same will be negotiated with the Subcontractor provided that:

   a. There is no fault or negligence of the Subcontractor contributing to the contamination;

   b. The Subcontractor has followed all the specific instructions of the authorized HP personnel who have surveillance over the work;

   c. Items or equipment confiscated from the Subcontractor will be documented by a Confiscation Notice furnished to the Subcontractor by the Contractor and signed by HP personnel and the Site Manager;

   d. The Subcontractor allows reasonable time (a minimum of 10 working days, excluding weekends and holidays) in which to attempt to decontaminate the item(s) in question. The reimbursement schedule will be as follows:

      1) Tools valued less than $300.00 at 95% of replacement cost.

2) Tools/Equipment $300.00 and or more: If less than one (1) year old or at top of depreciation schedule, at 75% of replacement cost; if at bottom of or off the depreciation schedule, at 50% of replacement cost.

e. Failure to agree upon equitable adjustment shall constitute a dispute within the meaning of Article GP-41 of the General Provisions.

f. In view of the foregoing, the Subcontractor is encouraged to plan his work so as to minimize the transfer of equipment into and out of the construction area.

SC-9 SUBMITTALS

Pursuant to the provisions of Specification Section 01300 - Submittals, the Subcontractor shall submit samples of materials, schedules and reports, shop drawings, product data, manufacturer's instructions, and design calculations and design drawings to the Contractor.

SC-10 QUALITY ASSURANCE

All work shall be performed to the requirements of the Contractor's Quality Assurance Program. This program meets the applicable requirements of 10 CFR 50 Appendix B and ANSI/ASME NQA-1-79. The program will be wholly administered by the Contractor for permanent record purposes. All Quality Records will be generated by and maintained by Contractor's personnel.

SC-11 PERMITS

A. The Contractor will provide the following permits and notifications as required for the Work and activities specified in the Subcontract Documents, except as noted below in Articles SC-11.B and SC-11.C:

1. National Pollutant Discharge Elimination System (NPDES) Permits - Monument Valley and Mexican Hat (U.S. - Environmental Protection Agency)

2. Threatened or Endangered Species Consultation (U.S. Fish and Wildlife Service, Navajo Nation)

3. Cultural Resource Clearance
(Bureau of Indian Affairs, Utah State Historic Preservation Officer, Navajo Nation)

4. Access and Borrow Permit (Sand and Gravel Permit) for the RB-4/RB-7 Borrow Sites (Radon Barrier), and for the general backfill area adjacent to the Monument Valley site
(Bureau of Indian Affairs and Navajo Nation)

5. Consigned Water Service Contract - for withdrawal of water from the San Juan River. The withdrawal rate shall not exceed the permitted rate.
(U.S. Bureau of Reclamation)

6. Access and Free Use Permits - for the Bluff borrow site
(U.S. Bureau of Land Management)

7. Revocable Use Permits - for temporary construction areas and water pipeline, as required
(Bureau of Indian Affairs)

8. Temporary Water Diversion Permit
(Utah State Engineer's Office)

9. Air Quality Notice of Intent
(Utah Department of Health, U.S. Environmental Protection Agency)

B. All other permits and notifications, including but not limited to the following, as required, shall be the responsibility of the Subcontractor in accordance with Article GP-47 of the General Provisions. The Subcontractor shall provide copies of all other permits and notifications to the Contractor.

1. Water Well Drilling Permit, if required.
(Navajo Division of Water Resources)

2. Well Abandonment Reports, if required
(Navajo Division of Water Resources)

3. State Highway Encroachment Permits - for turnoffs into the tailings site and quarries
(Utah Department of Transportation)

4. Review of Transportation on State Highways
(Utah Department of Transportation)

5. Right of Way for Navajo Road Encroachment/Modifications including for Indian Service Routes 6440 and 6480 (Bureau of Indian Affairs and Navajo Nation)

6. Air Quality Approval Order(s) - for rock crusher and screening equipment (Utah Bureau of Air Quality)

7. Borrow Permit - for general backfill for offsite areas including access and haul roads (Navajo Nation)

8. Spill Prevention Control and Countermeasures Plan - for on-site fuel/oil storage if required (U.S. Environmental Protection Agency)

9. Notification and Request for Identification Number - for quarry and borrow operations (U.S. Mine Safety and Health Administration)

C. If the Subcontractor elects to use borrow areas, quarries, or access roads other than those shown on the Subcontract Drawings, the Subcontractor shall be responsible for obtaining or determining that the owner/operator of an existing borrow pit has obtained all required permits and notifications for the use and operation of such borrow areas, quarries and access roads in accordance with the requirements of Article GP-47 of the General Provisions.

D. The Subcontractor shall comply with the provisions of the permits at all times during the execution of the Subcontract. The Contractor will make available to the Bidders the permits and their provisions for review by the Bidders.

E. Separate measurement or payment will not be made for work required of the Subcontractor for obtaining additional permits and for compliance with the provisions of all permits, unless specifically provided for in this Subcontract. All costs in connection with obtaining such permits and for compliance with such permits will be considered incidental to the Subcontract.

SC-12 SUBCONTRACTOR LABOR AND EQUIPMENT RATES

A. Within 30 days after receipt of Notice to Proceed, the Subcontractor shall furnish to the Contractor a list of all equipment to be used on the Project. The list, as a minimum, shall include the following for each piece of equipment:

1. Equipment number, make, model, type, year of manufacture, capacity and/or horsepower, attachments, and any other information necessary to determine applicable Blue Book Rental Rate for Construction Equipment. Attachments, if any shall be reasonable and necessary for the work intended on the job or not be included when calculating appropriate rates.

2. Hourly rental rate calculated at the Subcontractor's normal rate for each piece of equipment, not to exceed 60 percent of the monthly rate, divided by 176, from the current edition of the Rental Rate Blue Book for Construction Equipment.

3. An hourly operating rate for fuel, oil, parts, maintenance and repairs, etc. for actual hours of operation only. This rate shall be not more than 100 percent of the operating rate from the current edition of the Rental Rate Blue Book for Construction Equipment.

4. When standby of equipment is required, the standby rate shall be hourly rental rate calculated at 60 percent of the monthly rate, divided by 176, from the current edition of the Rental Rate Blue Book for Construction Equipment. Maximum standby time allowed shall be for 8 hours in any day, 40 hours in any week, or 176 hours in any month.

5. All equipment rates shall be inclusive of Subcontractor markups.

B. The above rate information shall also be provided for any subsequent equipment brought onto the site during the term of the Subcontract in addition to the initial list, and shall be provided within five days of the date the equipment arrives.

C. The initial equipment rate list submittal, with additions, shall be valid for all pieces of equipment from its receipt until January 1 of the following year.

D. The equipment rate list shall be revised on January 1 of each year with the current Blue Book rates. These rates shall be used until the equipment rate list is revised on January 1 of the following year.

E. Within 30 days after receipt of Notice to Proceed, the Subcontractor shall furnish to the Contractor labor rates including premium time for all craft designations to be used on the Project as follows:

1. List craft category and classification (i.e., loader operator, 6 cy; truck driver, 3 axle; etc.). The category and classification should be consistent with the Davis-Bacon wage determination for the Project.

2. Labor cost rates including fringe benefits, payroll, taxes, and insurance.

3. Each item in 1 and 2 above shall be listed separately.

The above labor rate information shall be revised and resubmitted on January 1 of each year with current payroll burden rates.

The above labor rates shall be exclusive of Subcontractor overhead and profit.

F. The rates provided in Paragraphs A through E above shall be used for changes to the Subcontract where unit prices or other methods of pricing do not apply and shall be used solely at the discretion of the Contractor.

SC-13 SUBCONTRACT CHANGE NOTICE PROPOSAL

The Subcontractor, in connection with any proposal he makes for a Subcontract Change Notice, shall furnish a price breakdown, itemized as required by the Subcontract Administrator. Unless otherwise directed, the breakdown shall include all estimated labor and equipment hours, and associated costs, materials, subcontracts, and overhead and profit required to permit an analysis, and shall cover all work involved in the Change Notice, whether such work was deleted, added or changed. Any amount claimed for subtier-subcontractors shall be supported by a similar price breakdown and/or quotes from the subtier-subcontractors. In addition, if the proposal includes a time extension, a justification therefor shall be furnished. The proposal, together with the price breakdown and time extension justification, shall be furnished to the Subcontract Administrator within 30 calendar days after receipt of the Change Notice.

SC-14 VARIATIONS IN QUANTITIES

In all cases, except cancellation of one or more line items, where the quantity of a unit priced line item in the Subcontract is an estimated quantity, and where the actual quantity of such line item varies by more than 10 percent above or 10 percent below the originally estimated quantity

stated in the Subcontract, an adjustment in unit price shall be negotiated upon demand of either party for the quantities above or below the stated variation.

SC-15 LAWS AND REGULATIONS

Subcontractor shall give all notices and comply with all laws, ordinances, rules and regulations applicable to the Work. If Subcontractor observes that the Specifications or Subcontract Drawings are at variance therewith, Subcontractor shall give Contractor prompt written notice thereof, and any necessary changes shall be adjusted by an appropriate Modification. If Subcontractor performs any Work knowing or having reason to know that it is contrary to such laws, ordinances, rules and regulations, and without such notice to Contractor, Subcontractor shall bear all costs arising therefrom; however, it shall not be Subcontractor's primary responsibility to make certain that the Specifications and Subcontract Drawings are in accordance with such laws, ordinances, rules and regulations.

SC-16 REMEDIAL ACTIONS ON LANDS OF INDIAN TRIBES

A. Pursuant to Section 105 of Public Law 95-605, the Uranium Mill Tailings Radiation Control Act of 1978 and the Cooperative Agreement between the United States Department of Energy and the Navajo Nation, whenever remedial actions are required to be performed on sites located on lands belonging to Indian Tribes, all Subcontractors shall make full use of any local qualified members of Indian Tribe residents in the vicinity of the mill tailings site, vicinity properties, and designated disposal areas for remedial action performed on reservation lands.

B. The Subcontractor shall submit with his proposal a plan for assuring the maximum utilization of local Indian labor as referenced above.

SC-17 FUNDING LIMITATIONS

A. Of the total Subcontract Price, the sum of $_____ (to be identified at time of award) is presently available for payment to the Subcontractor under this Subcontract. It is anticipated that additional funds will be allotted from time to time to this Subcontract subject to Government appropriations available in this fiscal year or succeeding fiscal years. The responsibilities of the Contractor are

limited by this clause notwithstanding any contrary provision of the "Payments to Subcontractors" clause or any other clause of this Subcontract.

B. The Subcontractor agrees to perform or have performed work up to the point at which, in the event of termination of this Subcontract pursuant to the clause hereof entitled "Termination for Convenience", the total amount payable by the Contractor (including amounts payable in respect of lower-tier subcontracts and settlement costs), pursuant to paragraph E below, would in the exercise of reasonable judgment by the Subcontractor approximate the total amount at the time allotted to this Subcontract. The Contractor shall not be obligated in any event to pay or reimburse the Subcontractor in excess of the amount from time to time allotted to this Subcontract, anything to the contrary in this clause or the clauses hereof entitled "Termination for Convenience" as specified in Article GP-55 and "Payments to Subcontractors" as specified in Article GP-38 of the General Provisions notwithstanding.

C. It is contemplated that funds presently allotted to this Subcontract will cover the work to be performed until _____ (to be identified at time of award). In the event funds allotted are considered by the Subcontractor to be inadequate to cover the work to be performed until the above date, the Subcontractor shall notify the Subcontract Administrator when the work will reach a point at which, in the event of termination of this Subcontract pursuant to the clause hereof entitled "Termination for Convenience", the total amount payable by the Contractor (including amounts payable in respect of lower-tier subcontracts and settlement costs) pursuant to Paragraph E below, will approximate 85% of the total amount then allotted to this Subcontract. Such notice shall be in writing and shall be given not less than 45 days nor more than 60 days prior to the estimated date when such point will be reached. Such notice shall also state the estimated amount of additional funds required to continue performance to the above stated date.

D. The Contractor may at any time allot additional funds for continued performance of this Subcontract. The Subcontract Administrator will promptly notify the Subcontractor, in writing, of any such allotment and: (a) determine the applicable period of Subcontract performance which shall be covered by such funding; (b) modify the date stated in Paragraph C above in order to reflect such extended period of coverage; and (c) modify the amount stated in Paragraph A above. The provisions of Paragraphs B and C, above, shall apply to such additional allotted funds and modified date.

E. In the event the Subcontractor incurs additional costs, or is delayed in the performance of the work under this Subcontract, solely by reason of the failure of the Contractor to allot additional funds pursuant to Paragraph D above in the amounts sufficient for the timely performance of this Subcontract, and if additional funds are allotted by the Contractor pursuant to Paragraph D for continued performance of this Subcontract, then an equitable adjustment may be made in the Subcontract Price (including appropriate target, billing and ceiling prices where applicable) or in the time required for the performance of the work, or both, and this Subcontract may be modified in writing accordingly; provided, that the Subcontractor provides to the Subcontract Administrator written notice of its claim of entitlement to an equitable adjustment prior to the date then stated in Paragraph C.

F. Nothing in this clause shall affect the right of the Contractor to terminate this Subcontract pursuant to the clause of this Subcontract entitled "Termination for Convenience".

G. In order to adequately determine the ongoing current status of the project, and to assure that adequate funding is available in the event that suspension or termination for convenience becomes necessary, the Subcontractor is hereby required to submit a report monthly detailing information necessary to properly determine the expected cost to the Government for such activity.

H. The monthly report specified in Paragraph G above shall be submitted monthly on the 20th of the month. This report shall be submitted to the Subcontract Administrator, and is not subject to approval. This report shall provide the actual cost to date, a reasonably accurate estimate of monthly suspension cost (assuming complete suspension), a reasonably accurate estimate of termination cost (as provided in GP-55) as of the date of this monthly report. This report shall include the total amounts that may be payable by the Contractor (including amounts payable in respect of lower-tier subcontracts and settlement costs).

SC-18 <u>CERTIFIED PAYROLLS</u>

In addition to the copies of certified payrolls that shall be submitted each week to the Subcontract Administrator, one copy shall also be submitted to the Site Manager.

SC-19 SUBCONTRACTOR'S LIABILITY

The Subcontractor has total liability for all of his own equipment, supplies, tools, etc., brought on the job site or used in the performance of this Subcontract.

SC-20 MEASUREMENT AND PAYMENT

A. Unless otherwise provided in the Subcontract Documents, no separate measurement or payment will be made for compliance with the provisions of the General Provisions, General Conditions and Special Conditions. Full compensation for such work will be considered to be included in the related items of Bid Schedule or incidental to the Subcontract.

B. Payment for the cost of premiums paid by the Subcontractor to obtain performance and payment bonds will be as specified in Article GP-38.E of the General Provisions. The Subcontractor shall quote the price for the premiums by the lump sum in the Bid Schedule. (Bid Schedule Item 005)

SC-21 WORK HOURS

The Subcontractor shall schedule all work on a single shift basis except in such cases where in the opinion of the Contractor, the Subcontractor falls behind the approved progress schedule. The Contractor may require him to increase manpower, number of shifts, and/or construction plant in accordance with Article GC-3 of the General Conditions. The standard 40-hour work week shall be based on four 10-hour days per week, Monday through Thursday.

SC-22 CONTAMINATED MATERIALS HAUL INSURANCE REQUIREMENTS

The Subcontractor shall provide the Contractor evidence of insurance (additional bonding will not be accepted) as required by 49 CFR 387, Minimum Levels of Financial Responsibility For Motor Carriers. This requirement is in addition to those limits required by General Condition (GC-7). All other conditions contained within GC-7 shall also apply to this additional insurance. It shall be the Subcontractor's responsibility to obtain a determination from the U.S. Department of Transportation as to the definition of a hopper-type vehicle. A copy of this determination shall be submitted to the Contractor along with the evidence of insurance as well as a description of the type of vehicle the Subcontractor will use.

[SC-23 BULLETIN BOARDS

The Subcontractor shall provide Bulletin Boards as necessary at locations approved by the Contractor for the display of Permits, Bulletins and other required items.]*

END OF SECTION 00800

* P.I.D. 09-S-15

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

UMTRAP CONSTRUCTION ENVIRONMENT SAFETY & HEALTH MANAGEMENT PROGRAM

Condensed Version for Comprehensive Field Application

In Part

"Management and supervision are charged with the responsibility of preventing the occurrence of incidents or conditions that could lead to occupational injuries or illness. While the ultimate success of a safety and health program depends upon the full cooperation of each individual employee, it is management's responsibility to see that safety and health rules and procedures are adequate and enforced, and to see that effective training and education programs are employed to the best advantage."

"Never should safety be sacrificed for production. It must be considered an integral part of quality control, cost reduction and job efficiency. Every supervisor will be held accountable for the safety performance demonstrated by the employees under his supervision."

Regulations and Standards

Basically, OSHA standards are followed, but we also comply with local, state, and applicable federal standards. Reference: Page vi in the Construction Environment Safety and Health Management Program.

Purpose

Provide safe and healthy working conditions for all RAC and subcontractor employees while protecting the general public. Reference: Page 1 in the Construction Safety and Health Management Program.

Scope of Responsibilities

1. DOE UMTRA Project Office will conduct periodic safety and health audits of remedial action contractors.

2. Technical Assistance Contractor will prepare health and safety survey reports.

3. Remedial action contractor will, under the guidance of the Project Director, provide a management overview for all safety and health requirements, ensure adherence to the management program, and participation by all supervision.

4. All remedial action subcontractors shall comply with all applicable local, state, DOE/UMTRA and federal safety and health codes, regulations, standards, and special procedures. The remedial action contractor's Construction Environment Safety and Health Management Program shall be an integral part of the subcontract, including mandatory implementation and compliance by the various remedial action subcontractors. Reference: Page 6 in the Construction Environment Safety and Health Management Program.

Inspection and Enforcement

1. The RAC Safety Department personnel or designated representative will make regular inspections of all facilities and operations within the scope of the contract. These inspections will include the facilities and operations of all subcontractors, but do not, in any way, relieve subcontractors of their responsibility for compliance with the provisions of this program.

2. Daily work area safety health inspections will be made by RAC personnel and subcontractor supervision.

3. Failure of the remedial action subcontractor to comply with the established safety regulations and procedures and/or conducting activities which are considered unsafe by the remedial action contractor or the Department of Energy shall constitute cause of stoppage of work in accordance with Article GP-35, "Safety and Health" of the General Provisions. Reference: Page 8 in the Construction Environment Safety and Health Management Program.

Audits

1. MK-F corporate safety staff will conduct audits quarterly or as needed based on scheduled work activity.

2. DOE UMTRA Project Office will conduct periodic safety and health audits of remedial action subcontractors.

3. RAC will conduct informal and formal audits.

   Reference: Page 9 in the Construction Environment Safety and Health Management Program.

Fire Prevention and Protection

1. All remedial action contractor and subcontractor employees shall take positive measures to prevent fires within their work areas on the site. There will be, in some cases, work sites that have established fire departments nearby for response in case of fire. In these instances, the phone number of the fire department will be posted and notified immediately in case of fire. Notification shall also be made to the on-site remedial action contractor management personnel. The on-site management shall immediately notify the Project Safety Department in Albuquerque, New Mexico.

2. If the fire results in property damage, notification to the RAC, reporting extent and estimated cost shall be made. An investigation shall be conducted to determine cause with factual information gathered for a formal report to DOE/UMTRA Remedial Action Project Office by the remedial action contractor.

3. Each remedial action contractor shall maintain a fire prevention and control effort appropriate for the needs of the site. In some cases there may be sufficient cause to require a trained fire brigade. Each remedial action subcontractor shall provide proper fire extinguishers, maintain them and train employees on how they are to be used.

   Reference: Page 10 in the Construction Environment Safety and Health Management Program.

First Aid and Medical

1. The subcontractor shall provide or arrange for adequate facilities and qualified personnel to ensure prompt and efficient first aid medical care and emergency transportation of injured or sick employees.

2. Advance arrangements to utilize nearby hospitals, clinics, local ambulance services, or other medical facilities and the services of professional medical personnel must be made prior to commencement of work. These arrangements will be made by the RAC Construction Safety and Health Management.

3. Each shift must have at least one supervisor holding a current first aid certificate.

4. All project management is encouraged to have every foreman or supervisor qualified for first aid certificates.

5. When required, as specified in the special conditions, a standby automotive unit shall be provided for ambulance service. This unit should be properly equipped to accommodate a stretcher and allow for prompt, comfortable transportation of personnel to medical or hospital facilities.

6. The emergency telephone numbers for the local hospitals, ambulances, fire and police departments must be conspicuously posted around the job site on the orange colored posters available through the Safety Department of the remedial action contractor.

   Reference: Page 13 in the Construction Environment Safety and Health Management Program.

Records - Reports and Postings

1. Remedial action contractor field records:

   a) Safety inspections (MK-F Form CAS-21).
   b) Employee complaints and response action.
   c) Daily First Aid Treatment Log (MK-F Form CAS-8) covering MK-F and CNSI personnel.
   d) Copies of all subcontract Daily First Aid Treatment Logs.
   e) Transmit a copy of all the above to RAC Safety Department, Albuquerque.

2. Remedial action subcontractor records:

   a) Daily First Aid Treatment Log (MK-F Form CAS-8) with the original sent to the RAC Safety Department, Albuquerque.
   b) Log of Occupational Injuries and Illnesses (OSHA Form No. 200)

3. Remedial action subcontractor reports:

   a) Supervisors Accident Investigation Report (MK-F Form CAS-24)
   b) Unusual Occurrence Report
   c) Report employee complaints with corrective action.
   d) Report all recordable accidents (those not first aid).

4. Remedial action subcontractor reports:

   a) Report all recordable accidents (those not first aid).
   b) Unusual Occurrence Report.
   c) Supervisors Accident Investigation Report (MK-F Form CAS-24)
   d) Employee's first report of injury to insurance carrier and Remedial Action Contractor Safety Department, Albuquerque.

5. Remedial action contractor and subcontractors:

   a) OSHA and DOE "Occupational Safety and Health Protection" posters. (OSHA Form No. 2203 and DOE-F-5480.2, formerly DOE Form EV-627).
   b) Emergency poster (MK-F Form CAS-22)
   c) OSHA Log Form No. 200. Summary will be posted for 30 days following the calendar year end between February 1 and March 12, at the work site.

   Reference: Page 17 in the Construction Environment Safety and Health Management Program.

Emergency Action

1. Categories with potential emergency action are:

   a) Accident with serious bodily injury or major equipment damage.
   b) Severe weather.
   c) Fire.
   d) Contaminated materials spill in transmit.

   The Site Manager and Radiation Safety Officer control emergency action by giving direction as needed. Alternate individuals must be preassigned to fulfill the responsibility for control in case key personnel are absent during emergency action.

2. The RAC Construction Safety and Health Manager will preplan and coordinate with local emergency and medical facilities for potential assistance in all categories.

3. Each site will have a plan with specific assignments for response to a truck spill.

4. Site Managers shall notify RAC, Albuquerque with all pertinent information immediately. Response, if necessary, and further notifications that are appropriate or required, will then proceed by responsible personnel in Albuquerque.

   Reference: Page 30 in the Construction Environment Safety and Health Management Program.

Safety and Health Training Program

1. The purpose for implementing a training program is to provide instruction to each employee to include the recognition and avoidance of unsafe acts and conditions applicable to the work environment. It is also designed to assist subcontractor supervision in instructing each employee to recognize regulations established to control or eliminate hazards or other exposure to illness or injury.

2. Construction safety and health training is an inherent responsibility of direct line supervision. Management for the remedial action contractor and the subcontractor, must monitor line supervisors' training activities to ensure compliance with the purpose of training.

3. Each employee shall be given an initial indoctrination by a remedial action contractor designated person at the work site. It may be oral or written and must take place before the employee may start work on the site.

4. The subcontractor supervisor or foreman will instruct each worker in a group or individually as to the nature of the work to which he or she will be assigned. The hazards on the job, the personal protective equipment which will be required, the safety rules under which the worker will work, and the penalties for failure to observe these rules will also be explained. Each employee will be advised of the requirements for fire protection and special precautions to be taken if the work requires the use of flammable liquids, toxic materials, or other harmful substances. The electrical hazards, if any, will be emphasized.

5. Weekly safety training meetings shall be conducted by RAC and subcontractor supervisors or foremen. Attendance is mandatory for all employees at the work site. A record of these meetings shall be maintained on MK-F Form CAS-11 for RAC and subcontractors. The original form must be transmitted to the RAC Safety Department in Albuquerque.

6. Each person expected to work 40 hours over a three-month period in an access controlled area will be required to complete an approved radiation worker training program. It consists of a two hour lecture discussion and a two hour practical applications demonstration.

   Reference: Page 32 in the Construction Environment Safety and Health Management Program.

Radiological Control and Monitoring (CNSI)

A separate document by CNSI will cover this topic.

Environmental Control and Monitoring (Industrial Hygiene)

Noise - Ionizing Radiation - Nonionizing Radiation - Extreme Pressure - Extreme Temperature - Gases, Vapors, Fumes, Dusts and Mists - Solvents - Occupational Illnesses.

All of the above may, at one time or another, exist on this project. Our collective efforts to identify these before potential exposure becomes a reality must be a constant priority. For most categories, it requires methods for detection and evaluating the hazards. Very soon the instruments needed for measuring and evaluation will be obtained. The RAC Construction Safety and Health Manager will perform these measuring functions and will bring others in, when needed, for assistance to comply with local, state, and federal standards.

Reference: Page 35 in the Construction Environment Safety and Health Management Program.

Access Control CNSI)

A separate document by CNSI will cover this topic.

FINAL VERSION

Specifications

Division 1
General Requirements

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF THE PROJECT

A. Project Location: The Mexican Hat (Hat) site is approximately twelve miles north of the Utah-Arizona border just southwest of Mexican Hat, Utah and lies within the Navajo Reservation. Major topographic features of the area include the San Juan River in the north and Alhambra Rock to the west. The topography slopes toward the northeast. The site is at 37° 07' 54" north latitude, and 109° 52' 30" west longitude (T42S and R18E). The Monument Valley (Mon) site is located on the Navajo Indian Reservation in Apache County, Arizona, 5 miles south of the Utah-Arizona border. The Mon site is approximately 17 miles south of the Hat, Utah site.

B. The Mexican Hat site contains a tailings embankment, retention basin, access control areas and areas of waterborne/windblown contamination. Most of the off-pile contaminated materials have been removed by others.

C. The Monument Valley site contains tailings piles, retention pond, access control area, numerous rubble piles, stone and concrete foundations and windblown/ waterborne contaminated areas. In order to stabilize the tailings and meet EPA standards, the tailings and other contaminated materials at Mon site shall be consolidated with other contaminated materials in the existing tailings embankment at Hat site.

D. Construction site access to the Hat site will be granted via an existing access road located southwest of the Hat site and Indian Service Route 6440 connecting the Mon and Hat sites. Route 6440 shall be upgraded in accordance with the requirements of this Subcontract.

1.2 SCOPE OF WORK

A. General:

1. The Work is generally described as site work related to the excavation of contaminated residual radioactive materials from the Monument Valley site and of windblown/waterborne areas at both sites, and placement

of these materials in the tailings embankment at the Mexican Hat site with a protective cover. The Work includes the restoration of both sites. The Work is outlined in Article 1.2.B below. Such Work is more fully detailed in the Specifications and Subcontract Drawings included herein.

2. The Work includes furnishing all plant, labor, tools, equipment, materials, transportation, and services, and performing all operations necessary for and properly incidental to the construction as shown and noted on the Subcontract Drawings and as specified in these Specifications.

B. The Work Includes:

1. Mobilization: See Section 01019.

2. Construction Facilities: Operation, maintenance, and removal of construction facilities include, but are not limited to, the following as specified in Section 01500 and other sections:

   a. Subcontractor's Office(s)
   b. Contractor's Offices
   c. Parking Areas
   d. Janitorial Services
   e. Snow Removal Services
   f. Temporary Roads
   g. Storage of Materials and Equipment
   h. Construction Equipment
   i. Temporary Sanitary Facilities
   j. Temporary Electric Power
   k. Temporary Water
   l. Decontamination System
   m. Temporary Heat
   n. Temporary Telephone Service
   o. Temporary Fences
   p. Permanent Crossing at Gypsum Creek

3. Temporary Controls: Temporary controls shall include dust control, noise control, pollution control, water control, and access, traffic and safety controls and protection of exposed surfaces as specified in Section 01560.

4. Permanent Facilities: Permanent facilities shall include construction of permanent features including, but not limited to, the following:

   a. Site Clearing as specified in Section 02110.

b. Demolition and disposal of structures specified in Section 02050.

c. Excavation, transportation and disposal of tailings and contaminated materials from Monument Valley and Mexican Hat sites as specified in Section 02200.

d. Construction of tailings embankment including radon barrier amended with bentonite.

e. Placement of protective cover over the tailings embankment as specified in Section 02278.

f. Construction of permanent drainage ditches.

g. Finish grading.

h. Seeding as specified in Section 02935.

C. The above description of the Work is for general information only, and in no way limits the responsibility of the Subcontractor for completing the Work in strict accordance with the Subcontract Drawings and Specifications listed in the Table of Contents.

D. Environmental Observations: The Work shall be performed in strict accordance with the applicable permit requirements and the requirements of U.S. Environmental Protection Agency (EPA), Navajo Nation, and other involved state and federal agencies (see Article SC-11 of Special Conditions for list of permits) having jurisdiction, and in accordance with the requirements of General Provisions, General Conditions and Special Conditions.

1.3 OTHER SUBCONTRACTS

A. The following subcontracts awarded by the Contractor for other work may be in progress during the term of this Subcontract. The Contractor or his authorized representative will be responsible for coordinating all activities between the subcontractors in accordance with the requirements of Article SC-3.A of the Special Conditions.

1. Installation, operation, maintenance and removal of the wastewater treatment plant at each of the sites.

2. Cleanup of vicinity properties.

1.4 CONSTRUCTION SEQUENCE

A. Unless otherwise specified, directed, or modified, the Subcontractor shall follow the recommended sequence of operations as set forth below. Modifications to this sequence shall be subject to the Contractor's approval. Full compensation for conforming to such requirements will be considered as included in the related Bid Schedule items of Work and no additional compensation will be allowed therefor.

B. Meetings will be conducted between the Contractor and Subcontractor prior to starting each sequence of construction listed below. The intent of these meetings is to review and discuss specification requirements for that particular sequence of construction. During these meetings, the Subconractor shall present a written construction plan that will outline and detail the equipment, personnel, schedule, and source, transportation, excavation, placement and compaction of materials proposed for each construction sequence as applicable. Submittals shall be in accordance with Section 01300.

C. The sequence of operations:

1. Phase I Mobilization as specified in Section 01019.

2. Construction facilities at Hat and Mon sites as specified in Section 01500.

3. Temporary controls at Hat and Mon sites as specified in Section 01560.

4. Construct, upgrade and maintain access and haul roads, including Gypsum Wash crossing.

5. Phase II Mobilization as specified in Section 01019.

[6. Demolish structure at Monument Valley site and transport demolition debris, boulders and rubble and place in tailings embankment as specified in Sections 02050 and 02200.]*

7. [Text Deleted]* [Not Used]*

8. Excavate, transport and place in the Hat tailings embankment tailings and other contaminated materials from the Mon site in the following sequence:

* P.I.D. 09-S-15

a - from the heap leach pad area and old pile.
b - from the new pile.
c - windblown/waterborne and the remaining contaminated materials.

9. At the Mon site, demolish decontamination facilities. Remove retention basin and dikes. Dispose of contaminated materials in the tailings embankment. Remove temporary fencing.

10. Perform final site grading and seeding of the Monument Valley site.

11. Excavate, transport and place in tailings embankment windblown/waterborne contaminated materials from the Hat site.

[12. Remove contaminated sediments and waterborne contaminated materials from the Hat site and place in the tailings embankment.]*

13. Subgrade preparation of aprons and permanent drainage ditches and gullies.

14. Final site grading at the Hat site may proceed concurrently with the construction of the permanent drainage ditches.

15. Fine grading of embankment side slopes.

16. Phase III Mobilization as specified in Section 01019.

17. Open up borrow areas, process and stockpile materials.

18. Construction of the radon barrier cover over the contaminated material in the tailings embankment. The cover shall consist of selected uncontaminated material obtained from designated borrow areas. The entire thickness of the radon barrier shall be mixed with bentonite.

[a. Demolish retention basin liner and embankment at the Hat site and dispose of in the tailings embankment as described in Section 02050.]*

19. Placing erosion protection materials over the radon barrier cover and in permanent ditches and gullies. The erosion protection materials consist of a layer of bedding material topped by a layer of rock riprap.

* P.I.D. 09-S-15

20. Site Cleanup: Removal and disposal of stockpiled materials and closing of the borrow sites and removal of temporary fencing.

21. Site Restoration: Grading of the sites and the borrow areas to provide drainage including placement of uncontaminated fill, and conditioning for natural revegetation.

22. Demobilization as specified in Section 01019.

D. Mobilization as identified above (Article 1.4.c) shall be conducted in three phases as specified in Section 01019. At the appropriate times during the Subcontract, the Subconractor shall present a written plan that outlines each mobilization phase to be discussed with the Contractor in meetings identified in Article 1.4.B of this Section.

1.5 BORROW AREA LOCATIONS

A. The following potential borrow areas are identified and shown on the Subcontract Drawings:

1. Borrow areas RB-4 and RB-7 are located approximately five miles south of the Mexican Hat site.

2. Bluff quarry areas located near Bluff, Utah approximately 30 miles northeast of the Mexican Hat site.

3. Sugarloaf Limestone borrow area (potential source only) located near Bluff, Utah approximately 15 miles northeast of the Mexican Hat site.

4. Borrow area for general fill at the Monument Valley site is located adjacent to the site.

B. Material for general fill at Mexican Hat site shall consist of uncontaminated materials within the Mexican Hat site and shall be obtained from areas approved by the Contractor.

1.6 SUBCONTRACT DRAWINGS

A. A list of Subcontract Drawings and Titles is provided in the Table of Contents of these Subcontract Documents under "Subcontract Drawings".

B. Where "as shown," "as detailed," "as noted," or words of like meaning are used in the Subcontract Documents, it shall be understood that reference is being made to the Subcontract Drawings unless otherwise specified.

1.7 TIME OF COMPLETION

A. The term of the Subcontract shall be 1,097 calendar days from the receipt of Notice to Proceed.

B. Termination for default, damages for delay and time extensions are specified in Article GP-56 of the General Provisions.

1.8 CODES AND STANDARDS

A. Pursuant to Article GC-3 of the General Conditions, any material, method, or procedure specified by reference to the number, symbol, or title of a specific specification or standard, such as a Commercial Standard, American National Standard, Federal or State Specification, Industry or Government Code, a trade association code or standard, or other similar standard, shall comply with the requirements in the latest revision thereof and any amendments or supplements thereto in effect on the date of Award of the Subcontract, except as limited to type, class or grade, or modified in such reference.

B. The code, specification or standard referred to, except as modified in these Specifications, shall have full force and effect as though printed in these Specifications. These Specifications and standards are not furnished to bidders because manufacturers and trades involved are assumed to be familiar with their requirements. The Contractor will furnish, upon request, information as to how copies of the specifications and standards referred to may be obtained.

1.9 MANUFACTURERS' SPECIFICATIONS AND INSTRUCTIONS

A. Unless otherwise indicated or specified, all manufactured materials, products, processes, equipment, or the like shall be installed or applied in accordance with the manufacturers' instructions, directions, or specifications. Said installation or application shall be in accordance with printed instructions furnished by the manufacturer of the material or equipment concerned for use under conditions similar to those at the jobsite. Two copies of such instructions shall be furnished to the Contractor and his acceptance thereof obtained before work is begun.

B. Any deviation from the manufacturers' printed recommendations shall be explained and acknowledged as correct for the circumstances, in writing by the particular manufacturer. Subcontractor will be held responsible for all installations contrary to the manufacturers' recommendations. If any item of material or equipment is found to be installed not in

accordance with the manufacturer's recommendations, Subcontractor shall make all changes necessary to achieve such compliance without additional cost to the Contractor.

1.10 WORK QUALITY

A. Shop and field work shall be performed by qualified craftsmen. All work on this Project shall be performed in accordance with the best practices of the various trades involved and in accordance with the Subcontract Drawings, reviewed shop drawings, and these Specifications.

B. All Work shall be erected and installed plumb, level, square and true, or true to indicated angle, and in proper alignment and relationship to the work of other trades. All finished work shall be free from defects and damage.

C. The Contractor reserves the right to reject any materials and work which are not considered to be up to the highest standards of the various trades involved. Such inferior material or work quality shall be repaired or replaced, as directed, at no additional cost to the Contractor.

1.11 FIELD MEASUREMENT AND TEMPLATES

Subcontractor shall secure all field measurements required for proper and accurate fabrication and installation of the work included in this Subcontract. Exact measurements are the Subcontractor's responsibility. Subcontractor shall also furnish or obtain all templates, patterns, and setting instructions required for the installation of all work. All dimensions shall be verified by the Subcontractor by survey in the field.

1.12 ACCESS TO WORK

A. Pursuant to the provisions of Article GC-17 of the General Conditions, the authorized agents of the following agencies will also have the right of access to inspect the Work covered by these Subcontract Documents during the performance of this Subcontract:

1. United States Department of Energy (DOE)

2. United States Nuclear Regulatory Commission (NRC)

3. Navajo Nation

4. Various Agencies listed in Article SC-11 of Section 00800.

5. Other Local, State and Federal agencies.

B. The inspections will be performed in conjunction with an inspection by the Contractor. Reasonable facilities for the proper handling and inspection of the materials and the Work and any documents shall be furnished by the Subcontractor.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

PART 4 - MEASUREMENT AND PAYMENT

(Not Used)

END OF SECTION 01010

SECTION 01019

MOBILIZATION

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers the following:

1. Organization, mobilization and demobilization of Subcontractor's forces and equipment;

2. Transporting construction plant and equipment to the site and setting up of same;

3. Transporting tools, materials, and equipment to the site; and

4. Furnishing, installation, construction, maintenance, operation, and subsequent removal and disposal of construction facilities and temporary controls not separately paid for under other Sections of Subcontract Documents but required for construction of permanent facilities.

5. Subsequent removal of construction equipment, materials and supplies; decontamination of equipment and facilities; cleaning of equipment for salvage; cleaning of the site; and restoration and reseeding of offsite construction facilities.

1.2 RELATED WORK

A. Section 01500 - Construction Facilities

B. Section 01560 - Temporary Controls

C. Section 01561 - Construction Cleaning

1.3 DESCRIPTION

A. Mobilization shall include:

1. Furnishing, installation/construction of construction facilities identified in Article 1.1.A.4 above, and mobilization of all construction equipment, materials,

supplies, appurtenances, and the like, manned and ready for commencing and performing the Work.

2. Assembly and delivery to the site of plant, equipment, materials, and supplies necessary for the performance of the Work but which are not intended to be incorporated in the work; the preparation of the Subcontractor's work area; the complete assembly, in safe working order, of equipment necessary to perform the required work; personnel services preparatory to commencing actual work; and all other preparatory work required to permit commencement of the actual work on construction items for which payment is provided under the Subcontract.

3. Maintenance and operation of construction facilities identified in Article 1.1.A.4 above.

B. Demobilization shall include:

1. Decontamination of construction facilities, equipment, materials, supplies and appurtenances.

2. Subsequent removal from the site of all construction equipment, materials, supplies, appurtenances, and the like upon completion of the Work.

3. Maintenance, operation, subsequent removal and disposal of construction facilities identified in Article 1.1.A.4 above, as required by the Contractor, cleaning of the site, and restoration and reseeding of offsite construction facilities.

C. Mobilization Phasing: Mobilization will be done in three phases as follows:

1. Phase I:

a. Phase I provides for furnishing and installing construction facilities at both sites including, but not limited to:

1) Subcontractor's Office(s)

2) Contractor's Offices and trailers

3) Parking Areas

4) Janitorial Services

5) Temporary Roads

6) Storage Facilities

7) Sanitary Facilities

8) Electric Power

9) Temporary Water

10) Decontamination System

11) Temporary Heat

12) Temporary Telephone Service

13) Temporary Fences

14) Permanent Crossing at Gypsum Creek

b. Mobilization for all work covered in Bid Schedule Items 201, 202, 203, 204, 205, 206, 207 and 208 is included in Phase I.

2. Phase II: Phase II is for mobilization required to complete the work at Monument Valley and for some site work at Mexican Hat, including but not limited to:

a. At Monument Valley:

1) Demolition

[2) Removal and Disposal of Debris, Boulders and Rubble.]*

3) [Text Deleted]* [Not Used]*

4) Excavating, Hauling and Placement in the Tailings Embankment all Contaminated Materials from Monument Valley.

5) Clean Up Rock Surfaces.

6) Demolish and Dispose of Temporary Facilities.

7) Final Site Grading and Seeding.

b. At Mexican Hat:

1) Excavate and Place in the Disposal Embankment, Windblown Waterborne Contaminated Materials.

* P.I.D. 09-S-15

2) Clean Up of Rock Surfaces.

3) Rock excavation for permanent drainage features.

4) Preparation of Subgrade.

5) Fine Grading of Embankment Slopes.

6) Earthwork for Final Site Grading.

c. Mobilization for all work covered in Bid Schedule Items 209, 210, 211, 401, 402, 403, 801, 802 and 804 is included in Phase II.

3. Phase III:

a. Phase III is for mobilization required to complete the embankment cover and the remaining work of Mexican Hat and includes:

1) Setting Up and Operating Borrow Sources for Radon Barrier and Riprap Material.

2) Setting Up Plant for Mixing Radon Barrier Materials.

3) Providing Bentonite for Radon Barrier Materials

4) Placement of Radon Barrier Material.

5) Placement of Erosion Protection Material including Bedding, Riprap and Rockfill Materials.

6) Maintenance of Existing and Placement of New Displacement Monuments.

b. Mobilization for all work covered in Bid Schedule Items 404, 501, 502, 601, 602, 603, 604, 803 and 804 is included in Phase III.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

Each phase of Mobilization will be accomplished in accordance with the construction sequence provided in Section 01010,

Article 1.4, and as detailed in the Subcontractor's approved Construction Schedule.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement for payment for each phase of mobilization for the following items will be by the lump sum basis.

1. Mobilization Phase I
2. Mobilization Phase II
3. Mobilization Phase III

B. Measurement for payment for demobilization for all phases of the work will be by the lump sum basis.

4.2 PAYMENT

A. Payment for the items of Article 4.1 A. above for each phase of mobilization will be made at the lump sum price quoted therefor in the Bid Schedule, and shall include all work items as specified herein. Payment for each item of mobilization will be made as follows:

1. Payment of 50 percent of the lump sum price will be made upon completion of "move-in". Move-in is defined as organization of the Subcontractor's manpower and equipment, transporting equipment to the site, and installation of Subcontractor's equipment and other supporting structures for each phase of mobilization.

2. Payment of the remaining 50 percent of the lump sum price will be made upon completion of work corresponding to 10 percent of the total price quoted in the Bid Schedule for the Bid Schedule items included in each Phase of Mobilization exclusive of the price quoted for mobilization.

B. Payment for demobilization will be made at the lump sum price quoted therefor in the Bid Schedule and shall include all work items as specified herein.

C. Payment for furnishing, installing, operating, maintaining, decontaminating, removing and disposal, if required, of construction facilities not specifically included for payment under any other Bid Items will be considered to be included in the Bid Schedule item for Mobilization.

END OF SECTION 01019

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers descriptions of measurement and payment as they apply to this Subcontract. The provisions of this Section shall be supplemental to the requirements specified in General Provisions, General Conditions and Special Conditions.

B. Measurement methods specified in the individual Sections of these Specifications shall govern if they differ from methods specified in this Section.

C. The Subcontractor shall compute all quantities. Such computations shall be based upon surveys performed by the Subcontractor and subject to approval by the Contractor before any progress payments related thereto are made.

1.2 RELATED WORK

A. General Provisions - Article GP-38: Payments to Subcontractors

B. General Conditions - Article GC-4B: Progress Payments

C. Section 00800 - Special Conditions: Article SC-14, Variations in Quantities

D. Section 01052 - Layout of Work and Surveys

E. Section 01300 - Submittals: Schedule of Values and Progress Payment Schedule

1.3 MEASUREMENT OF QUANTITIES

A. Measurement Standards: All work to be paid for at a Contract price per unit of measurement will be measured in accordance with United States Standard Measures. A ton shall consist of 2,000 pounds avoirdupois.

B. Measurement by Weight:

1. Reinforcing steel, steel shapes, castings, miscellaneous metal, metal fabrications, and similar items, to be paid for by weight, shall be measured by scale or by handbook weights for the type and quantity of material actually furnished and used.

2. Material to be measured and paid for by scale weight shall be weighed on accurate, Contractor-approved scales, furnished by and at the expense of the Subcontractor. Use platform scales of sufficient size and capacity to permit the entire vehicle or combination of vehicles to rest on the scale platform while being weighed. Combination vehicles may be weighed as separate units provided they are disconnected while being weighed. All scales shall be inspected and certified as often as the Contractor may deem necessary to ascertain accuracy. Costs incurred, as a result of regulating, adjusting, testing, inspecting, and certifying scales, shall be borne by the Subcontractor.

3. The Contractor may be present to witness the weighing and to check and compile the daily record of such scale weights; however, in any case, the Contractor will require that the Subcontractor furnish weigh slips and daily summary weigh sheets. A duplicate weigh slip or a load slip for each vehicle weighed shall be delivered to the Contractor at the point of delivery of the material.

4. If the material is shipped by rail, the certified car weights will be accepted, provided that only actual weight of material will be paid for and not minimum car weight used for assessing freight tariff. Car weights will not be acceptable for material to be passed through mixing plants.

5. Trucks used to haul material being paid for by weight, shall be weighed empty daily and at such additional times as the Contractor may require. Each truck shall bear a plainly legible identification mark. The Contractor may require the weight of the material verified by weighing empty and loaded trucks on such other scales as the Contractor may designate.

C. Measurement By Volume:

1. Measurement by volume will be by the cubic dimension listed or indicated in the Bid Schedule. Method of volume measurement will be as specified in the applicable

Section of the Specifications or as determined or directed by the Contractor.

2. When material is to be measured and paid for on a volume basis and it is impractical to determine the volume by the specified method of measurement, or when requested by the Subcontractor in writing and accepted by the Contractor in writing, the material will be weighed in accordance with the requirements specified for weight measurement. Such weights will be converted to volume measurement for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Contractor and shall be agreed to by the Subcontractor before such method of measurement of pay quantities will be accepted.

D. Measurement by Area: Measurement by area will be by the square dimension listed or indicated in the Bid Schedule. Method of square measurement will be as determined or directed by the Contractor.

E. Linear Measurement: Linear measurement will be by the linear dimension listed or indicated in the Bid Schedule. Method of linear measurement will be as determined or directed by the Contractor. Generally, items, components, or work to be measured will be measured at the centerline of the item in place.

F. Lump-Sum Measurement:

1. Lump-sum measurement will be for the entire item, unit of work, structure, or combination thereof, as listed or indicated in the Bid Schedule.

2. If the Subcontractor requests progress payments for lump-sum items or amounts in the Bid Schedule, such progress payments will be made in accordance with a Schedule of Values for that item as specified in Specification Section 01300 and Article GC-4B of the General Conditions.

1.4 FIELD MEASUREMENT FOR PAYMENT

A. The Subcontractor shall compute all quantities of Work performed or of materials and equipment delivered to the site, for payment purposes. All such computations shall be subject to approval by the Contractor before any progress payments related thereto are made.

B. The Contractor may, at any time, verify quantities calculated by the Subcontractor in accordance with the provisions of Section 01052 of these Specifications.

C. The Subcontractor shall take measurements by providing all equipment, workers, and survey crews, as required, for verification of quantities by the Contractor in accordance with the provisions of Section 01052 of these Specifications.

D. All such assistance in measurement services required of the Subcontractor, as specified, shall be performed under the direction and supervision of the Contractor.

1.5 PAYMENT

A. Payment will be full compensation for furnishing all labor, materials, tools, equipment, transportation, services, and incidentals, as specified, in Article GP-38 of the General Provisions and Article GC-4B of the General Conditions, and for performing all work necessary for completing the erection or installation of the item or work classification, including all adjusting and balancing, testing, cleaning, and all other incidental work.

B. Full compensation for all expense involved in conforming to the requirements for measuring materials or work shall be considered as included in the unit or lump-sum prices paid for the materials or work being measured, and no additional compensation will be permitted therefor.

C. When progress payments are to be made on a portion, area, or section of the work, that portion, area, or section of the work shall be clear of deficiencies and nonconforming items, as determined by the Contractor, prior to making a progress payment.

1.6 VALUES OF UNIT PRICES

A. The number of units and quantities contained in the Bid Schedule are approximate only, and final payment will be made for the actual number of units and quantities which are incorporated in or made necessary by the Work included in this Subcontract.

B. In the event that work and/or materials or equipment are required to be furnished to a greater or lesser extent than is indicated by the Subcontract Drawings and Specifications, such work and/or materials or equipment shall be furnished in greater or lesser quantities, and the adjustment in unit

price shall be made as specified in Article SC-14 of the Special Conditions.

1.7 REJECTED MATERIALS

Quantities of material wasted or disposed of in a manner not called for under the Subcontract; rejected loads of material, including material rejected after it has been placed by reasons of the failure of the Subcontractor to conform to the provisions of the Subcontract; material not unloaded from the transporting vehicle; material placed outside the limits indicated on the Subcontract Drawings or established by the Contractor; or material remaining on hand after completion of the Work, will not be paid for, and such quantities shall not be included in the final total quantities. No compensation will be permitted for loading, hauling, and disposing of rejected material.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Separate measurement for payment will not be made for work required under this Section.

4.2 PAYMENT

Separate payment will not be made for work required under this Section. All costs in connection with the work specified herein will be considered to be included in the related item of work in the Bid Schedule, or incidental to the Subcontract.

END OF SECTION 01025

SECTION 01052

LAYOUT OF WORK AND SURVEYS

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers the procedures and accuracy requirements for survey services for the following:

1. Layout and performance of Work

2. Field measurement of work quantities.

3. Locations of sampling and testing performed by the Contractor.

4. Determination of as-built locations, lines, and grades at completion of the work for preparation of as-built drawings as specified in Section 01300.

B. Before commencing any layout of work and surveys, the Subcontractor shall give the Contractor five working days written notice in advance so that the Contractor may witness such work.

1.2 DESCRIPTION

A. Reference Points: The reference points to be provided by the Contractor will include referenced monuments and elevation bench marks in the vicinity of the project. Initial reference points will be furnished and established by the Contractor. Replacement by the Contractor of Contractor-established reference points which have been damaged or destroyed by the Subcontractor will be charged to the Subcontractor at a rate of $150 per hour. All other necessary reference points shall be established by the Subcontractor.

B. The Subcontractor shall furnish all necessary detail surveys including all lines, grades, and appropriate surveys as specified.

C. The Contractor reserves the right to perform any desired checking and/or correction of the Subcontractor's surveys but this shall not relieve the Subcontractor of responsibility for the adequate performance of the work.

D. Equipment and Personnel: The Subcontractor's instruments and other survey equipment shall be accurate, suitable for the surveys required in accordance with recognized professional standards, and in proper condition and adjustment at all times. A competent surveyor shall perform the work.

E. Field Notes and Records: The Subcontractor shall record surveys in duplicate page field notebooks. The original pages of such records shall be furnished to the Contractor at intervals required by the Contractor. A duplicate of each field notebook shall be furnished to the Contractor when filled or completed or to meet the requirements of Article GC-4, Progress Payment.

F. Use by the Contractor: The Contractor may at any time use line and grade points and markers established by the Subcontractor. The Subcontractor's surveys are a part of the Work and may be checked by the Contractor or representatives of the Contractor at any time. The Subcontractor shall be responsible for any lines, grades, or measurements which do not comply with specified or proper tolerances, or which are otherwise defective, and for any resultant defects in the Work. The Subcontractor will be required to conduct re-surveys or check surveys to correct errors indicated by review of the field notebooks or otherwise detected.

1.3 SURVEYS FOR LAYOUT AND PERFORMANCE OF WORK

The Subcontractor shall perform all surveys for layout and performance of the Work, and shall reduce the field notes and make all necessary calculations and drawings necessary to carry out the Work.

1.4 SURVEYS FOR MEASUREMENT FOR PAYMENT

When the Specifications or the Contractor require Bid Schedule items of work to be measured by surveying methods, the Subcontractor shall perform the surveys. All such surveys, including control surveys run for establishing the measurement reference lines, shall be performed and recorded in duplicate field survey notebooks. The Subcontractor shall reduce the field notes and calculate final quantities for payment purposes. A duplicate of the note reductions and calculations shall be given to the Contractor. Original field survey notebooks shall be submitted upon request or when notebooks are completely filled, and become the property of the Contractor.

1.5 SURVEYS FOR CONTRACTOR SAMPLING AND TESTING LOCATIONS

A. The Subcontractor shall perform surveying services as specified herein for the locations of Contractor sampling and testing.

B. Materials Sampling and Testing: The Subcontractor shall provide surveying services to locate positions, both plan and elevation, of in-place material sampling and testing locations used by the Contractor. The number of sampling and testing locations will be determined by the associated Specification Section.

C. The Subcontractor shall mark sampling locations for radiologic samples in the tailings embankment at locations shown on the Drawings and as specified herein. As contaminated materials are placed in the uppermost 20 feet of contaminated materials, the Subcontractor shall mark each location at each 2-foot increment of elevation.

D. All sampling and testing location information shall be submitted in writing to the Contractor showing coordinates and elevations.

E. The Subcontractor shall assist the Contractor in the radiological survey by establishing a 150 foot x 150 foot survey grid in excavated contaminated areas.

1.6 SURVEYS FOR AS-BUILT CONDITIONS

A. The Subcontractor shall provide surveying services for as-built conditions as specified herein.

B. The Subcontractor shall provide survey data to confirm that as-built locations of the Work conform to the Subcontract Drawings where coordinates and/or elevations are shown.

C. Where the Subcontract Drawings or Specifications permit variable locations or detail for specific items of the Work, the Subcontractor shall survey the as-built locations or details. Surveys shall be sufficient to define the features or details at any given location.

D. The Subcontractor shall survey as-built elevations, at each location as directed by the Contractor for radiologic sampling of the tailings embankment, for the as-built finished top surface of the following:

1. Contaminated materials
2. Radon barrier

3. Bedding
4. Riprap

E. The Subcontractor shall survey as-built locations of all slope breaks for the tailings embankment and site grading.

F. The Subcontract Drawings shall be neatly marked in red ink with all as-built survey information and submitted to the Contractor in duplicate.

G. The requirements for submitting as-built survey data shall not relieve the Subcontractor in any way from his responsibility to conform to the requirements of the Work.

1.7 SURVEYING FOR DISPLACEMENT MONUMENTS

A. Displacement monuments shall be surveyed immediately following installation and thereafter on a weekly basis. Existing displacement monuments shall be surveyed immediately following mobilization and thereafter on a weekly basis. The Subcontractor shall report the coordinates and elevation of the top of the 3/4-inch steel rod and the top of the 1-1/2 inch steel pipe as shown on the Subcontract Drawings and in the Information for Bidders.

B. For displacement monuments having total lengths of steel rod and steel pipe greater than 5 feet, the Subcontractor shall survey the top of the steel rod and steel pipe immediately prior to and following installation at each segment of steel rod or steel pipe during construction, as specified in Article 1.7.A.

C. The top of steel pipe shall be surveyed at the same location on the diameter of the pipe for each measurement.

D. Displacement monuments shall be surveyed immediately following any disturbance to any displacement monument.

1.8 SURVEYING ACCURACY AND TOLERANCES IN LAYOUT OF WORK

A. Tolerances in layout of Work shall not exceed the following:

Type of Line or Mark	Horizontal Position	Elevation
Permanent reference points and displacement monuments	1 in 10,000	± .01 ft.
Reference points for general excavation and earthwork	1 in 2,000	± .10 ft.

B. Tolerances for designed thicknesses shown on Subcontract Drawings with the exception of erosion protection materials, and for elevations shown on the Subcontract Drawings shall be ± 0.10 foot. Tolerances for erosion protection material thickness are specified in Section 02278.

C. These tolerances shall not supersede stricter tolerances required by the Drawings or Specifications, or by the governing authorities, and shall not otherwise relieve the Subcontractor of responsibility for measurement in compliance therewith.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Separate measurement for payment will not be made for work required under this Section.

4.2 PAYMENT

Separate payment will not be made for work required under this Section. All costs in connection with the work specified herein will be considered to be included in the related item of work in the Bid Schedule, or incidental to the Subcontract.

END OF SECTION 01052

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Specification Section describes the requirements for the following submittals:

1. Technical Submittals:
   a. Schedule of Technical Submittals
   b. Shop Drawings
   c. Samples
   d. Product Data
   e. Certificates of Compliance
   f. Manufacturer's Instructions
   g. Design Calculations and Design Drawings
   h. Winter Shutdown Plans
   i. Drawings Showing Lines and Grades and Survey Data for Conditions at Completion of Construction (As-Built)
   j. Erosion Protection Materials Production Plan
   k. Proactive Dust Suppression Plan
   l. Operations Plan for each Decontamination Facility

2. General Submittals:
   a. Schedule of General Submittals
   b. Site Mobilization Schedule
   c. Project Construction Schedule
   d. Schedule of Values/Cost Profile
   e. Hazard Communications Plan
   f. Safety Plan
   g. Traffic Plan
   h. Waste Minimization and Recycling Plan
   i. Spill Prevention, Control and Countermeasure Plan
   j. Hazardous Waste Operations, Site Safety and Health Plan
   k. Monthly Report Detailing Costs in the Event of a Suspension or Termination

3. Submittals Not Requiring Contractor's Approval:
   a. Weekly Status Reports
   b. Weekly Manhour Reports/Equipment and Truck Hours Report/Maintenance Report
   c. Certified Payroll
   d. Monthly Construction Schedule and Schedule of Values, Progress Updates
   e. Labor and Equipment Rates

B. The requirements specified in this Section shall be supplemental to the requirements specified in General Provisions, General Conditions, Special Conditions and any other requirements specified in individual sections.

C. All submittals shall be in the English language, and signed by the Subcontractor's Site Manager or designee.

D. The Subcontractor shall submit all submittals to the Site Manager. A reproducible copy of the submittal, marked "Information Only," shall be sent to the Subcontract Administrator by the Subcontractor.

E. Technical and General Submittals shall be numerically serialized by type, Technical Submittal with a "T" prefix (T-1, T-2, T-3, etc.) and General Submittals with a "G" prefix (G-1, G-2, G-3, etc.).

F. The Site Manager will clearly label the submittals as follows and return to the Subcontractor:

1. Approved
2. Approved as Noted
3. Revise and Resubmit
4. Rejected
5. Information Only

G. When submittals are returned marked with either "Revise and Resubmit" or "Rejected" the Subcontractor shall make such revisions and corrections as required and resubmit the submittal with the same submittal number followed by R1 (Revision One). Example: T-5 - R1.

1.2 TECHNICAL SUBMITTALS

A. Schedule of Technical Submittals:

1. The Subcontractor shall prepare and submit a Technical Submittals Schedule listing all technical submittals required in accordance with this Section. The Technical Submittals Schedule shall be submitted at the preconstruction meeting.

2. The Technical Submittals Schedule shall separate submittals by major specification section. This schedule shall include submittal delivery dates, required return dates, material delivery dates, and other pertinent data which may be required to ensure that the project schedule is met by the Subcontractor.

3. This Schedule shall be continually updated to reflect progress and any additions or deletions to the submittal

schedule. Copies of the updated schedule shall be furnished to the Contractor during the first week of each calendar month.

B. Shop Drawings:

1. Shop drawings shall establish the actual detail of all manufactured or fabricated items, indicate proper relation of adjoining work, and incorporate minor changes of design or construction to suit actual conditions. Shop drawings shall be drawn to scale and shall be completely dimensioned.

2. Sheet sizes of shop drawings shall be 8 1/2 inches x 11 inches, 11 inches x 17 inches, or 22 inches x 34 inches.

3. A clear space of 3 inches x 3 inches shall be provided on each drawing for the Contractor's review stamp and comments.

4. Shop drawings shall be submitted to the Contractor in the form of a reproducible transparency, together with three blackline or blueline prints.

5. After the Contractor has completed his review of shop drawings, he will return one print to the Subcontractor indicating the approval status as described in Article 1.1.F.

6. The Contractor will review and generally return shop drawings within ten days of receipt by the Site Manager but in no case will this process take longer than 30 days.

C. Samples:

1. The Subcontractor shall furnish the Contractor at least three samples of each of the various materials, together with the finish thereon, as specified for and intended to be used on or in the work. Samples shall be sent to the Contractor.

2. The Subcontractor shall submit all samples to the Contractor at least 30 days (or earlier if so specified elsewhere) before purchasing, fabricating, applying, or installing such materials and finishes, unless otherwise stated. The Contractor will review the samples for visual aspects such as kind, color, pattern, and texture, and will approve or ask for resubmittal of samples generally within 10 days. All approvals of samples will be given by the Contractor in writing.

3. Unless otherwise specified in the various sections of these specifications, the Subcontractor shall submit all samples, other than field samples, in triplicate. A cover letter shall accompany the sample and shall list all items being transmitted, designating their particular usage and location in the project.

4. Each sample shall be identified completely as to product, color, manufacturer, trade name, lot, style, model, location of use, and Subcontract Document reference, as well as the names of the Subcontractor, Supplier, Project and Contractor.

5. Samples shall be submitted and resubmitted until approved as satisfactory. Approval of a sample shall not be taken in itself to change or modify any Subcontract requirement.

6. After the Contractor has performed his review and analysis of samples, two samples will be retained and the remaining sample will be returned to the Subcontractor, with the Contractor's comments.

7. All materials, color, pattern and texture in the completed building or structure shall be equal in every respect to that of the approved samples.

8. Test samples, as designated by the Contractor, may also be selected from the materials or equipment delivered by the Subcontractor to the site for use in the work. If any test sample fails to meet the specification requirements, such materials or equipment which fail the testing, shall be removed and replaced by the Subcontractor with materials or equipment meeting the Specification requirements.

9. Field samples shall be prepared at the site by the Subcontractor in the manner and number as specified in these specifications. Affected finish work shall not be commenced until the Contractor has approved the field samples, in writing.

D. Product Data:

1. Each copy shall be marked to identify applicable products, models, options, and other data; manufacturers' standard data shall be supplemented to provide information unique to the work.

2. The Subcontractor shall submit the number of copies which the Subcontractor requires to be returned, plus two copies which will be retained by the Contractor.

E. Certificates of Compliance: The Certificate shall clearly identify the applicable materials and reference the applicable Sections of the Subcontract Documents.

F. Manufacturer's Instructions: When required by the manufacturer's warranty requirements, the Subcontractor shall submit manufacturer's printed instructions for delivery, storage, shelf life, assembly, installation, adjusting, and finishing.

G. Design Calculations and Design Drawings:

1. Design Calculations: When requested by the Contractor, design calculations shall be submitted to the Contractor for review with all pertinent data, assumptions, objective, criteria, applicable codes, standards and references. The calculations shall be on 8-1/2 by 11-inch or 11 by 17-inch sheets. Each design calculation set shall bear page numbers, titles, revision numbers, date and calculation number. Where multiple number of items are designed in a particular system, the calculations shall be preceded by a table of contents.

2. Design Drawings:

a. When requested by the Contractor, design drawings shall be submitted to the Contractor for review.

b. Pertinent requirements of Article 1.2.B of this Section shall be applicable for submittal of design drawings.

H. Winter Shutdown Plans: A separate mandatory winter shutdown plan will be required each year covering the period from December 1 through February 28 during which time there will be no site work. As specified in Section 01500, all facilities and utilities will be installed and maintained providing uninterrupted service throughout these shutdown periods. The plans shall include grading modifications to drawings, product data and a narrative of the steps the Subcontractor will take to address the following subjects:

1. Erosion from wind and water runoff of both contaminated and uncontaminated areas.

2. Slope protection.

3. Temporary ditching.

4. Grading of excavations and embankments to drain.

5. Segregation of contaminated and non-contaminated runoff.

6. Reduction of water in the retention ponds to allow for spring snow melt.

7. Protection of all equipment and piping from damage due to freezing.

8. Other items may be required by the Contractor such as personnel and equipment to maintain access and to prepare for emergency situations.

I. Drawings Showing Lines and Grades and Survey Data for Conditions at Completion of Work (As-Built): The Subcontractor shall prepare and submit at completion of work drawings showing lines and grades (as-built) and survey data for as-built conditions as specified in Section 01052.

J. Erosion Protection Materials Production Plan: See Section 02278, Article 1.6.

K. Proactive Dust Suppression Plan: See Special Conditions, Article SC-3.D.

L. Operations Plan for Each Decontamination Facility: See Section 01500, Article 1.15.G.

1.3 GENERAL SUBMITTALS

A. Schedule of General Submittals: The Subcontractor shall prepare and submit a Schedule of General Submittals listing all General Submittals required in accordance with the requirements of this Section. The Subcontractor shall prepare and make the initial submittal at the preconstruction meeting of all General Submittals required.

B. Schedules and Reports:

1. The Subcontractor shall prepare and submit Schedules and Reports in accordance with the requirements of this Section.

2. The schedules and reports shall describe the Subcontractor's work plan in sufficient detail as delineated below to provide:

a. Assurance to the Contractor that the finished work complies accurately with the Subcontract Documents,

b. A basis for determining the progress of the work, and

c. A basis for the Contractor's internal planning activities.

[3. Within fifteen calendar days after Notice to Proceed, the Subcontractor shall provide the Contractor with initial copies of the General Submittals specified in this Section. If the CPM Project Construction Schedule is generated by computer, a copy of all schedule submittals shall also be provided on 3-1/2-inch floppy disks. The specific format for the floppy disk files will be approved by the Contractor following subcontract award.]*

4. The schedules shall be in a reproducible form and all of the same scale or may be combined as approved by the Contractor.

5. Unless otherwise specified, the schedules shall be presented in graphic format and shall be updated for each construction meeting, or at least monthly, and transmitted to the Contractor.

6. The Subcontractor shall obtain approval of the various schedules specified in this Section before submitting the first application for payment. Schedule revisions also require Contractor approval.

C. Site Mobilization Schedule:

1. Format: The Subcontractor shall present, at the preconstruction meeting, the schedule for Phase I Site Mobilization in bar chart format. The schedule for Phase I Mobilization shall delineate the establishment of the construction facilities identified in Section 01500 and as referenced in Section 01019.

[2. Written Narrative: The Site Mobilization Schedule shall be accompanied by a written narrative discussion of the schedule. The narrative shall provide transportation routes proposed for delivery of major construction equipment to be used on the project, identification of special permits required and when they are needed, and a description of the temporary facilities to be provided.]*

* P.I.D. 09-S-15

3. Status and Progress: The status of mobilization schedule items shall be reported in the Weekly Status Report discussed below.

D. Project Construction Schedule:

[1. Scheduling: A preliminary issue of the Project Construction Schedule shall be prepared for review at the pre-construction meeting. Fifteen days after receipt of Notice to Proceed the Subcontractor shall submit the Project Construction Schedule for approval and submit the approved Project Construction Schedule ten days after receipt of approval and comments from the Contractor.]*

2. Format: The Project Construction Schedule shall consist of the following items, each compatible with the other and developed from the same basis:

a. Method of Construction Narrative

[b. CPM Schedule: A time scaled Critical Path Method (CPM) Schedule which depicts proper restraints, activity durations, total float and free float for each schedule activity including a predecessor-successor report and logic diagram.]*

c. Critical Milestone Dates as listed below.

1) Start/complete mobilization (Phase I) at Hat Disposal Site and Mon Processing Site.

2) Installation of temporary facilities, utilities and controls.

3) Start/complete mobilization (Phase II) at Hat Disposal Site and Mon Processing Site.

4) Start/complete transportation of demolished materials, debris and rubble from Mon Processing Site to Hat Disposal Site.

5) Start/complete excavation and transportation of tailings and other contaminated materials from Mon Processing Site to Hat Disposal Site.

6) Start/complete site restoration at Mon Processing Site.

* P.I.D. 09-S-15

7) Start/complete mobilization (Phase III) at Hat Disposal Site.

8) Start/complete excavation and transportation to disposal embankment of contaminated materials from Hat Disposal Site.

9) Start/complete construction of radon barrier at the disposal embankment.

10) Start/complete grading for permanent ditches and gullies.

11) Start/complete transportation and placement of erosion protection materials at Hat Disposal Site.

12) Start/complete site restoration at Hat Disposal Site.

13) Start/complete demobilization.

d. Schedule of Values

3. Method of Construction: Method of construction submitted at the preconstruction meeting with the preliminary schedule shall be a written discussion of the Subcontractor's methods for completing the work. The Subcontractor shall briefly describe his approach to the Subcontract.

4. The Use of Schedule Float: In as much as the Subcontractor's Schedule represents the Project Construction Schedule, the calculated float for an activity is shared by the Subcontractor and Contractor. Adjustments to the schedule float will be equitably resolved by the Contractor.

5. Computer Generated Schedule: The Subcontractor may generate the CPM Schedule manually or by using a computer. The CPM Schedule shall include all significant items of Work. The Schedule shall identify any interruption of work activities due to winter shutdown as applicable.

6. Comments Incorporated: The Subcontractor shall incorporate the Contractor's comments into revisions of the Project Construction Schedule, adjust the manpower loading as required and resubmit the schedule to the Contractor for approval along with a summary of the changes.

7. Revisions made to the schedule shall be given a new revision number and submitted to the Contractor for approval. A written narrative shall accompany any changes to the logic and/or durations of the Construction Schedule. This narrative shall explain in detail what the change involves, the reason for the change, and any effect to the critical path of the schedule.

E. Schedule of Values/Cost Profile:

[1. Each time a construction schedule is submitted, it shall be accompanied by a Schedule of Values for the entire Scope of Work. The Schedule of Values shall conform to the format sample (01300-A) provided with this Section. The Schedule of Values shall be based upon that specific revision of the Construction Schedule, and presented in such a format to clearly provide total period and cumulative cost information for each month for the entire duration of the Subcontract. This Schedule of Values shall be in a form which will provide a correlation between the subcontract bid items and the Subcontractor's schedule activities.]*

2. The format and the substance of the finalized Schedule of Values shall be as approved by the Contractor.

F. Hazard Communications Plan: See Section 00800, Article SC-7.

G. Subcontractor's Safety Plan: See Section 00800, Article SC-7.

H. Traffic Plan: See Section 00800, Article SC-7.

I. Waste Minimization and Recycling Plan: See Section 01560, Article 1.6.B.5.

J. Spill Prevention Control and Countermeasure Plan: See Section 01560, Article 1.6.B.4.

K. Hazardous Waste Operations, Site Safety and Health Plan: See Section 00800, Article SC-7.

[Text Deleted]*

1.4 SUBMITTALS NOT REQUIRING CONTRACTOR APPROVAL

A. The Subcontractor shall furnish the following submittals for information only. These submittals will not be approved and returned to the Subcontractor.

* P.I.D. 09-S-15

1. Weekly Status Reports: The Subcontractor shall submit a Weekly Status Report to the Contractor by Thursday noon. The report shall be on a form satisfactory to the Contractor, and shall include items such as a Summary of Work completed and a Two-Week Look Ahead Bar Chart. Weekly Status Report shall also include each major piece of equipment present on the site, its make, model, type, number of hours idle, number of hours used, etc. as required by the Contractor.

2. Weekly Manhour Report/Equipment and Truck Hours Report/Maintenance Report: The Subcontractor shall tabulate total manhours worked each week with a regular and overtime total, equipment hours of operation and truck miles driven each week, listing all data for Subcontractor and lower-tier subcontractor operations. The tabulations shall be prepared and submitted weekly to the Contractor. The Maintenance Report shall be submitted to the Contractor monthly as follows:

   a. Preventative Maintenance:

      _____ # Items Completed within Monthly Schedule

      _____ # Items Not Completed within Monthly Schedule

   b. Corrective Maintenance:

      _____ # Number of Corrective Work Requests During Month

      _____ # Number of Corrective Work Requests Open at End of Month

3. Certified Payrolls: Certified Payrolls shall be submitted in strict compliance with Section 10 of MK-Ferguson Company Standard Documents Package for proposed construction subcontracts.

[4. Monthly Construction Schedule Progress Updates: The Subcontractor shall submit an updated schedule, with the Critical Milestones clearly identified, by the first of each month. The status of the CPM Schedule shall indicate percent complete by activity, remaining duration of in-progress activities, total float and free float for each schedule activity. If the CPM Project Construction Schedule is generated by computer, a copy of all schedule submittals shall also be provided on 3-1/2-inch floppy disks as well as in a reproducible form. The specific

format for the floppy disk files will be approved by the Contractor following subcontract award.]*

5. Labor and Equipment Rates: The Subcontractor shall submit labor and equipment rates as stipulated in Subcontractor Labor and Equipment Rates of the Special Conditions.

[6. Monthly Report Detailing Costs in the Event of a Suspension or Termination: See Section 00800, Articles SC-17.G and H.]*

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Separate measurement for payment will not be made for work specified in this Section.

4.2 PAYMENT

Separate payment will not be made for work specified in this Section. All costs in connection therewith shall be considered to be incidental to the applicable items of work to which they pertain.

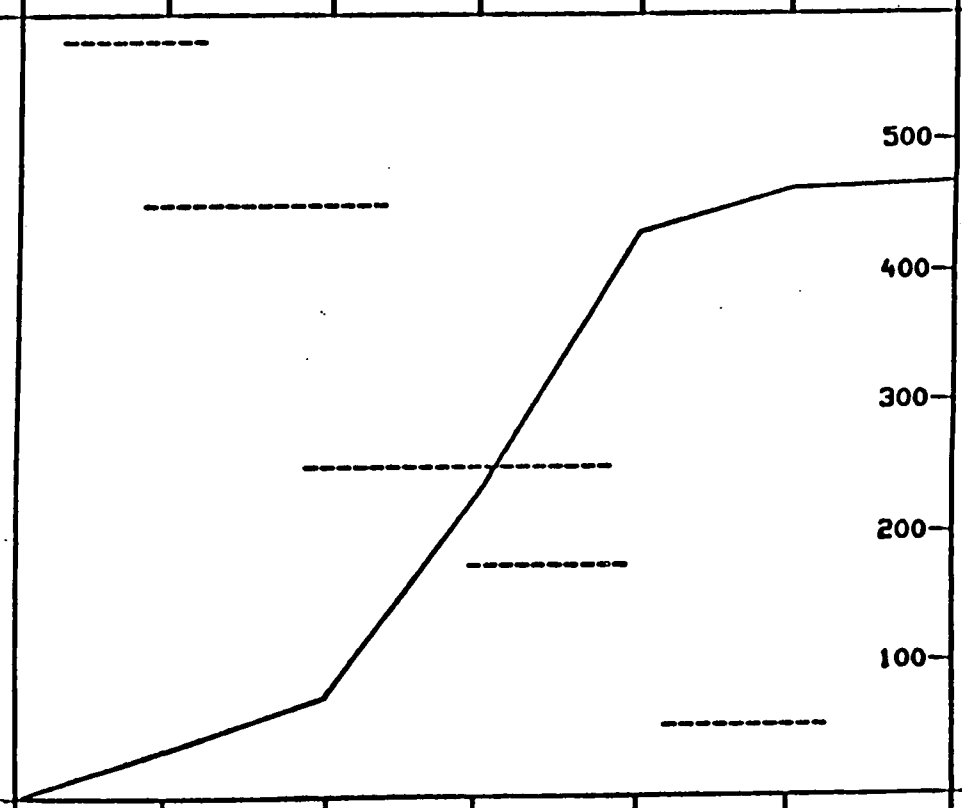
END OF SECTION 01300

* P.I.D. 09-S-15

UMTRA PROJECT
SUBCONTRACT DOCUMENTS _____
SCHEDULE OF VALUES

SAMPLE

DESCRIPTION	SCHEDULE ACTIVITY NUMBER	BID ITEM NUMBER	BID ITEM PERCENT	1987 MARCH	APRIL	MAY	JUNE	JULY	AUGUST	TOTAL DOLLARS
MOBILIZATION	1	001	50%							$32,000
INSTALL FENCE AT CONTRACTOR'S OFFICE	2	901 902	25% 100%							$57,000
EXCAVATION (TAILINGS)	3	204	100%							$320,000
INSTALL REMAINING FENCE	4	901	75%							$21,000
DEMOBILIZATION	5	001	50%							$32,000
TOTAL:		PERIOD		$31,000	$40,000	$152,000	$207,000	$30,000	$2,000	$462,000
		CUMULATIVE		$31,000	$71,000	$223,000	$430,000	$460,000	$462,000	



CONSTRUCTION START DATE: 3/10/87
CONSTRUCTION COMPLETION DATE: 8/07/87

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

SECTION 01500

CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers the requirements for the construction facilities.

B. Construction facilities shall include, but not be limited to, the following temporary offices, utilities, equipment, materials and services:

1. Subcontractor's Office
2. Contractor's Offices
3. Parking Areas
4. Janitorial Services
5. Snow Removal Services
6. Temporary Roads
7. Storage of Materials and Equipment
8. Construction Equipment
9. Temporary Sanitary Facilities
10. Temporary Electric Power
11. Temporary Water
12. Decontamination System
13. Temporary Heat
14. Temporary Telephone Service
15. Temporary Fences

C. Construction facilities shall also include the permanent crossing at Gypsum Wash.

D. The Subcontractor shall be responsible for furnishing, installing, constructing, operating, maintaining, removing and disposing of the facilities as shown on the Subcontract Drawings, as specified in this Specification, and as required by the Contractor for the completion of the Work under the Subcontract.

E. All such temporary facilities shall be located as shown on the Subcontract Drawings, or as directed, and maintained in a clean, safe and sanitary condition at all times until completion of the Subcontract.

F. Upon completion of the Subcontract, the temporary facilities shall be left in the status specified in Article 1.21 of this Section.

G. The requirements specified herein are in addition to any requirements specified elsewhere in the Subcontract Documents. Temporary facilities shall meet the requirements for all-weather service.

H. Certain facilities specified in this Section, although referred to in singular, may be required in greater numbers. The number of facilities required shall be as shown on the Subcontract Drawings.

I. All utilities shall be designed and constructed to provide uninterrupted service during winter. The nearest utilities are located in Halchita, Utah. There, the Navajo Tribal Utility Authority provides domestic water, sanitary sewage collection service and electricity, and the Navajo Communications Company, Inc. provides telephone service. The domestic water system is a complete water-treatment facility on the San Juan River just north of Halchita. It has a production capacity of 0.43 million gallons per day and a storage capacity of 125,000 gallons. The sewer system consists of two lagoons, only one of which is currently utilized at less than full capacity. There is no natural gas service in the nearby area, but bottled propane service is available from Doxol Propane in Kayenta, Arizona.

J. All land disturbances related to the temporary facilities shall be minimized to the greatest extent possible and the land restored to the extent reasonable and practical, to its original contours by grading to provide positive drainage and, where required, by seeding the area to match with existing vegetation.

1.2 RELATED WORK

A. Section 00800 - Special Conditions

B. Section 01019 - Mobilization

C. Section 01560 - Temporary Controls

D. Section 02050 - Demolition

E. Section 02200 - Earthwork

1.3 APPLICABLE PUBLICATIONS

A. The Publications listed below form a part of this Specification to the extent referenced. The Publications are referred to in the text by the basic designation only:

1. UMTRA Project Construction Environment, Safety and Health Management Program (MK-UMTRA-4)

2. Arizona Highway Department: "Standard Specifications", as applicable.

3. State of Utah, Standard Specifications for Road and Bridge Construction, 1979 Edition and Subsequent Revisions, as applicable.

4. Uniform Building Code (UBC):
1988 Edition, applicable Chapters and Sections.

5. National Fire Protection Association (NFPA), as applicable.

6. Occupational Safety and Health Administration (OSHA), as applicable.

7. Code of Federal Regulations, Title 29, Part 1926: Safety and Health Regulations for Construction.

B. All required facilities, equipment and utilities shall also be constructed/installed, maintained and operated in accordance with applicable Federal, Navajo Nation, State, County, and Utility laws, rules, and regulations. Notwithstanding contrary provisions of General Provisions, General Conditions and Special Conditions, nothing in the Subcontract Drawings and Specifications shall be construed to permit work not conforming to the above.

C. Unless otherwise specified elsewhere in the Subcontract Documents, the Subcontractor shall be responsible for obtaining applicable Federal, Navajo Nation, State and County permits and for complying with the provisions of such permits.

1.4 SUBCONTRACTOR'S TEMPORARY OFFICE TRAILER(S)

A. Subcontractor shall furnish and install, in good condition, one or more temporary office trailer(s) of suitable sizes for himself and his office staff.

B. The location of the trailer(s) shall be approved by the Contractor prior to setting in place.

1.5 CONTRACTOR'S TRAILERS

A. The Subcontractor shall furnish and install the following trailers for the Contractor's staff:

1. Contractor's Office Trailer at the Monument Valley Site: 720 square feet (12 ft. x 60 ft.).

2. Access Control Trailers:

a. The trailers will be used by the Contractor's administrative, security and Health Physics personnel. Each trailer shall include decontamination facilities including change facilities for all personnel working on the site, a single shower for occasional use by all personnel, a sink, and provisions for a washer and dryer, including plumbing and electrical services. All waste water shall drain directly to the recirculation pond. The Subcontractor shall provide two trailers, one at each of the sites.

b. Each trailer shall provide a floor space of 720 square feet (12 ft. x 60 ft.) and generally follow the arrangement shown in the Information for Bidders.

3. Quality Control Trailer:

a. The trailer will be used as a laboratory for testing of construction materials, and shall be located at the Mexican Hat site.

[b. The trailer shall provide a floor space of 720 square feet (12 ft. x 60 ft.) and generally follow the arrangement shown in the Information for Bidders.]*

4. Meeting and Training Room Trailer:

a. The trailer shall be used by the Contractor for required Health and Safety training for all personnel and shall be located at the Mexican Hat site.

b. The trailer shall provide a total floor space of 720 square feet (12 ft. x 60 ft.) which includes a 180 square foot (12 ft. x 15 ft.) office at one end, and generally follows the arrangement shown in the Information for Bidders.

* P.I.D. 09-S-15

5. Change Facilities Trailers:

a. The trailers shall be used by the Contractor to provide changing facilities for all personnel. The facilities shall include a 144 square foot (12 ft. x 12 ft.) changing and personal storage areas at each end. The central area shall contain at least 200 locker cubicles, each 12 inches x 12 inches x 16 inches deep along the walls. The Subcontractor shall provide two trailers, one at each site.

b. The trailers shall provide a total floor space of 720 square feet (12 ft. x 60 ft.), and generally follow the arrangement shown in the Information for Bidders.

B. The Contractor's office trailer and Subcontractor's office trailers shall be located inside the fenced Contractor's office area at each site. One access control trailer shall be located at the decontamination area at the upper access control area at Mexican Hat. The other access control trailer shall be located at the decontamination area at Monument Valley. The quality control trailer shall be located at the lower access control area at Mexican Hat. The meeting and training room trailer shall be located inside the fenced Contractor's office area at the Mexican Hat site. The decontamination trailers shall be located at each site within the site fence near the access control trailers. Final location of the trailers shall be as approved by the Contractor.

C. Each trailer shall be provided with running water and power, and shall be properly lighted and temperature conditioned for summer and winter use. Wash basins and toilets shall be connected to sanitary facilities specified in Article 1.12.

D. Each trailer shall be equipped with steps, stoops, handrailings, a deck at the door sill level, skirting all around the trailer, and trailer tie-downs.

E. The Subcontractor shall furnish and install the trailers on site no later than 20 calendar days after Notice to Proceed.

1.6 PARKING AREAS

A. No personal vehicles will be permitted inside the construction work area. Vehicles used for construction purposes will be allowed inside the work area, but will be monitored for radioactive contamination at the access gate or control point before leaving the area.

B. An aggregate based parking area for Contractor and Subcontractor's representatives, visitors and maintenance and delivery vehicles exists within the fenced Contractor's office area at each site. Parking for Subcontractor's laborers and workers and others shall be near the access control gate outside the fenced area. At the Mexican Hat site, the parking for Subcontractor's laborers and workers shall only be at the upper access control area.

C. Any additional parking required shall be the responsibility of the Subcontractor and subject to the Contractor's approval.

1.7 JANITORIAL AND MAINTENANCE SERVICES

A. The Subcontractor shall provide daily maintenance and janitorial services including, but not limited to, the following for all Contractor's trailers, toilet facilities and the access control area:

1. Sweep, vacuum, mop, and, if required, polish floors.

2. Clean toilets, doors and windows, office furniture.

3. Collect and dispose of office and yard solid waste.

4. Furnish toilet paper, hand towels, soap, cups, napkins, light bulbs, etc.

5. Operate and maintain trailer services including, but not limited to, the water supply and wastewater collection systems; heating, ventilating and air-conditioning system; and lighting and security systems, including doors, windows, steps, floors and lighting fixtures.

6. Janitorial and maintenance services shall be provided throughout the term of the Subcontract.

1.8 SNOW REMOVAL SERVICES

A. The Subcontractor shall provide snow removal services in the following areas throughout the term of the Subcontract:

1. Walkways to the office trailers,

2. Parking areas,

3. Equipment and material storage areas, and

4. Access roads to site facilities as necessary.

1.9 TEMPORARY ROADS

A. Temporary roads as defined in Article SC-1 of the Special Conditions shall include, but not be limited to, the following. The design, construction and maintenance shall meet the requirements of this Article.

1. Existing Indian Service Route 6440 connecting the Monument Valley and Mexican Hat sites which shall also be used as an access or haul road. The road is approximately 16-1/2 miles long and 40 feet wide. It crosses several drainage courses. Existing culverts shall be maintained. Part of the existing alignment follows a winding course. The roadway is utilized by local residents. Prior to hauling contaminated materials from Monument Valley, the Subcontractor shall complete the permanent crossing at Gypsum Wash.

2. Existing Monument Valley site bypass road as shown on the Subcontract Drawings. The bypass road is at least 12 feet wide.

3. New access road from U.S. Highway 163 to the Mexican Hat upper access control area.

4. Existing access road from U.S. Highway 163 to the Mexican Hat lower access control area.

5. Maintenance of the existing Halchita bypass road from Indian Service Route 6440 to the upper access control area at Mexican Hat.

[Text Deleted]*

B. Construction shall be coordinated with and shall be as approved by the Contractor.

C. The improvements shall conform to the provisions of the applicable local, Navajo Nation, federal and state agencies having jurisdiction.

D. Thirty days prior to the start of any roadway work, the Subcontractor shall submit, for review and approval, improvement drawings to the Contractor. The drawings shall indicate approval by the agency having jurisdiction over such roads.

E. The Subcontractor shall coordinate all road construction activities with local utilities, fire and police departments.

* P.I.D. 09-S-15

F. Erosion shall be kept to a minimum and suitable grades and radii of curves shall be maintained to facilitate ease of movement of vehicles and equipment.

G. The Subcontractor shall furnish and install road signs and signals, and shall mark and stripe pavements if pavement is provided, as required, for the safe operation of vehicles.

H. Longitudinal and cross drainage facilities including, but not limited to, the Gypsum Wash crossing, the ditches, structures, pipes and the like shall be furnished and installed by the Subcontractor.

[I. Damaged sections of CMP culvert, used in the existing and previous crossing shall become the Subcontractor's property and shall be disposed of off-site. Riprap in the existing crossing shall be stockpiled and placed around the final permanent crossing to protect the approaches and structure as directed by the Contractor.]*

1.10 STORAGE OF MATERIALS AND EQUIPMENT

A. Subcontractor shall make arrangements for exterior storage areas for materials, equipment, and debris. Locations and perimeters of such facilities shall be subject to the approval of the Contractor.

B. All operations of the Subcontractor, including storage of materials, shall be confined to approved areas. Subcontractor shall be liable for any and all damage caused by him during such use by him of property of the Contractor or other parties. Materials shall be stored in accordance with manufacturer's instructions as applicable.

C. Subcontractor shall store construction materials and equipment within boundaries of designated areas. Storage of gasoline or similar fuels shall conform to the requirements specified in Article SC-7 of the Special Conditions and Article 1.6.B of Section 01560.

1.11 CONSTRUCTION EQUIPMENT

A. Subcontractor shall erect, equip, and maintain all construction equipment in accordance with all applicable statutes, laws, ordinances, rules and regulations of the Contractor or other authority having jurisdiction.

* P.I.D. 09-S-15

B. Scaffolding, staging, runways, hoists, barricades, and similar equipment required for performance of the Subcontract shall be provided and maintained by the Subcontractor. Hoists or similar equipment shall be provided with operators and signals, as required.

C. Subcontractor shall provide, maintain, and remove upon completion of the work, all temporary rigging, scaffolding, hoisting equipment, debris boxes, barricades around openings and excavations, fences, ladders, and all other temporary work, as required for all work hereunder unless otherwise directed by the Contractor.

D. Construction equipment and temporary work shall conform to all the requirements of state, county, Navajo Nation, and local authorities, OSHA, and underwriters which pertain to operation, safety, and fire hazard. Subcontractor shall furnish and install all items necessary for conformity with such requirements, whether or not called for under the separate sections of these Specifications.

E. The Subcontractor shall provide suitable space and lighting for the maintenance of the equipment.

1.12 TEMPORARY SANITARY FACILITIES

A. Subcontractor shall provide temporary sanitary facilities for use by all employees and persons engaged in the Work, including lower-tier subcontractors, Contractor, DOE, their employees and authorized visitors.

B. Sanitary facilities include enclosed chemical toilets, washing sinks, pipes, tanks and pumping equipment. These facilities shall meet the requirements of local public health standards. Open pit or trench latrines will not be permitted.

C. Chemical toilets and washing sinks shall be provided for use by the Subcontractor, his employees and all other workers and suppliers.

D. Contaminated water from the Access Control and Quality Control trailers' wash sinks and from the emergency shower shall be collected into an underground holding tank by a separate piping system. The contents of the underground holding tank shall be pumped into the wastewater retention basin or to decontamination washwater recycling system. The existing facilities at the Hat and Mon sites shall be used as much as practical.

E. Sanitary waste from wash sinks and toilets provided in the Contractor's trailers shall be drained to an underground septic tank by a separate piping system, or at the Subcontractor's option to existing sanitary sewer system where available. The contents of the underground septic tank, if provided, shall be disposed of offsite as Subcontractor's property.

F. During the term of the Subcontract, both tanks shall be kept pumped out at regular intervals to prevent overflow and contamination of the ground, flowing streams or surface drainage.

G. Sanitary facilities shall be located adjacent to the trailers, as approved by the Contractor, and shall be maintained in a sanitary condition during the term of the Subcontract. Subcontractor shall keep such facilities adequately supplied with toilet paper, paper toweling, paper cups, etc., as required.

H. At completion of the Work, sanitary facilities shall be properly disinfected and the tank and the contents disposed of as required by the Contractor.

1.13 TEMPORARY ELECTRIC POWER

A. The Subcontractor shall provide and maintain during the course and progress of the Work all electrical power and wiring requirements to facilitate the work of all trades and services associated with the Work. Power shall be provided on a 24-hour basis. The Subcontractor shall make arrangements with the Navajo Tribal Utilities Authority (NTUA) and shall pay all charges for providing and maintaining electrical service including usage costs at the Hat site. All temporary wiring, feeders, and connections shall be furnished by the Subcontractor. At the Mon site, the Subcontractor shall provide generators providing power 24 hours a day, 7 days a week.

B. Routing of temporary conductors, including welding leads shall not create a safety hazard nor interfere with operation and maintenance of existing facilities. Approval from Site Manager shall be obtained prior to making connections to existing power panels.

C. All temporary wiring installed by the Subcontractor shall be accomplished in accordance with the requirements of the National Fire Protection Association (NFPA) Standard Nos. 70 and 70E (latest edition), using acceptable code materials and equipment.

D. There may be times during the period of the Subcontract when the Contractor will schedule power outages which will make temporary electrical power unavailable over any of the electrical transmission and distribution systems. Normally, these outages will be scheduled sufficiently in advance to give the Subcontractor prior notification; however, due to operational requirements, it may be necessary to "kill" the lines without prior notification. The Contractor assumes no liability for interruptions, delays, or inconveniences caused to the Subcontractor as a result of such electrical power outages or power failure, scheduled or unscheduled, except that any delay in completion of the work resulting directly from such power outages shall be deemed a delay due to unforeseeable causes beyond the control and without the fault or negligence of the Subcontractor within the meaning of the Article GP-56, "TERMINATION FOR DEFAULT-DAMAGES FOR DELAY TIME EXTENSIONS," of the General Provisions, and the Subcontractor shall be entitled to relief in accordance with the provisions of said Article GP-56, provided he gives written notice of such delay in accordance with the requirements thereof. There will be no adjustment in the Subcontract Price due to any such electrical power outage or power failure.

E. Subcontractor shall provide power and lighting to all trailers, and for all Work as required, including yard lighting, at no extra cost to the Contractor, and as follows:

1. A minimum of 240/120V, 3-phase, 200A electric service to all Contractor's trailers.

2. Adequate temporary lighting to all trailers, and for all Work, as required.

3. Exterior areas around offices and parking areas shall be provided with security flood lighting conforming to the current IES standards. Yard security lighting to consist of one pole mounted mercury vapor yard light at each office layout.

4. One electrical outlet in each of the Contractor's trailers shall be provided with a surge suppressor suitable for personal computer use.

5. Temporary power for the radiological monitoring stations at the MON site, as shown on the Subcontract Drawings, shall be provided by the Subcontractor. Power for these stations shall be 120V, single phase, provided on a 24-hour basis, seven days a week. This power shall be provided and available for use 30 days prior to excavating contaminated materials.

F. Temporary power shall be removed at the completion of the Subcontract.

1.14 TEMPORARY WATER

A. General:

1. Temporary water for potable, sanitary and construction use shall be provided at no additional cost to the Contractor. The Subcontractor shall comply with all requirements of the Code of Federal Regulations Title 29, Part 1926, governing the supply of potable (drinking) water.

2. Subcontractor shall furnish, install, operate and maintain all equipment, including necessary tanks, piping, hoses, meters, valves, fixtures, and the like, to provide water to various points of usage throughout the site.

B. Potable Water:

1. The Subcontractor shall provide an adequate supply of potable water in all places of employment. The Subcontractor shall comply with 29 CFR 1926.51 and maintain documented evidence that weekly inspections are conducted to assure compliance.

2. Subcontractor shall provide chilled drinking water in bottles from an approved source to all Contractor's trailers.

3. Potable water for sanitary uses shall be provided to all fixtures in all Contractor's trailers.

C. Construction Water:

1. A source of construction water for Mexican Hat site has been identified as the San Juan River and permits for its use will be obtained by the Contractor. The Subcontractor shall be responsible for obtaining any necessary permission, permits, etc., which may be required for utilizing other sources of water.

2. Construction water for the Monument Valley site shall be obtained by the Subcontractor from his own source(s). The Subcontractor may investigate the possibilities of using existing water wells in the area. Locations of previous production wells are shown on the Subcontract Drawings. Data from these wells are included in the

Information for Bidders. High ground water is sighted at an approximate depth of 30 feet in the area. The Subcontractor shall be responsible for obtaining any necessary permission, permits, etc., which may be required for utilizing the source(s) of water.

1.15 DECONTAMINATION SYSTEM

A. The Subcontractor shall design, furnish, install, operate, maintain, remove and dispose of, a high-pressure, medium-flow type decontamination system at the sites. The decontamination system shall be installed at the existing decontamination pads. Details of existing decontamination facilities are given in the Information for Bidders. The decontamination system will be used for:

1. Washing contamination from vehicles, equipment, tools and materials that become contaminated during use in the Work.

2. Recycling washwater from recirculation pond for reuse as washwater for decontamination.

3. Furnishing make-up water and emptying the surplus water, when required, to maintain the recirculation pond capacity at 3/4 full.

4. Emptying the solids from the recirculation ponds or sumps, as required.

B. The system shall, as a minimum, consist of the following:

1. Subcontractor-furnished and installed high-pressure (75 to 100 psi), medium-flow wash system capable of decontaminating vehicles, tools and equipment, as required, for Work under the Subcontract, consisting of pumps, motors, tanks with suction and discharge piping, valves, meters, gages, nozzles, etc.

2. Existing decontamination pads.

3. Existing recirculation lined ponds. Subcontractor shall repair or replace existing liners as required by the Contractor.

4. Existing drainage ditch or piping from decontamination pad to the ponds.

C. Contaminated washwater and sediments shall be collected from the decontamination pad by gravity through existing ditch

into the lined recirculation pond. The water from the pond shall be recycled for reuse as washwater by a pumping system. The water level in the pond shall be maintained at 3/4 full. Excess capacity shall be used to the extent feasible for dust control of contaminated areas and in moisture-conditioning of soils during construction of fills in contaminated areas, and the remainder pumped out to the wastewater retention basins. Sediment from the pond shall be collected and disposed of as contaminated material.

E. The Subcontractor shall submit his proposed system designs, including calculations, drawings, and equipment list with capacities, to the Contractor for review at least 45 days prior to commencement of installation.

F. Demolition and disposal of decontamination system shall conform to Section 02050.

G. The Subcontractor shall submit his operations plan for each decontamination facility 30 days prior to commencement of hauling operations. The submittal shall include, but not be limited to, the following:

1. Safety.
2. Manpower required.
3. Decontamination of vehicles other than haul units.

1.16 TEMPORARY HEAT

Subcontractor shall provide, at his own expense, all temporary heat as necessary for the trailers, for proper installation of all work, equipment, and materials, and for the protection of all work and materials, against damage from dampness, cold, and freezing.

1.17 TEMPORARY TELEPHONE SERVICE

A. The Subcontractor shall make all necessary arrangements with Navajo Communication Company of Kayenta, Arizona for telephone service to his office.

B. All costs of telephone service connections, external and internal, shall be borne by the Subcontractor.

C. The Contractor will make his own arrangements for telephone service to his offices.

1.18 TEMPORARY FENCES

The Subcontractor shall maintain existing chain link and woven wire fences shown on the Subcontract Drawings.

1.19 SHUT-DOWN TIME OF SERVICES

The Subcontractor shall not disconnect or shut down any part of the existing utilities and services, except by express written permission of the Contractor. The Subcontractor shall submit a schedule of estimated shut-down time in order to obtain such permission, and shall notify all interested parties, utilities, county authorities, etc., as required.

1.20 MAINTENANCE

A. Subcontractor shall maintain all temporary facilities and utilities in good working condition as required by the Contractor during the term of the Subcontract.

B. Subcontractor's maintenance shall include, but not be limited to, all temporary roads including access control areas and fencing during the term of the Subcontract for the safe and efficient transport of equipment, supplies and personnel.

C. The Subcontractor shall remove from the access and the haul roads any contaminated material deposited there by his operations. Such removal and cleanup shall be at no additional cost to the Contractor.

1.21 STATUS AT COMPLETION

A. Upon completion of the Work, or prior thereto, when so required by the Contractor, Subcontractor shall:

1. Repair the Gypsum Wash crossing and all existing roads including the access/haul road improved by the Subcontractor for his convenience (used as temporary roads) including recompacting and resurfacing to at least equal or better conditions existing prior to the start of the Subcontract in accordance with permit requirements, at no additional cost.

2. Obliterate all on-site temporary roads.

3. Remove and dispose of all construction facilities including all equipment and Subcontractor-supplied

trailers. Disconnect utilities to the trailers and remove the trailers from the Site.

4. Restore the areas occupied by the construction facilities to their near original contours by grading to provide positive drainage and to promote natural vegetation.

5. Remove and dispose of the fencing and gates as Subcontractor's property.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement for payment for the following items will be by their lump sum basis:

1. Temporary Offices and Trailers
2. Temporary Roads and Parking Areas
3. Temporary Sanitary Facilities
4. Temporary Electric Power
5. Temporary Water
6. Decontamination System
7. Gypsum Wash Crossing

B. Measurement for payment for janitorial services will be by the number of months of janitorial services actually provided. Month will be a calendar month.

C. Separate measurement for payment will not be made for snow removal services.

D. Separate measurement for payment will not be made for any other item of work specified in this Section.

4.2 PAYMENT

A. Payment for items 1 through 7 of Article 4.1.A above will be by their applicable lump sum prices quoted therefor in the Bid Schedule.

B. Payment for janitorial services will be by the unit price per month quoted therefor in the Bid Schedule.

C. The prices quoted shall include full compensation for furnishing all labor, materials, equipment, tools, accessories, and incidentals, and for performing all work including designing, fabricating, installing/constructing, operating, maintaining, removing and disposal of facilities and providing specified services as required, through the term of the Subcontract.

D. Separate payment will not be made for snow removal services which will be considered incidental to the Work.

E. Separate payment will not be made for any other item of work specified in this Section. Full compensation for such work will be considered to be included in the applicable related items of Work under the Subcontract or in the Bid Schedule item for Mobilization.

END OF SECTION 01500

SECTION 01560

TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers the requirements for temporary controls required during the construction of the temporary and permanent works. Temporary controls shall include related equipment, facilities, and incidentals.

B. Temporary controls shall include, but not be limited to, the following:

1. Dust Control (Nuisance and Radiological)
2. Noise Control
3. Pollution Control
4. Water Control
5. Access, Traffic and Safety Controls
6. Protection of Exposed Surfaces

C. The Subcontractor shall be responsible for furnishing, installing, constructing, operating, maintaining, removing and disposing of the controls as shown on the Subcontract Drawings, as specified in this Specification, and as required by the Contractor for the completion of the Work under the Subcontract.

D. All such temporary controls shall be located as shown on the Subcontract Drawings and as directed by the Contractor, and maintained in clean, safe and sanitary condition at all times until completion of the Subcontract.

E. Upon completion of the Subcontract, the temporary controls shall be left in the status specified in Article 1.11 of this Section.

F. The requirements specified herein are in addition to any requirements specified elsewhere in the Subcontract Documents. Temporary controls shall meet the requirements for all-weather service.

G. All land disturbances related to the temporary controls shall be minimized to the greatest extent possible and the land restored to the extent reasonable and practical, to its original contours by grading to provide positive drainage and by seeding the area as specified in Section 02935.

1.2 RELATED WORK

A. Section 00800 - Special Conditions

B. Section 01019 - Mobilization

C. Section 01500 - Construction Facilities

D. Section 02141 - Dewatering and Drainage

E. Section 02200 - Earthwork: Site Restoration

F. Section 02935 - Seeding

1.3 APPLICABLE PUBLICATIONS

A. The Publications listed below form a part of this Specification to the extent referenced. The Publications are referred to in the text by the basic designation only:

1. UMTRA Project Construction Environment, Safety and Health Management Program (MK-UMTRA-4)

2. State of Utah, Standard Specifications for Road and Bridge Construction, 1979 Edition and Subsequent Revisions, as applicable.

3. Arizona Highway Department, "Standard Specifications", as applicable.

4. Uniform Building Code (UBC):
1988 Edition, applicable Chapters and Sections.

5. National Fire Protection Association (NFPA), as applicable.

6. Occupational Safety and Health Administration, Standards as applicable.

7. National Electric Code, Standards as applicable.

8. DOE Order 5480.11, Radiation Protection for Occupational Workers.

B. All required facilities, equipment and utilities shall also be constructed/installed, maintained and operated in accordance with applicable Federal, State, Navajo Nation, local, and Utility laws, rules, and regulations. Notwithstanding contrary provisions of General Provisions, General Conditions and Special Conditions, nothing in the

Subcontract Drawings and Specifications shall be construed to permit work not conforming to such laws, rules and regulations.

1.4 DUST CONTROL

A. The Subcontractor shall be responsible for providing adequate dust control measures during the term of the Subcontract as required by the Contractor.

B. Dust control shall consist of furnishing water supply, required equipment, additives, accessories and incidentals, and carrying out proper and efficient measures wherever and as often as necessary to reduce dust nuisance, and to prevent dust originating from construction operations and causing damage to dwellings, or causing a nuisance to persons during the completion of the Subcontract, as required by the Contractor. Dust shall be controlled.

C. Water shall be applied by means of pressure-type distributors or pipe lines equipped with a spray system or hoses with nozzles that will ensure a uniform application of water.

D. All equipment used for the application of water shall be equipped with a positive means of shut-off.

E. [Text Deleted]* [Not Used]*

F. All equipment shall be in good operating condition for applying water in the project at all times.

G. To conserve water, the Subcontractor may use chemical additives in dust control water. If such additives are used, furnishing and applying the additives shall be at no additional expense to the Contractor.

H. The use, location of application, and the amount and type of additives proposed for use by the Subcontractor shall be subject to approval by the Contractor and appropriate regulatory agencies.

I. The primary sources of water for dust control in contaminated areas at the sites will be recycled water from wastewater retention basins to the extent feasible. When these sources are judged inadequate or unacceptable the Subcontractor may, with the Contractor's approval, use water from an alternate source.

* P.I.D. 09-S-15

J. The source of water for dust control in non-radiologically contaminated areas shall be free of contamination.

K. Dust in parking areas shall also be controlled.

L. The Subcontractor shall only apply the amount of water necessary for dust control and compaction. Excess water shall not be applied to tailings placed in the disposal cell.

1.5 NOISE CONTROL

See Section 00800, Article SC-7, Paragraph M.

1.6 POLLUTION CONTROL

A. Pollution of Waterways: The Subcontractor's construction and related activities shall be performed by methods that prevent entrance or accidental spillage of solid or liquid matter, contaminants, debris and other objectionable pollutants and wastes into streams, watercourses, flowing or dry, and underground water sources. Such pollutants and wastes will include, but will not be restricted to refuse, earth and earth products, garbage, cement, concrete, sewage effluent, industrial waste, radioactive substances, hazardous chemicals, oil and other petroleum products, aggregate processing tailings, and mineral salts. Pollutants and wastes shall be disposed of in accordance with applicable permit provisions or in a manner acceptable to and approved by the Contractor.

B. Storage and Disposal of Petroleum Products:

1. Petroleum products covered by this Section include gasoline, diesel fuel, lubricants, heating oils, and refined and used oil. During project construction, all petroleum products shall be stored in such a way as to prevent contamination of all ground and surface waters.

2. Storage facilities shall conform to the requirements of Construction Environment, Safety and Health Management Program specified in Article SC-7 of the Special Conditions.

3. Lubricating Oil: Lubricating oil may be brought into the project area in steel drums or other means, as the Subcontractor elects. If the total volume of stored oil is greater than 1320 gallons, then the Subcontractor shall provide secondary containment facilities in accordance with EPA regulations contained in the Code of

Federal Regulations 40 CFR 112. Used lubricating oil shall be stored in steel drums, or other approved means, and shall be returned to the supplier for disposal. It shall not be burned or otherwise disposed of at the project area.

4. If the total volume of stored petroleum products is greater than 1320 gallons and these products are stored above ground, the Subcontractor shall prepare a Spill Prevention Control and Countermeasure Plan in accordance with applicable EPA and state regulations. The plan shall be submitted to the Contractor for approval 30 days prior to storing petroleum products on site.

5. The Subcontractor shall submit for approval by the Contractor a waste minimization and recycling plan for material generated on-site including, but not limited to, used oil, used anti-freeze, used fuels, used oil filters, used containers of maintenance products (e.g. paint cans), oily rags, and petroleum product contaminated soils, prior to the generation of any such materials. This plan shall address all points of generation surveillance, handling, recycling, record keeping,and other pertinent items. The Subcontractor shall make all efforts not to become subject to Federal or State hazardous waste regulations.

C. The following environmental pollution control measures shall be adopted by the Subcontractor for the trucks hauling contaminated materials on public roads to prevent the spread of radioactive contamination in uncontaminated areas:

1. Trucks shall be equipped with leakproof seals and locking devices on dump gates or other approved means to prevent leakage of contaminated material onto roadways.

2. In addition to the above mentioned provisions, the Subcontractor shall take the following additional measures:

a. Trucks shall be totally enclosed by a system that structurally contains the sides and covers all surfaces or a tarpaulin system that covers the top surface completely. The use of crusting agents such as Wen-Don CDB-12 or approved equal applied to the surface of the contaminated materials being transported shall conform to the applicable local, state, tribe and federal requirements. Chemical crusting agents shall only be used after demonstating the proposed agent's effectiveness and after obtaining Contractor's approval.

b. Prior to travel on offsite roadways or beyond the contaminated site area, trucks shall be decontaminated by washing with water. All contamination shall be removed, as determined by the Contractor. Leakage of material from the vehicle will not be allowed. The Subcontractor shall be responsible to assure locking devices and seals are adequately secure prior to release from the contaminated area.

3. Health Physics personnel employed by the Contractor will routinely check trucks for residual contamination prior to release from contaminated areas.

1.7 WATER CONTROL

A. When water hose usage is required on the project, the water hoses shall be located inside the site areas such that any spills which might be contaminated are contained within the site areas. When it is not feasible to locate hoses inside any site perimeter such that any potentially contaminated spill can be contained inside the site boundary, berms shall be constructed so that any spill will be contained inside the site boundary.

B. For other water control requirements, see Section 02141, Dewatering and Drainage.

1.8 ACCESS, TRAFFIC AND SAFETY CONTROLS

A. Access Control:

1. Private, personal or agency vehicles not used for authorized construction purposes will not be allowed in the controlled site areas.

2. Parking of private, personal or agency vehicles shall be in a restricted area outside of the controlled site areas as designated by the Site Manager or his representative.

B. Traffic and Safety Controls:

1. The Subcontractor shall post construction areas and roads with traffic control signs or devices used for protection of workmen, the public and equipment. The signs or devices shall conform to the American National Standards Institute D6.1E-1988, Manual on Uniform Traffic Control Devices for Streets and Highways, and the latest revision of the Utah and Arizona Supplements thereto.

2. Temporary signs or traffic control devices shall be removed or covered as soon as they have served their purpose. It is particularly important to remove any markings on road surfaces which under conditions of poor visibility could cause a driver to turn off the road or into traffic moving in the opposite direction. Permanent signs or traffic control devices shall remain in place as directed by the Contractor.

3. Barricades for protection of employees shall conform to the portions of the American National Standards Institute, Manual on Uniform Traffic Control Devices for Streets and Highways, relating to barricades.

4. Flag persons, properly equipped with International Orange protective clothing and flags, shall be provided at all such times, as necessary, to direct or divert pedestrian or vehicular traffic. Flag persons shall be provided at both ends of the existing bridge on U.S. Highway 163 in the City of Mexican Hat during truck transport hours.

5. Pursuant to Article GP-51 of General Provisions, Section GC-3C.1.a of General Conditions, the Subcontractor shall construct and maintain fences, planking, barricades, lights, shoring, and warning signs as required by local authorities and Federal and State safety ordinances, and as required, to protect the Contractor's property from injury or loss and as necessary for the protection of the public, and provide walks around any obstructions made in a public place for carrying on the Work covered in this Subcontract. All such protection shall be left in place and maintained until removal is authorized.

6. In addition, the Subcontractor shall guard and protect all workers, pedestrians, and the public from excavations, blasting operations, construction equipment, all obstructions, and other dangerous items or areas by means of adequate railings, guard rails, temporary walks, barricades, warning signs, sirens, directional signs, overhead protection, planking, decking, danger lights, etc.

7. Material Haul on Public Roads: All requirements stated in the permits shall be followed for using public roads for hauling materials.

8. The Subcontractor shall be responsible for providing all necessary bonding required by the Utah and Arizona State Highway Departments and the Navajo Nation.

9. The Subcontractor shall submit a detailed traffic plan for all sites, prior to hauling activities, for Contractor approval.

1.9 PROTECTION OF EXPOSED SURFACES

See Section 02200, Article 3.1.A.

1.10 MAINTENANCE

Subcontractor shall maintain all temporary controls in good working conditions during the term of the Subcontract for the safe and efficient transport of equipment and supplies, and construction of permanent works, as required by the Contractor.

1.11 STATUS AT COMPLETION

A. Upon completion of the Work, or prior thereto, when so required by the Contractor, Subcontractor shall:

1. Remove all temporary controls as required by the Contractor.

2. Restore and seed disturbed areas as specified in Sections 02200 and 02935.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Separate measurement for payment will not be made for work specified in this Section.

4.2 PAYMENT

Separate payment will not be made for work specified in this Section. Payment for such work will be considered to be included in the applicable related items of Work specified elsewhere in the Subcontract Documents or incidental to the Subcontract.

END OF SECTION 01560

SECTION 01561

CONSTRUCTION CLEANING

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers furnishing of all labor, materials, equipment, and services, and performing all operations necessary for, and properly incidental to, cleanup during construction and final cleaning of the site, prior to acceptance of the Project by the Contractor as specified herein and in other sections when specified.

B. The requirements specified in this Section are supplemental to the requirements specified elsewhere in the Subcontract Documents.

1.2 WORK NOT INCLUDED

Chemical, Toxic or Hazardous Waste

1.3 RELATED WORK

A. Article GC-1D - General Conditions

B. Section 00800 - Special Conditions: Definitions

C. Section 01560 - Temporary Controls

D. Section 02110 - Site Clearing

E. Section 02200 - Earthwork

1.4 GENERAL

A. It is required that the entire site be kept in a neat and orderly condition, and the Contractor or his representative may, at any time during construction, order a general cleanup of the site as a part of the work under this Section.

B. Subcontractor shall dispose of waste, trash, and debris in a safe, acceptable manner, in accordance with applicable laws and ordinances and as prescribed by authorities having

jurisdiction. No waste material and debris shall be buried on the site. Burning of trash and debris on the site will not be permitted. The Subcontractor shall put into operation a waste minimization and recycling plan as specified in Section 01560, Article 1.6.

C. Location of a dump for trash and debris and the length of haul to such a location are the Subcontractor's responsibility.

1.5 CLEANUP DURING CONSTRUCTION

A. Cleanup: The Subcontractor will be required to clean up construction work areas including all trailers, parking and storage areas and dispose of waste material. Cleanup of construction work areas will be required on a daily basis. At the close of each day's work all small quantities of waste and debris resulting from construction activities shall be gathered up and disposed of as designated in paragraph B below. Waste and debris shall not be allowed to accumulate in such quantities as to create an unsightly appearance, or safety or fire hazard, nor shall it interfere in any way with free access to, and operation of existing facilities.

B. Waste Disposal:

1. General: Material determined to be waste will be tested for radioactive contamination prior to removal from the construction site. Testing will be performed by the Contractor at no cost to the Subcontractor to classify the waste into the following two categories for disposal purposes:

   a. Uncontaminated Waste: The Subcontractor shall provide suitable receptacles for all construction office waste material such as wrapping paper, discarded containers, scrap lumber, scrap metals, etc. Other uncontaminated waste including construction office waste shall be disposed of offsite as Subcontractor's property in a safe, acceptable manner, in accordance with the applicable laws and ordinances and as prescribed by authorities having jurisdiction. No waste material and debris shall be buried on the site. The Subcontractor shall be responsible for the location of dump for trash and debris, length of haul, and disposal costs.

   b. Contaminated Waste: Waste materials identified as contaminated materials defined in Article SC-1 and

materials resulting from demolition operations and demolished materials stockpiled on site shall be disposed of in the construction of the tailings embankment as specified in Section 02200.

1.6 FINAL SITE CLEANUP

A. Prior to final inspection, the entire site shall be thoroughly cleaned and shall be put into a neat, acceptable condition. All construction waste and unused materials, dunnage, loose rock and stones, excess earth, and debris of any description resulting from the work shall be removed from the entire site.

B. All construction areas shall be thoroughly cleaned to the satisfaction of the Contractor prior to final acceptance of the completed Subcontract.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

Separate measurement or payment will not be made for work required under this Section. All costs in connection with the work specified herein will be considered incidental to the Subcontract.

END OF SECTION 01561

Division 2
Sitework

SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section describes the requirements for the demolition and disposal of the following facilities:

1. Existing Structures and Facilities:

   a. Concrete structures at the Monument Valley Site.

   b. Steel debris at the Monument Valley Site.

   c. Rubble, boulder and ore piles at Monument Valley Site. The piles are scattered throughout the site in the south, west and northwest areas of the site.

   d. Decontamination pad.

   e. Membrane liners from ditches, retention basins, spillways, collection sumps, recirculation ponds and water supply ponds.

   f. Existing chain link and woven wire fences.

   [g. Miscellaneous debris scattered throughout the site or included in the contaminated material.]*

2. Structures installed/constructed under this Subcontract including Washwater recirculation system including piping, tanks, and new pond liners.

B. Approximate descriptions and data of these facilities are listed in attached Table 02050-A and identified on the Subcontract Documents. Additional details are included in the Information for Bidders.

C. The structures and facilities installed/constructed under this Subcontract are specified under various Specification Sections of this Subcontract and are shown on the Subcontract Drawings. Although these structures are not listed in Table 02050-A, all temporary structures and facilities built at the sites shall be demolished and disposed of.

* P.I.D. 09-S-15

1.2 WORK NOT INCLUDED

Removal and disposal of existing stockpiles of demolished materials and debris is not included in the Scope of Work of this Section. Disposal of demolished materials and debris is specified in Section 02200.

1.3 RELATED WORK

A. Section 00800 - Special Conditions: Articles SC-7 and SC-8

B. Section 01300 - Submittals

C. Section 01500 - Construction Facilities

D. Section 01560 - Temporary Controls

E. Section 02200 - Earthwork: Disposal of demolished materials and debris.

1.4 DEFINITIONS

A. Demolition includes complete dismantling, cutting and breaking up of structures, including all solid contents and associated services and utility lines including their foundations and below grade slabs and footings.

[B. Removal and Disposal of Rubble: This shall consist of the removal of demolition debris, rubble containing wood, concrete, steel and boulders, breaking into specified sizes, loading, transporting to Mexican Hat site, unloading and placing in the tailings embankment as specified in Section 02200. The size and location of rubble piles is described in the Information for Bidders. The location of the rubble piles is also shown on the Subcontract Drawings.]*

[Text Deleted]*

1.5 SUBMITTALS

A. General submittal requirements are specified in Section 01300.

B. Ten days prior to the start of Work, the Subcontractor shall submit to the Contractor, for review, a demolition plan including the following:

* P.I.D. 09-S-15

1. Methods of demolition to be used.
2. Schedule showing dates and structures to be demolished.
3. List of equipment to be used.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.1 DEMOLITION

A. During the execution of this Subcontract, if unidentified waste material is suspected or encountered, the Site Manager shall be immediately notified for identification and subsequent disposition.

B. Locations of structures to be demolished are shown on the Subcontract Drawings and listed in attached Table 02050-A; however, the Subcontract Drawings do not show the locations of all foundations, rubble and debris, concrete pads, and the like, all of which are required to be demolished and removed within the boundaries of the project sites.

C. Pollution Controls:

1. Water sprinkling, temporary enclosures, and other Contractor-approved methods shall be used to limit the amount of airborne dust and dirt to the lowest practical level. Demolition work shall comply with governing regulations pertaining to environmental protection.

2. Water shall not be used if it is likely to create hazardous or objectionable conditions such as ice, flooding, or pollution. An approved water-based biodegradable wetting agent (surfactant), such as Dupont "Duponol WAQ" or equal, may be used to reduce the quantity of water required.

D. Demolition work shall be carried out using equipment compatible to the structures to be demolished and by methods required to complete the Work in accordance with governing regulations. The structures shall be demolished, and the materials and debris disposed of as specified in Section 02200.

E. After the completion of the construction phase, the synthetic membranes shall be removed, decontaminated and disposed of as

required by the Contractor. If the membrane cannot be decontaminated by practical means, it shall be disposed of by cutting into strips, shredding and placing in the tailings embankment in a manner that would not induce settlement, inhibit water migration, or exceed the 5 percent limit on organic material by volume.

[F. Demolished materials, consisting of steel, concrete, wood, masonry and other man-made materials, rubble, debris and boulders shall be reduced in size to pieces to be no greater than 3 feet in any dimension and no more than 27 cubic feet in volume.]*

G. Metal objects with voids shall be crushed to sizes no greater than 27 cubic feet in volume, with the least dimension not exceeding 6 inches.

H. Grading shall be performed, as required by the Contractor, to restore existing grades to near natural conditions and as specified in Section 02200.

I. Fences and gates shall be removed and disposed of as Subcontractor's property. Concrete footings shall be disposed of in the tailings embankment or as directed by the Contractor.

J. Any pipe, conduit and ducts shall be cut to sizes no greater than 10 feet in length.

3.2 DISPOSAL OF DEMOLISHED MATERIALS AND DEBRIS

[A. Demolished materials, consisting of steel, concrete, wood, masonry and other man-made materials, rubble, debris and boulders shall be transported to the Mexican Hat site and disposed of in the tailings embankment, as specified in Section 02200 and as shown on the Subcontract Drawings.]*

B. Burning of materials resulting from demolition operations will not be permitted.

C. Uncontaminated materials such as fencing, piping membranes, wooden platforms, and stairs for trailers and other materials shall be removed as Subcontractor's property as directed by the Contractor.

D. Water supply facilities designated by the Contractor shall remain in place.

* P.I.D. 09-S-15

[Text Deleted]*

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement for payment for demolition and disposal of structures specified in this Section will be on a lump sum basis.

B. Measurement for payment for removal and disposal of rubble specified in this Section will be on a lump sum basis.

[Text Deleted]*

4.2 PAYMENT

[A. Payment for demolition and disposal of structures, removal and disposal of rubble, debris and boulders specified in this Section will be by the respective lump sum prices quoted therefor in the Bid Schedule. The prices quoted shall include full compensation for furnishing all labor, materials, equipment, incidentals, and for performing all work specified including, but not limited to, transportation and placement of demolished materials, debris and boulders in the tailings embankment.]*

B. Separate payment will not be made for any other work specified in this Section. Full compensation for such work will be considered incidental to the applicable related items of work.

END OF SECTION 02050

* P.I.D. 09-S-15

TABLE 02050-A

EXISTING STRUCTURES AND FACILITIES TO BE DEMOLISHED

I - MEXICAN HAT SITE

A. Chain link fence and gates - approximately 640 linear feet.

B. Woven Wire Fence - approximately 12,890 linear feet.

C. Lower Access Control Area:

1. Decontamination pad - concrete, 150-foot x 30-foot x 8-inch thick, reinforced with wire mesh.

2. Membrane liners for collection ditch, sump retention basin and holding ponds.

3. Wood platform and steps for trailers.

4. Membrane liner for fuel storage basin.

5. Miscellaneous, concrete and piping associated with temporary facilities.

6. Concrete septic tanks.

D. Upper Access Control Area:

1. Decontamination pad with sump - concrete, 150-foot x 60-foot x 8-inch thick reinforced.

2. Membrane liner for recirculation ponds and holding ponds.

3. Miscellaneous, concrete footings and piping.

E. Retention Basin Embankment: Membrane liner - approximately 2500 square yards of 30 mil thick chlorinated polyethylene (CPE).

II - MONUMENT VALLEY SITE

A. Chain link fence and gates - approximately 1030 linear feet.

B. Woven Wire Fence - approximately 9970 linear feet.

TABLE 02050-A (continued)

C. Access Control Area:

1. Decontamination pad - concrete, 150-foot x 60-foot x 8-inch thick, reinforced.

2. Membrane liners for recirculation pad.

3. Miscellaneous concrete slabs, pipelines and 5-foot x 7-foot septic tank.

D. Membrane liner for retention basin.

E. Water supply facilities including holding pond.

F. Approximately 159 cubic yards of shattered concrete. The bottom and 1/3 of the walls of the original structure are still intact. Located at approximately N58,850, E87,600.

G. Approximately 30 cubic yards of steel and miscellaneous debris. Located at approximately N58,700, E87,600.

H. Two concrete tunnels, partly demolished.

[I. Miscellaneous steel, concrete, plastic, wood, etc., scattered throughout site, either on the surface or buried, and abandoned loading ramps located throughout the site.]*

[J. Approximately 35 cubic yards of steel debris, consisting mainly of abandoned mill equipment located approximately at N 58,090, E 85,690.]*

* P.I.D. 09-S-15

SECTION 02110

SITE CLEARING

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section describes the requirements for the following:

1. Clearing of vegetation.

2. Disposal of cleared and stripped materials.

1.2 DEFINITIONS

Clearing: Clearing is defined as removing brush, other vegetation and immature trees. All such vegetation and immature trees shall be cleared down to the natural ground surface.

1.3 RELATED WORK

Section 02200 - Earthwork

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.1 PRESERVATION OF PROPERTY

Existing improvements, adjacent property, utility and other facilities that are not to be removed shall be protected from injury or damage.

3.2 CLEARING

A. Clearing shall be performed on the existing sideslopes and topslope of the tailings embankment prior to placing any other materials and in areas where contaminated materials shall be removed. Contaminated cleared materials shall be kept separate from uncontaminated cleared materials.

B. Uncontaminated cleared materials shall be disposed of by the Subcontractor.

C. Contaminated cleared material shall be reduced in size and disposed of in the tailings embankment as specified in Section 02200 and as required by the Contractor.

3.3 STRIPPING

A. Uncontaminated Areas: Stripping will be required in the following areas:

1. Beneath all fill areas where excavation is not otherwise required;

2. In areas of excavation where excavated materials are to be used as fill.

B. Contaminated Areas: In areas of excavation where the contaminated surfaces are covered by vegetation, the removal of topsoil may be carried out together with the excavation of contaminated materials in one operation as specified in Section 02200.

C. Stripped material shall be disposed of as specified in Article 3.4.

3.4 BURNING OF CLEARED AND STRIPPED MATERIAL

Burning of cleared and stripped materials, if performed, shall conform to the requirements of the Navajo Nation.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Separate measurement for payment will not be made for work specified in this Section.

4.2 PAYMENT

Separate payment will not be made for work specified in this Section. Full compensation for such work will be considered to be included in the applicable related items of work specified elsewhere in the Subcontract Documents or incidental to the Subcontract.

END OF SECTION 02110

SECTION 02141

DEWATERING AND DRAINAGE

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section describes the requirements for dewatering and drainage work in contaminated and uncontaminated areas of the site. The Work shall include the following:

1. Collection and disposal of surface and subsurface water from the work areas, and

2. Design, construction, maintenance and removal of dewatering and drainage facilities.

B. Surface (gravity) and subsurface (pump system) dewatering and drainage system shall consist of swales, ditches, dikes, drainage pipes, inlets and manholes, sumps, pumps, drives, piping, meters, gages, valves and other accessories and incidentals as required.

C. If the groundwater level is higher than the bottom of excavation, the Subcontractor shall dewater the excavation, as required, for performance of work in the dry. Stormwater shall be removed from the excavation to maintain dry conditions during excavation and backfill placement.

D. A dewatering scheme for work in uncontaminated areas is not shown on the Subcontract Drawings. The Subcontractor shall, as required, design and construct gravity or pump systems or a combination of both systems for dewatering uncontaminated work areas.

E. A gravity dewatering scheme for work in contaminated areas is limited to the temporary drainage ditches, dikes and retention basins as shown on the Subcontract Drawings. The Subcontractor shall, as required, design and construct additional gravity or pump systems or a combination of both systems for dewatering contaminated work areas. Dewatering from wind-blown tailings and off-pile areas will be accomplished incrementally as removal of contaminated materials proceeds.

F. Earthwork operations shall be planned, scheduled and executed to minimize dewatering.

1.2 WORK NOT INCLUDED

A. Existing retention basins and drainage ditches are shown on the Subcontract Drawings.

B. Drainage work related to the construction facilities specified in Section 01500.

1.3 DESCRIPTION

A. The work of this Section includes, but is not limited to: dewatering the excavations by installing sump pumps in the excavations and disposal of water by providing drainage facilities including swales, ditches, interceptor dikes, pipes, and other drainage structures. Water from uncontaminated areas shall be pumped, or allowed to flow by gravity, to drainage ditches leading to the existing drainage courses that flow offsite. Water from contaminated areas shall be pumped, or allowed to flow by gravity, to drainage ditches leading to the wastewater retention basins. Excess wastewater, after recycling from the decontamination pad, shall be collected in the wastewater retention basins or used for dust control or moisture conditioning of fills in contaminated areas.

B. The Subcontractor shall be responsible for designing, scheduling, utilizing, providing, and maintaining any dikes, ditches, channels, flumes, drains, sumps, pumping equipment, monitoring wells, other subsurface dewatering devices, and other temporary diversion and protective work necessary to ensure that construction shall be performed in areas free from water and in accordance with all applicable permits.

1.4 RELATED WORK

Section 02200 - Earthwork: Construction and restoration of areas.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

The Subcontractor shall furnish all materials, equipment, tools, accessories, and incidentals required for furnishing, installing, operating, maintaining and removing dewatering and drainage facilities, and for providing sufficient standby pumping and auxiliary equipment to preclude any interference

to pumping operations during periods of breakdown and maintenance.

PART 3 - EXECUTION

3.1 DEWATERING PROCEDURES

A. Water from uncontaminated areas shall be pumped, or allowed to flow by gravity to natural uncontaminated drainage courses.

B. Water from contaminated areas shall be pumped or allowed to flow by gravity to the retention basins.

C. Water level in the excavations shall be maintained below the lowest point in the excavation until the backfilling of the excavation has been completed, unless otherwise approved by the Contractor.

D. The Subcontractor shall use contaminated water from the retention basins for dust control over contaminated areas at both sites and for compaction control at the Mexican Hat site. Uncontaminated water may be used if there is insufficient contaminated water in the basins or if approved by the Contractor.

3.2 TEMPORARY DRAINAGE DITCHES

Additional new drainage ditches, if required, shall be constructed by the Subcontractor for collection of contaminated wastewater into the retention basins or for offsite discharge of water from uncontaminated areas.

3.3 MAINTENANCE

A. The Subcontractor shall be responsible for the maintenance of dewatering and drainage facilities during the term of the Subcontract. Drainage ditches may require periodic cleaning. Ditches shall be kept free of sediment deposits, debris and other materials that may restrict or prevent drainage. The Subcontractor, when directed by the Contractor, shall remove and replace all items not functioning properly because of clogging, damage, or deterioration.

B. After removal of uncontaminated material, the Subcontractor shall fill all depressions and low spots where surface water can pond. The areas shall be graded to drain.

3.4 REMOVAL

A. When no longer required for water control:

1. Dewatering equipment shall be removed and disposed of as Subcontractor's property.

2. Contaminated sediments deposited in the wastewater retention basins shall be removed and placed in the tailings embankment as specified in Section 02200 and as required by the Contractor. Uncontaminated sediments may be used in the grading of uncontaminated areas of work.

3. Areas occupied by the wastewater retention basins, dikes, spillway, and temporary drainage ditches shall be restored and graded to drain as specified in Section 02200 and as shown on the Subcontract Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Separate measurement for payment will not be made for dewatering and drainage work specified in this Section.

4.2 PAYMENT

Separate payment will not be made for dewatering and drainage work specified in this Section. Full compensation for furnishing all materials, equipment, labor, tools, accessories, incidentals, and for performing all work as specified in this Section including, but not limited to, the construction of additional lined and unlined temporary drainage ditches, check dams, temporary detention ponds or other facilities, the provision of pumps, sumps, piping, valves, meters, gages, other accessories and incidentals such as pipe supports, excavation and backfill of pipes and pipe supports, and the like, if required, will be considered to be included in the related applicable items of Work specified in the Subcontract.

END OF SECTION 02141

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers earthwork for the following:

1. Excavation of contaminated materials from the Mexican Hat and Monument Valley sites.

2. Transportation of contaminated materials from Monument Valley to Mexican Hat.

3. Excavation of uncontaminated common materials.

4. Excavation of uncontaminated rock materials.

5. Construction of the tailings embankment excluding radon barrier and erosion protection which includes disposal of (contaminated and uncontaminated) demolished materials and debris and other contaminated materials including the following in the construction of the tailings embankment:

   a. Existing stockpiles of demolished materials, debris and rubble.

   b. Demolished materials and debris resulting from work specified in Section 02050.

   c. Contaminated cleared vegetation resulting from site clearing specified in Section 02110.

   d. Contaminated sediments from retention basins, dikes and ditches specified in Section 02141.

   e. Stockpiled contaminated vicinity property materials.

6. Construction of permanent drainage ditches.

7. Finish grading of the site, including restoration and regrading of areas occupied by existing temporary drainage ditches, existing wastewater retention basins

and dikes, existing contaminated water recirculation pond, sumps, and temporary facilities areas.

8. Placement of selected rockfill from on-site stockpiles.

9. Furnishing and installing new displacement monuments and extend existing displacement monument as shown on the Subcontract Drawings.

1.2 WORK NOT INCLUDED

A. Earthwork related to the construction of offsite construction facilities specified in Section 01500 is not included in this Section.

B. Earthwork for pipe trenches is not included in this Section.

C. Construction of protective cover of the tailings embankment and for permanent ditches and gullies. Protective cover includes (1) radon barrier materials, (2) bedding materials, and (3) erosion protection materials.

D. Delivery and stockpiling of contaminated vicinity property materials in the tailings embankment by others.

[Text Deleted]*

1.3 RELATED WORK

A. Section 00800 - Special Conditions

B. Section 01300 - Submittals

C. Section 01500 - Construction Facilities

D. Section 01560 - Temporary Controls

E. Section 02050 - Demolition

F. Section 02110 - Site Clearing

G. Section 02141 - Dewatering and Drainage

H. Section 02228 - Radon Barrier

I. Section 02278 - Erosion Protection

1.4 DEFINITIONS

A. Contaminated materials and uncontaminated materials are defined in Article SC-1 of the Special Conditions.

* P.I.D. 09-S-15

B. Excavation: Excavation shall include excavation of all materials including silt, clay, sand, gravel, talus, soft or disintegrated rock, boulders or detached pieces of solid rock and rippable rocks (see definition) but shall exclude rocks requiring drilling and blasting operations or grinding and planing. Excavation shall be classified into the following categories:

1. Contaminated Materials Excavation.

2. Uncontaminated Materials Excavation.

C. Contaminated Materials Excavation: Contaminated materials excavation shall include excavation of contaminated materials regardless of the nature (soil or rock) of the materials from the tailings piles, existing and heap leach pads area at Monument Valley, windblown and waterborne areas, the wastewater retention basins, and the dikes.

D. Uncontaminated Materials Excavation: Uncontaminated materials excavation shall include excavations of uncontaminated materials from the various areas of the site including, but not limited to, excavations for permanent drainage ditches and for finish grading. Uncontaminated materials excavation shall be classified into common excavation and rock excavation in accordance with the following designations and classifications:

1. Rock Excavation: Rock excavation shall include excavation by drilling and blasting or by grinding and planing of material classified as rock and shall include the satisfactory removal of boulders 1/2 cubic yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; and conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock that is impossible to remove without systematic drilling and blasting. The Subcontractor shall not proceed with the excavation of this material until the Contractor has classified the materials as common excavation or rock excavation and cross-sections are taken as required. Failure on the part of the Subcontractor to uncover such material, notify the Contractor, and allow ample time for classification and cross-sectioning of the undisturbed surface of such material will cause the forfeiture of the Subcontractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contractor for the areas of work in which such deposit occurs.

2. Common Excavation: Common excavation shall include the satisfactory removal of all such materials including rippable rocks (see definition below), not materials classified as rock excavation defined above.

E. Overexcavation: Overexcavation is defined as (1) excavation carried out beyond the lines and grades indicated on the Subcontract Drawings or in the Subcontract Specifications or (2) excavation not authorized by the Contractor.

F. Slimes: Slimes are the fraction of the tailings consisting of silty clay, clay and clayey silt, generally defined as containing 70 percent or more of minus No. 200 sieve material.

G. Percent Maximum Density: Percent maximum density is the field dry density expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D698, as applicable.

H. Tailings Embankment: Tailings embankment shall consist of in situ tailings pile materials, contaminated windblown/ waterborne materials from the Mexican Hat site, relocated tailings from Monument Valley and other areas of the site, including contaminated materials from windblown and waterborne areas, heap leach pads area, wastewater retention basins, contaminated water recirculation pond, demolished materials and debris, vicinity property materials and the protective cover materials.

I. Subgrade Preparation: Preparation of surfaces of excavations including permanent drainage ditches, backfills, apron, and embankments upon which bedding materials, riprap, or other features are to be constructed. Such surface preparation shall include mixing and manipulation, fine grading, and compaction of materials.

J. Cover: Cover shall consist of the layers of following fill materials placed over the relocated contaminated materials in the tailings embankment as shown on the Subcontract Drawings:

1. Bedding and riprap materials.

2. Radon barrier material.

K. Demolished Materials and Debris:

1. Demolished materials and debris resulting from the demolition work specified under this Subcontract.

2. Stockpiles of Demolished Materials, Debris and Rubble: Existing stockpiles consist of pieces of ore, rock, wood, concrete, steel and debris from demolished work specified under this Subcontract.

L. Finish grading of the site shall include excavation, fill and backfill of the various areas of the site including removal of retention basin dikes (existing), backfilling of temporary drainage ditches (existing), wastewater retention basin (existing), contaminated water recirculation ponds (existing), and temporary facilities (existing) areas as shown on the Subcontract Drawings.

M. Temporary Drainage Ditches: Temporary drainage ditches shall include temporary diversion, collection and interceptor ditches as required by the Subcontractor or as shown on the Subcontract Drawings.

N. Rippable Rock: Rippable rock is defined as mineral matter in place and of such hardness and texture that it can be effectively loosened or broken down by ripping in a single pass with a late model tractor-mounted hydraulic ripper equipped with one digging point of standard manufacturer's design adequately sized for use with and propelled by a crawler-type tractor Caterpillar Model D10N or equal, operating in low gear; or in areas where the use of the ripper described above is impracticable, rippable rock is defined as mineral material of such hardness and texture that it can be loosened or broken down by a 6-pound drifting pick. The drifting pick shall be Class D, Federal Specification GGG-H-506D, with handle not less than 34 inches in length.

O. Disposal of Demolished Materials and Debris: Disposal shall include loading and transporting demolished materials and debris from existing stockpiles or from demolition operations performed under the Subcontract, and unloading, placing and compacting in the final placement location as indicated on the Subcontract Drawings.

P. Frozen Material or Subgrade or Foundation: Material on subgrade or foundation that has a temperature at or below 32°F and/or generally contains a visible amount of water in the form of ice.

Q. Rockfill Selected by the Contractor: Rockfill from existing stockpiles or required rock excavation which is selected by the Contractor. Selected rockfill generally consists of larger size pieces of sound limestone or sandstone which are of a better quality than most of the on-site rock.

1.5 APPLICABLE PUBLICATIONS

A. The Publications listed below form a part of this Specification to the extent referenced. The Publications are referred to in the text by the basic designation only:

1. American Society for Testing and Materials (ASTM):

D422-63	Test Method for Particle-Size Analysis of Soils Including Percent Passing No. 200 Sieve (and excluding hydrometer analysis)
D698-78	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.49-kg) Rammer and 12-in. (305-mm) Drop
D1556-90	Test Method for Density of Soil in Place by the Sand-Cone Method
D2167-84	Test Method for Density and Unit Weight of Soil In-Place by the Rubber-Balloon Method
D2216-90	Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
D2487-90	Test Method for Classification of Soils for Engineering Purposes
D2922-81	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D3017-88	Test Method for Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D4643-87	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

2. Blasting practices shall generally be in accordance with the "Blasters Handbook" - 16th Edition by E. I. du Pont de Nemours and Co. (INC) of Wilmington, Delaware 19898.

3. U.S. Federal Specifications (FS):

GGG-H-506D Hoe, Mattock and Pick
Int AMD 1

1.6 PERMITS AND APPLICABLE LAWS

A. All required Federal, State, and local permits for blasting and explosives shall be obtained and paid for by the Subcontractor. Copies of such permits shall be furnished to the Contractor before any blasting operations are started.

B. All blasters and blasting foremen shall be properly qualified and licensed in accordance with the applicable laws and regulations of Federal, State, and local governments.

C. All transportation and storage of explosives shall be in accordance with the applicable laws and regulations of Federal, State and local governments.

1.7 QUALITY ASSURANCE

A. The Contractor will take soil samples and perform moisture-density, gradation and other tests to ascertain that the work is being performed in compliance with these Specifications. Samples may be taken at the place of excavation, stockpiles, or in the fill itself. The Contractor will conduct the density and other tests on the fill and related laboratory testing as frequently as the Contractor considers necessary. The Subcontractor shall remove surface material and render assistance as necessary to enable sampling and testing to be carried out.

B. Methods of Sampling and Testing:

1. In-Place Density: ASTM D1556, D2167, or D2922

2. Particle Size Analysis: ASTM D422

3. Moisture Content: ASTM D2216

4. Laboratory Moisture-Density Relations: ASTM D698

5. Soil Classification: ASTM D2487

6. In-Place Moisture Content: ASTM D3017, or ASTM D4643

C. Suitability of Materials: The suitability of all materials for foundations and backfill will be determined by the Contractor. Fill material will be approved material from borrow areas or required excavations.

D. The Subcontractor shall make his own determination of any processing that may be required and shall perform testing as

required to ensure that the materials meet the Specification requirements.

E. The Contractor may direct that inspection trenches or test pits be cut into fills to determine that the Specifications have been met. Such trenches or pits will be of limited depth and size, and shall be backfilled with the material excavated therefrom, or other fill material meeting the requirements for the zones cut into. Backfill shall be compacted to a density at least equal to that of the contiguous fill.

F. When the Contractor directs inspection trenches or test pits to be excavated into fills and backfills and materials are found to meet all Specification requirements, the excavation and refilling shall be paid for as additional work pursuant to the applicable provisions of the General Conditions. Inspection trenches or test pits, and the refilling of the same, shall be at the Subcontractor's expense when it is found that the materials do not meet the Specification requirements.

G. Tolerances: See Specification Section 01052, Article 1.8.

1.8 SUBMITTALS

A. General submittal requirements are specified in Section 01300.

B. At least 90 days before opening borrow areas, the Subcontractor shall submit a mining plan for each separate borrow area. The plan shall include method of stripping and processing of materials, excavation plan, and a site restoration plan.

C. At least 30 days before commencing blasting operations, the Subcontractor shall submit to the Contractor for review a detailed blasting plan covering the area to be blasted. The blasting plan shall contain complete hole layouts, proposed loading, delays and all information required by this Specification. The Contractor may require changes in the blasting plan if the results of blasting do not meet Subcontract requirements.

D. All changes in the blasting plan shall be submitted for approval at least 48 hours prior to the time of the proposed changes.

E. At least 48 hours before blasting within one-quarter mile of a stream course, the Subcontractor shall submit for approval

a plan showing all details of his proposed blasting operation and the scheduled time for the blast.

F. The Contractor's review of the Subcontractor's proposed blasting procedures shall not be construed to relieve the Subcontractor of his responsibility to protect existing facilities not to be demolished. Any damage done by the Subcontractor's operations shall be repaired at Subcontractor's expense.

[1.9 SAFETY PROVISIONS FOR BLASTING]*

A. The Subcontractor shall provide and operate at all times an instrument for the detection of approaching electrical storms, including an automatic alarm such as a Litton TSM/C.

B. Electrical Storms: No explosive material shall be handled, transported or in any way made use of during any period of electrical storm or lighting or other electrical phenomenon. In the event that any such condition should appear imminent or occur, or if some known leakage of electricity should occur in the neighborhood of, or in, the work, while the transport, handling, making-up or charging or other use of explosives is being effected, then the work shall be evacuated and abandoned completely until at least thirty minutes after the condition has ceased or the leakage stopped.

C. Detonating Explosive Charges:

1. Only approved exploding devices shall be used for detonating charges. Under no circumstances are lighting and power cables to be used for detonating. All pipes, ducts, track, and other metal shall be properly grounded.

2. An adequate warning system shall be provided by the Subcontractor to ensure that all personnel, staff, visitors and anyone else are at a safe distance before blasting takes place.

3. No radio transmitter shall be operated within 75 feet of the area where electric blasting operations are in progress.

4. No naked lights or sparks are allowed anywhere in the vicinity of blasting operations on the surface.

5. Where detonating is carried out electrically the Subcontractor shall take every precaution necessary to prevent premature explosions and misfires. Before

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connection of the detonating wires to the detonating cable the round shall be tested for electrical continuity in an approved manner with an approved testing device or meter. In the event that this testing should show a lack of continuity then the round shall be retested leaving out one detonator at a time until the fault is identified. Should this procedure identify a faulty detonator then stemming shall be carefully removed from the hole and an additional primer inserted and wired into the circuit in place of the defective one. No attempt shall be made to draw a defective detonator or primer. On satisfactory completion of the circuit all workers other than those immediately necessary shall be withdrawn to a safe distance before detonating wires are connected to the detonating cable, and the connection of the detonating cable to the detonator shall be the last operation:

6. Where detonating is carried out by electricity, following a blast, before any person returns to the work place affected by the operation,

   a. The detonating cables shall be withdrawn from the battery, blasting machine or other source of electricity and shall be short circuited.

   b. The blasting switch shall be locked in the open position.

7. Blasting cables and wires shall be clearly distinguishable from other cables and wires and shall only be used for blasting.

D. Misfires of Explosive Charges:

1. Should a misfire occur, then the Subcontractor shall warn all persons affected, and no persons other than those required shall enter the workings until the charge has exploded or, in the case of electrical detonating, an interval of at least twenty minutes has elapsed after operation of the exploder.

2. A misfired detonator may only be removed from the face by means of approved apparatus which permits such an operation to be carried out with absolute safety. Under no circumstance shall charges which have misfired be otherwise tampered with. Should it prove impossible to extract the charge with safety, then the Contractor may authorize the Subcontractor to explode the charge by sympathetic detonation, the greatest care being taken to ensure that no new hole is drilled to intersect an old

one or that the unexploded charge is in any other way affected. After the second shot is detonated, the search shall be made for the unexploded charge.

1.10 PROTECTION

A. The Subcontractor shall preserve and protect the following:

1. Trees, shrubs and other features remaining as a portion of final grading.

2. Bench marks and monuments, existing structures, fences, walks, pavings, curbs, etc. from equipment and vehicular traffic.

3. Utilities not specified for removal.

4. Excavations from cave-in by shoring, bracing, sheet-piling, underpinning or by other methods.

5. Bottoms of excavations and soil adjacent to and beneath foundations from frost.

6. Perimeter of excavation to prevent surface water runoff into excavation.

7. Monitor wells to be saved.

8. Finished work.

9. Existing features not part of this Subcontract, e.g., existing roads or existing wells.

10. Archaeological areas identified by the Contractor or encountered during the work.

11. Displacement monuments.

1.11 EXISTING CONDITIONS

The Subcontractor shall not disturb the existing asbestos-containing materials burial area shown on the Subcontract Drawings.

PART 2 - PRODUCTS

2.1 EXPLOSIVES

A. A record shall be maintained by the Subcontractor for storage and withdrawal of explosive stocks and detonators. The inventory record shall be subject to inspection at all times. The Subcontractor shall provide such reasonable and adequate protective facilities as may be necessary to prevent loss and theft of explosives and to minimize hazards of subversive action or sabotage. Loss or theft of explosives shall be reported to the Contractor immediately. Overnight storage of explosives and detonators outside of the magazine will not be permitted. Only qualified personnel shall be permitted to handle explosives.

2.2 UNCONTAMINATED FILL MATERIALS

A. General:

1. Fill materials shall be obtained from required excavations and from borrow areas shown on the Subcontract Drawings or from other approved borrow areas selected by the Subcontractor and approved by the Contractor.

2. The Subcontractor shall be responsible for obtaining required permits and approvals for Subcontractor-selected borrow areas in accordance with the provisions of Article SC-11 of the Special Conditions. Designation of a borrow area does not indicate that all material within that area meets the Specification requirements specified herein.

a. The Subcontractor shall make his own determination of any processing or selective excavation that may be required, and shall perform testing as required to meet the Specifications for the various construction materials.

b. Submittals to the Contractor for approval of sources proposed for use by the Subcontractor shall include boring logs, borrow area maps and supporting laboratory test data. The Subcontractor also shall provide evidence of availability, right of access to private property including access by the Contractor for sampling and testing, and his plan for hauling the materials to the site. Submittals for approval of sources for uncontaminated fill materials shall

be received by the Contractor at least 30 days (60 days for radon barrier materials) before use of the material at the site. The Contractor may perform additional tests to determine if the materials meet the requirements specified herein.

c. Approval will be based on evidence of compliance with the requirements specified herein and on verification by the Subcontractor that the volume of materials available is sufficient for construction requirements.

3. Gradations: Gradations specified shall be as determined after delivery to the site, except where normal compaction operations reduce materials to acceptable sizes, in which case in-place gradations shall be acceptable.

B. Uncontaminated Common/General Fill Materials: Uncontaminated common/general fill materials for general fill shall conform to the following requirements. All references to "uncontaminated fill" or "uncontaminated fill materials" shall mean "uncontaminated common/general fill" or "uncontaminated common/general fill materials".

1. Uncontaminated fill materials shall not contain more than 5 percent, by volume, of organic material or other deleterious substances.

2. Maximum particle size shall not be greater than the compacted lift thickness in any dimension, except as noted hereinafter. Individual large stones shall be distributed within the fill materials to provide visual void-free mass, and be able to meet the requirements of Article 3.8. For fill areas under pavement locations, maximum stone dimension allowed in the upper 6 inches of the fill shall be 4 inches. Larger stones may be utilized in initial backfill in the lower layers of finish grading of the site.

2.3 CONTAMINATED FILL MATERIALS

Contaminated materials as defined in Article SC-1 of the Special Conditions resulting from the clearing, stripping and excavation operations in contaminated areas. These materials shall include materials excavated from tailings piles, windblown and waterborne areas, contaminated sediments from drainage ditches and wastewater retention basins, recirculation pond, and any other areas designated by the

Contractor including vicinity properties and demolished materials and debris.

2.4 DEMOLISHED MATERIALS AND DEBRIS

A. The demolished materials and debris shall include the following:

1. Existing stockpiles of contaminated and uncontaminated demolished materials and debris.

2. Contaminated and uncontaminated demolished materials and debris resulting from work specified under Sections 02050 and 02110.

3. Rubble and debris located within the site boundary.

B. For disposal purposes all demolished materials and debris shall be considered as contaminated materials.

2.5 VICINITY PROPERTY MATERIALS

Excavated contaminated materials resulting from cleanup of vicinity properties will be hauled to the site and stockpiled on the tailings embankment by others. The Subcontractor shall make provisions in his schedule and work plan for placement and compaction of vicinity properties materials stockpiled in the tailings embankment by others. The Subcontractor shall make allowances for decontamination of vicinity property subcontractor vehicles.

2.6 ROCKFILL SELECTED BY THE CONTRACTOR

Rockfill selected by the Contractor shall come from either existing stockpiles as designated by the Contractor or from required rock excavations as selected by the Contractor.

PART 3 - EXECUTION

3.1 PROTECTION OF EXPOSED SURFACES

A. During seasonal shutdowns and during other periods of prolonged exposure (more than six weeks) of excavated or filled areas, the Subcontractor shall provide labor, materials and equipment, as required by the Contractor, to

maintain and protect exposed surfaces of uncontaminated and contaminated materials against wind erosion and excessive stormwater erosion. Prior to the application of protective erosion control measures, the exposed surfaces shall be sloped to drain and compacted with a smooth drum roller to eliminate ruts and ridges formed by construction equipment. Unless otherwise approved by the Contractor, acceptable methods of erosion protection are as follows:

[1. Spraying with Water containing Chemical Additives: Acceptable chemical additives are CPB-12 as manufactured by Wen-Don Corporation, 206 West 2nd South, Price, Utah 84501; "Soil Seal Concentrate" as manufactured by Soil Stabilization Products Company of Merced, California; "Soil-Sement" as manufactured by Midwest Industrial Supply, Inc. of Canton, Ohio; or approved equal. Mixing and application shall be in accordance with the manufacturer's recommendations.]*

2. Covering exposed surfaces with geotextile fabric such as "Supac" as manufactured by Phillips Fibers Corporation of Sacramento, California, or approved equal. Handling and installation shall be as recommended by the manufacturer of the product.

[B. After removal of contaminated materials and completion of finish grading, the Subcontractor shall provide labor, materials and equipment as required by the Contractor to protect exposed surfaces against erosion. This shall be achieved by spraying with water containing chemical additives such as CPB-12 as manufactured by Wen-Don Corporation, 206 West 2nd South, Price, Utah 84501; "Soil Seal Concentrate", as manufactured by Soil Stabilization Products Company of Merced, California; "Soil-Sement" as manufactured by Midwest Industrial Supply, Inc. of Canton, Ohio; or approved equal. Mixing and application shall be in accordance with the manufacturer's recommendations. Exposed rock surfaces do not require treatment. The soil sealant shall only be applied to areas that are backfilled or where uncontaminated soils remain.]*

[C. Following a seasonal shutdown or period of prolonged exposure of more than six (6) weeks, the Contractor will verify by density test, that the last lift of material placed has been maintained at the applicable minimum specified density. Verification by density test will be performed prior to placing any additional materials on the surface and at frequencies described in Article 3.7. Material failing to meet the specified density requirements shall be removed or reworked to satisfy the minimum specified density requirements.]*

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3.2 EARTHWORK - GENERAL

A. Preparation:

1. Clearing and stripping shall be as specified in Section 02110.

2. Required lines, levels, contours and datum shall be identified before the start of earthwork operations.

3. The Subcontractor shall verify the existing above-ground and underground utilities, identify them, and notify the Contractor immediately of his finding, if any, for appropriate action.

B. Dewatering and Drainage: Prior to commencement of earthwork operations, the Subcontractor shall verify that the dewatering and drainage facilities are constructed and operational in accordance with the requirements of Section 02141.

C. In order to avoid cross-contamination of uncontaminated material, the contaminated and uncontaminated materials shall be kept separated during earthwork operations. Stockpiles of contaminated materials shall be placed on contaminated areas and the drainage collected in the retention basin.

D. Earthwork shall conform to lines and grades indicated on the Subcontract Drawings or specified in this Section.

E. The excavated uncontaminated common materials, where practicable, shall be used as fill in various areas of the sites including general fill, roadway fill, structure fill, backfill, fill for the final grading of the site and for the construction of the tailings embankment, as required.

F. The excavated uncontaminated rock materials shall be placed in the spoil area indicated on the Subcontract Drawings. The Contractor may direct the Subcontractor to place selected excavated uncontaminated rock materials in stockpiles. Rockfill selected by the Contractor shall come from existing or new stockpiles of selected, excavated, uncontaminated rock.

3.3 EXCAVATION

A. General:

1. Excavation shall be carried out to reach the lines and grades indicated on the Subcontract Drawings or specified

herein, or, in the case of contaminated materials, as required by the Contractor's Health Physics Personnel.

2. At all times, the Subcontractor shall conduct his operations in such a manner as to prevent free standing water and contamination of uncontaminated materials. The Subcontractor shall, as a minimum, take the following measures to safeguard against such problems:

   a. Water leaving a contaminated excavation area or contaminated area otherwise disturbed by construction activities shall be routed into the retention basin as specified in Section 02141.

   b. Exposed surfaces of contaminated and uncontaminated materials excavations shall be protected from erosion as specified in Article 3.1 above.

3. The Subcontractor shall remove all excavated material from the excavation site and dispose of it in fills required at the site or use it for other purposes, as approved.

4. Unsuitable or low density subgrade material not readily capable of in-place compaction shall be excavated as directed by the Contractor and disposed of as specified in Article 3.4.

[5. Adequate working space for safety of personnel shall be provided within the limits of the excavation. Extra precautions shall be taken to protect workers when excavating near steep rock faces. Boulders or loose rock on the rock face shall be removed as they become exposed.]*

6. Except as otherwise noted, care shall be exercised to preserve the material below and beyond the lines of all excavation. Where excavation is carried below grade, the Subcontractor shall backfill to the required grade or to indicated invert grade, as specified, and recompact the backfill to meet the existing conditions.

7. Excavation for the convenience of the Subcontractor shall conform to the limits approved by the Contractor and shall be at no additional expense to the Contractor.

8. Excavated material shall be placed at sufficient distance from edge of excavations to prevent cave-ins or bank slides. Slopes of excavated cuts and stockpiles shall

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not be steeper than 2(H) to 1(V) unless indicated otherwise on the Subcontract Drawings.

9. Where practicable, suitable materials removed from excavation shall be used as fill or backfill.

B. Contaminated Materials Excavation:

1. Contaminated materials excavation shall include excavation of (a) contaminated materials from the tailings piles at the Monument Valley site, (b) windblown and waterborne off-pile areas including wet slimes and rippable rock, at both sites, and (c) existing retention basins and dikes and heap leach pads area. The Subcontractor shall minimize the open excavation area of contaminated materials at any time during excavation work. The Subcontractor shall operate from one or two sides at one time, progressing uniformly to opposite sides for completion, unless directed otherwise by the Site Manager. Contaminated materials shall be excavated to the depths indicated on the Subcontract Drawings, or as required by the Contractor, and placed in the proper part of the tailings embankment. Contaminated materials will be excavated generally in priority of its placement in the tailings embankment to minimize rehandling and stockpiling. Excavation shall be carried out to the limits and grades required by the Contractor. Rock requiring drilling and blasting operations shall not be included in this excavation.

[2. The Subcontractor shall remove contaminated material from rippable rock surface to acceptable finish. Examples of an acceptable rock finish are available at each site. The locations of areas with an acceptable rock finish are shown on the Subcontract Drawings. The Subcontractor shall employ whatever equipment methods are necessary in order to achieve an acceptable rock finish, and remove windblown/waterborne contamination from within rock crevices.]*

3. During excavation operation, tests will be performed by the Contractor to determine radioactive contamination of the material to be excavated.

C. Uncontaminated Materials Excavation:

1. General: Uncontaminated materials excavation shall include excavations of uncontaminated materials from the

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various areas of the site. The excavated materials shall be used as fill in various areas of the sites including construction of berms, dikes, general fill, roadway fill, structure fill, backfill, and fill for final grading of site, as required. Uncontaminated excavated material may be stockpiled for later use.

2. Rock Excavation:

   a. The Subcontractor shall perform required rock excavation to the limits shown on the Subcontract Drawings or as directed by the Contractor.

   b. Care shall be exercised to avoid excessive overbreak beyond or below grade lines of excavation.

   c. Blasting methods and procedures shall be such that, upon completion of the excavation, all rock surfaces will be sound and relatively uniform. Explosives shall be of such quantity and power and shall be used in a manner that will minimize opening of seams and disturbing of rock outside the prescribed limits of excavation. As the excavation approaches its final limits, the depths of holes for blasting and the quantity of explosives used for each hole shall be reduced so that the rock underlying or adjacent to the final limits is not shattered or otherwise disturbed.

   d. The Subcontractor shall remove all shattered material and debris from excavation.

   e. Excavated rock materials shall be used as fill, where required, or may be stockpiled in approved locations for later placement as fill.

   f. Where shown on the Subcontract Drawings, rock shall be chipped or ground to final grade. Blasting or ripping of rock within this area will not be permitted.

3. Permanent Drainage Ditches Excavation:

   a. Ditches shall be excavated true to line and grade. Any erosion which occurs to ditch excavation before placing erosion protection materials shall be repaired with compacted backfill. All such repairs shall be at Subcontractor's expense and shall not be included in pay quantities, unless otherwise shown on the Subcontract Drawings.

b. Where the subgrade consists of common fill, the subgrade shall be compacted as specified in Article 3.8 below. After compaction has been completed, finish grading shall be done in such a manner that the sideslopes and bottom are rendered smooth surfaces. All loose rocks, brush, roots, large clods, and other objects shall be removed before placement of the bedding material and the riprap material.

4. Borrow Area Excavation:

a. General:

1) Borrow areas for general fill are indicated on the Subcontract Drawings.

2) Borrow areas shall meet all permit and negotiated requirements as required by the Contractor.

3) Necessary clearing, grubbing, and disposal of debris shall be performed by the Subcontractor as incidental operations to the borrow excavation.

4) After borrow excavations are completed, borrow areas shall be graded to drain. Natural drainage patterns shall be maintained.

5) Where general fill materials are not available in sufficient quantity from the required excavations, such materials shall be obtained from approved offsite borrow areas.

b. The Subcontractor shall notify the Contractor at least 30 days in advance of opening any borrow area so that adequate time will be allowed for testing the material.

3.4 DISPOSAL OF EXCAVATED MATERIALS

A. Contaminated Materials: All contaminated materials excavated from the Mon tailings piles, retention basins, heap leach pads, windblown, and other areas of the site shall be used in the construction of the tailings embankment as specified herein. Contaminated material will be placed in the tailings embankment by priority generally as indicated Article 3.5.B.5. Radiological monitoring of contaminated materials

or construction expediency may change this priority, as directed by the Contractor.

B. Uncontaminated Materials:

1. Materials excavated from the sites, including excavations for drainage ditches which do not classify as contaminated materials, shall be used as uncontaminated material fill for construction of various features, or stockpiled for later use for site grading as specified in this Section and as required by the Contractor.

2. Where used in fills, such material shall be transported directly from the excavation and placed in its final position in such fills whenever possible. If required by the Subcontractor's schedule, the material may be placed temporarily in stockpiles at approved locations. Material in stockpile shall be protected from contamination of any kind that would render it unsuitable for use in fills.

3. Clean, sound, unweathered rock, of suitable material, from the required excavation may be incorporated into fills, after processing as necessary, provided it meets the appropriate specifications and as approved by the Contractor.

4. Uncontaminated Common and Rock Materials: See Article 3.2, Paragraphs E and F.

5. Garbage, refuse, debris, oil, and any waste material which is harmful to the environment shall be removed from the job site and disposed of offsite in a manner approved by the authority having jurisdiction over the offsite disposal facility.

6. Excess uncontaminated materials shall be disposed of on site or in the spoil area shown on the Subcontract Drawings as approved by the Contractor.

C. Disposal of Demolished Materials and Debris:

1. Existing stockpiles of demolished materials and debris, and demolished materials and debris resulting from demolition work specified in Section 02050 shall be disposed of in the tailings embankment conforming to the applicable provisions of this Section and as required by the Contractor.

2. During construction of the tailings embankment, provision shall be made to leave required space at proper location

in the embankment for the placement of the demolished materials and debris resulting from the demolition work specified in Section 02050.

3.5 FILL CONSTRUCTION

A. General Requirements:

1. Clearing and stripping shall be as specified in Section 02110.

2. Fill materials shall be placed and compacted to the lines and grades shown on the Subcontract Drawings or as required by the Contractor.

3. Prior to placing of uncontaminated fill materials, the subgrade will be radiologically surveyed by the Contractor to confirm that EPA standards have been met. These radiological surveys may cause delays to backfill operations of up to seven working days. The Subcontractor shall plan his work accordingly.

4. If any portion of the materials placed as fill does not meet the specified requirements, the Subcontractor shall remove such material and replace it with fill materials meeting the specification at no additional cost to the Contractor.

5. Constructed fills shall be maintained to meet the requirements of this Specification until final completion and acceptance of the Work. This shall include all measures to prevent erosion or contamination during construction, including contamination by radioactive material. During seasonal or other extended shutdowns, all exposed surfaces shall be protected with special treatments specified in Article 3.1 above.

B. Placing Requirements:

1. Prior to placement of materials, the in-place density of the subgrade shall be as specified in Article 3.9. Subgrade preparation, where required, shall be as specified in Article 3.8.

2. No material shall be placed on any portion of the subgrade or against or upon any structure until consent to place such fill has been obtained from the Contractor.

3. Fill materials may require moisture conditioning (wetting or drying) prior to compaction. Some tailings slimes particularly will require spreading and extended drying time prior to compaction.

4. Fill materials shall be placed in continuous and approximately horizontal lifts for their full length and width unless otherwise specified or specifically permitted by the Contractor.

5. The following sequence shall be followed in placing materials in the tailings embankment:

   [a. Materials from the heap leach pad area and the old pile area at Monument Valley including demolished materials, boulders, ore and debris.]*

   b. Tailings materials from the new pile area at Monument Valley.

   c. Contaminated materials from windblown, waterborne and off pile areas.

   d. Vicinity property material as delivered to the site and as directed by the Contractor.

   e. Excess uncontaminated materials from required excavations, including retention basin dikes.

   f. Radon barrier material: The entire thickness shall be amended with 10 percent bentonite.

   g. Bedding material.

   h. Riprap protection.

6. Method of dumping and spreading the materials shall ensure uniform distribution of the material.

[7. The loose thickness of each layer shall not be greater than that required to achieve the specified compaction. For material containing particles having a maximum dimension of less than 10 inches the loose lift thickness shall not exceed 12 inches. For material containing particles greater than 10 inches, the loose lift shall be kept to the minimum constructible thickness, as approved by the Contractor. Oversize material shall be placed in

* P.I.D. 09-S-15

accordance with Article 3.5.B.10 and graded to avoid ponding of surface water. Oversize material shall be compacted in accordance with Article 3.5.C.8. Rubble and boulders from Monument Valley shall be broken to a maximum rock size of 36 inches before placing in the tailings embankment.]*

8. Unless otherwise indicated, fill materials shall be placed to a grade no flatter than 2 percent to facilitate drainage of water. In areas where ponding cannot be prevented or ponding has occurred and fill is required to be placed, placing shall begin only after the area is dewatered and permission to place is obtained from the Contractor.

9. Materials shall not be placed on frozen subgrade or frozen fill, nor shall frozen material be used as fill.

10. Bulky (demolished materials and debris) materials shall be disposed of in the lower portion of the tailings embankment fill. The materials shall be placed evenly in each lift to minimize the volume of voids created in the disposal mass and to avoid nesting. Organic matter shall be distributed to provide a concentration of not more than five percent in any area of the embankment.

11. When no longer needed for control of contamination, as determined by the Contractor, the retention basins, recirculation pond, and the like shall be removed and the area restored.

C. Compaction Requirements:

1. Each lift of fill materials shall be compacted to a minimum density specified in Article 3.9.

2. During compaction, the moisture content of fill material shall be maintained to achieve specified density. Uniform moisture distribution shall be obtained by disking, blading, or other methods approved by the Contractor prior to compaction of a lift.

3. If the surface of the prepared foundation or the rolled surface of any lift of fill is too dry or too smooth to bond properly with the lift of material to be placed thereon, it shall be scarified and moistened by sprinkling to the acceptable moisture content prior to placement of the next lift of fill.

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4. If the rolled surface of any lift of the fill in place is too wet for proper compaction of the lift of fill material to be placed thereon, it shall be removed, allowed to dry or worked with harrow, scarifier, or other suitable equipment to reduce the water content to the required amount, and then re-compacted before the next succeeding lift of fill is placed.

5. Fill placed at densities lower than the specified minimum density or at moisture contents that make compaction difficult shall be reworked to meet the density and moisture requirements or removed and replaced by acceptable fill compacted to meet these requirements.

6. Uncontaminated fill material in the stockpile areas shall be placed by spreading with a bulldozer and track walking. Lift thickness before compaction shall not exceed one foot. Compaction shall be accomplished by routing of hauling and spreading equipment units.

7. Unfavorable Weather: Placing, spreading, rolling or compacting fill material that is frozen or thawing, or during unfavorable weather conditions shall not be permitted.

8. Compaction of fill with more than 30 percent retained on a 3/4-inch standard sieve:

   a. Prior to compaction, materials shall be moisture conditioned as approved by the Contractor. If required, moisture addition shall be limited to the amount of water required to lubricate rock particles. When adding moisture, care shall be taken not to increase the moisture content of underlying soils.

   b. Compaction shall be accomplished by any of the following combinations of passes and equipment, or approved equal combination:

Equipment	Minimum No. of Passes for 90% Compaction	Minimum No. of Passes for 95% Compaction
BOMAG Vibratory Roller Model 213D	2	4
CAT CS 553 Vibratory Roller	2	4
CAT Compactor Model 825C	2	4
Raygo Vibratory Roller Model 400A	2	4
Track-Type Tractor with Ground Pressure of at Least 9.8 psi	3	5
Towed 5x5 Sheepsfoot, Fully Ballasted	3	4

c. Depending on soil conditions, the Subcontractor may be required to change the compaction equipment or increase the number of passes to achieve the desired compaction. Approval of a combination of equipment and number of passes suitable for certain soil types and conditions may not apply to different soil conditions.

d. Materials shall not be subject to requirements of Article 3.8.A.

3.6 ROCKFILL PLACEMENT

A. Selected rockfill shall be placed as shown on the Subcontract Drawings or as directed by the Contractor. Rockfill shall be placed by end dumping and may be spread by bulldozers or other suitable equipment.

B. Rockfill shall be placed so that larger stones are well distributed throughout the mesh. Rearranging of individual stones will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes.

C. Excavated rock other than rockfill selected by the Contractor shall be placed on the designated spoil area or in other areas within the site as designated by the Contractor. Spoiled rockfill shall be compacted by routing tracted construction equipment over the surface.

3.7 FIELD QUALITY CONTROL

A. General: The Contractor will take samples and perform tests throughout the construction period, and the Subcontractor shall cooperate in providing access for the Contractor to areas where testing is to be performed and shall schedule his placing to avoid interference with the testing operations.

B. Tests: The Contractor will perform the following tests on a regular basis.

1. In-place density and moisture content tests where density is specified will be as follows:

   a. A minimum of one test per 1000 cubic yards of contaminated and uncontaminated materials placed excluding radon barrier material. At least two tests shall be performed for each day of material placement in excess of 150 cubic yards.

   b. Foundation and Subgrade: Prior to placing the first layer of material on the foundation, the subgrade will be inspected to assure that it has no sign of deterioration due to frost action, erosion due to rainwater, rutting, areas of subsidence, or drying out of the surface. The inspection shall verify that the foundation surface has been moistened, but there is no standing water on the surface and that the foundation surface of cohesive soils has been scarified or penetrated to ensure proper bonding of overlying material. Unacceptable surface material shall be either removed or excavated and recompacted to Specification requirements.

   [c. A minimum of one test per 30,000 sq.ft. on the surface of previously placed materials after a seasonal shutdown or period of prolonged exposure and prior to placing additional materials.]*

2. The placing and compaction of temporary stockpiles will be subject to the approval of the Contractor.

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3.8 SUBGRADE PREPARATION

A. Subgrade Preparation: Subgrade preparation includes fine grading and compaction of excavations, backfills, embankments (including stockpiles) upon which pavement, surfacing, base, subbase, and riprap or other structures are constructed.

B. The entire surface of the subgrade shall be plowed, harrowed, and mixed to a depth of at least 6 inches. Compaction shall be carried out for the full area below finished subgrade to at least the density specified in Article 3.9 below.

3.9 COMPACTION DENSITIES

A. Subgrade of permanent drainage ditches and embankments, and each layer of embankment and backfill shall be compacted to at least the following percentage of maximum dry density, as determined by ASTM D698 test method:

1.	Subgrade Preparation:	90 percent
2.	Subgrade Preparation for Permanent Drainage Ditches	95 percent
3.	Tailings Embankment Fill Except Top 3 feet	90 percent
4.	Tailings Embankment Fill Top 3 feet Immediately Below the Bottom of Radon Barrier	95 percent
5.	Trench Backfill and Common Fill	95 percent
6.	Site Restoration	90 percent

3.10 DISPLACEMENT MONUMENTS

Displacement monuments shall be furnished and installed by the Subcontractor as shown on the Subcontract Drawings. The Subcontractor shall take precautions not to damage the existing monument or new monuments once they are installed. Damaged monuments shall be replaced by the Subcontractor at no additional cost to the Contractor. The Subcontractor shall add extension rods to existing monuments as the fill is being placed. All displacement monuments shall be permanently protected as shown in the Subcontract Documents.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement for payment for the following items of earthwork will be by the cubic yards of material excavated and placed in the disposal cell. The quantities for payment will be computed by average end area method from surveys conducted before and after fill operations. Separate measurement for payment will not be made for excavation of the materials in their original locations. A survey of the existing tailings embankment will be required by the Subcontractor prior to placement of any materials on the embankment.

1. Placement in the Tailings Embankment of all Contaminated and Other Materials Including Demolished Materials, Debris, Rubble and Vicinity Property Materials (Bid Schedule Item 401)

B. Measurement for payment for the following items of excavation will be by the cubic yards of materials excavated. The quantities for payment will be computed by average end area method from surveys conducted before and after excavation operations:

1. Rock Excavation for Finish Grading of the Mexican Hat Site Including Ditches and Gullies and Grinding or Planing of Rock Adjacent to the North Ditch (Bid Schedule Item 801)

C. Measurement for payment for the following items of fills will be by the cubic yards of materials placed. The quantities for payment will be computed by average end area method from surveys conducted before and after placement:

1. Uncontaminated Material Fill for Finish Grading of the Mexican Hat and Monument Valley Sites (Bid Schedule Item 802)

2. Rockfill Selected by Contractor for Finish Grading of the Mexican Hat Site (Bid Schedule Item 803)

D. Measurement for payment for the following items of work will be by the acre measured in the horizontal plane from surveys conducted before and after the work as shown on the Subcontract Drawings, or by the methods determined by the Contractor:

1. Fine Grading of Existing Side Slopes of the Tailings Embankment (Bid Schedule Item 402)

2. Cleanup of Rock Surfaces at the Mexican Hat and Monument Valley Sites (Bid Schedule Item 403)

E. Separate measurement for payment will not be made for the following items, and such work will be considered incidental to the related items of work:

1. Subgrade preparation.

2. Stockpiling of excavated materials.

3. Required rehandling of materials.

4. Blasting.

5. Borrow area excavation, restoration, reseeding and incidental activities.

6. Protection of exposed surfaces during shutdown.

F. Overexcavation: Overexcavation for the Subcontractor's convenience or due to error or lack of control by the Subcontractor will not be measured for payment. At the discretion of the Contractor, overexcavation shall be backfilled with compacted uncontaminated fill, as required, at the Subcontractor's expense.

G. Separate measurement for payment will not be made for any other excavations or fills specified in this Section.

H. Measurement for payment for furnishing and installing displacement monuments will be by the number of new monuments installed. The price shall include extending and protecting the existing displacement monuments. (Bid Schedule Item 404)

4.2 PAYMENT

A. Payment for the item of Article 4.1.A above will be by the applicable unit price per cubic yard quoted therefor in the Bid Schedule. The price quoted shall include full compensation for excavating, loading, hauling, unloading, and placing the excavated materials in their final locations including all clearing, stripping, grading, shaping, preparing subgrade, compacting, temporary stockpiling and required rehandling.

B. Payment for the items of Article 4.1.B above will be by their applicable unit prices per cubic yard quoted therefor in the Bid Schedule. The prices quoted shall include full compensation for excavating, hauling, and placing the

excavated materials in temporary stockpiles, or in spoil areas if excess or unsuitable for use as fill, as required, including all clearing, stripping, shaping, and compacting such stockpiles or areas as specified.

C. Payment for the items of Article 4.1.C above will be by their applicable unit prices per cubic yard quoted therefor in the Bid Schedule. The prices quoted shall include full compensation for hauling the materials from excavated areas or retrieving the materials from temporary stockpiles, and placing and compacting the materials in their final locations including all clearing, stripping, grading, shaping, preparing subgrade, and compacting. The prices quoted shall also include full compensation for furnishing imported uncontaminated materials from the Subcontractor's own sources. No separate payment will be made for temporary stockpiles and rehandling or for moisture/dust controls which are considered included in the Subcontract unit prices.

D. Payment for the items of Article 4.1.D above will be by their applicable unit prices per acre quoted therefor in the Bid Schedule. The prices quoted shall include full compensation for removing the materials from the required areas, as required, and placing the excavated materials in their final locations including all grading, shaping, preparing subgrade, and compacting, as required.

E. Separate payment will not be made for the items mentioned in Article 4.1.E above. All costs for such work will be considered to be included in the prices quoted for the applicable related items of work.

F. Separate payment will not be made for any other excavations or fills specified in this Section. All costs for excavations or for furnishing and placing such fills will be considered to be included in the related items of excavation.

G. Payment for furnishing and installing new displacement monuments will be by the unit price per each quoted therefor in the Bid Schedule.

END OF SECTION 02200

SECTION 02228

RADON BARRIER

PART 1 - GENERAL

1.1 SCOPE

A. This Specification Section covers the following:

1. Production of radon barrier materials by mixing bentonite with uncontaminated soil from borrow areas RB-4 and RB-7.

2. Placement of the radon barrier layer in the construction of the cover for the tailings embankment.

1.2 RELATED WORK

A Section 00800 - Special Conditions

B. Section 01052 - Layout of Work and Surveys

C. Section 01300 - Submittals

D. Section 01500 - Construction Facilities

E. Section 01560 - Temporary Controls

F. Section 02200 - Earthwork

1.3 DEFINITIONS

A. Radon Barrier - The layer constructed on top of the contaminated materials in the tailings embankment consisting of bentonite amended soils from borrow areas RB-4 and RB-7. The purpose of this layer is to retard the emanation of radon gas from the tailings embankment into the atmosphere and to reduce infiltration of incident precipitation into the tailings embankment.

B. Cover - See Section 02200.

1.4 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. American Society for Testing and Materials (ASTM):

D422-63	Method for Particle-Size Analysis of Soils (R1972)
D698-78	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.49-kg) Rammer and 12-in. (305-mm) Drop
D1140-54	Test Method for Amount of Material in Soils Finer than the No. 200 (75-um) Sieve (R1971)
D1556-90	Test Method for Density of Soil in Place by the Sand-Cone Method
D2167-84	Standard Test Method for Density and Unit Weight of Soil In-Place by the Rubber-Balloon Method
D2216-90	Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
D2922-81	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D4643-87	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

2. American Petroleum Institute (API):

Specification 13A, Section 4, Specification for Oil Well Drilling-Fluid Materials

1.5 QUALITY ASSURANCE

[A. The Contractor will take soil samples and perform moisture, density, gradation and other tests to ascertain that the work is being performed in compliance with these Specifications. Samples will be taken during excavation and on the fill itself. The Contractor will conduct the density and other tests on the fill and related laboratory testing at

frequencies described in Article 3.5. The Subcontractor shall remove surface material and render assistance as necessary to enable sampling and testing.]*

B. Methods of Sampling and Testing:

1. Particle Size Analysis including Percentage Passing No. 200 Sieve (and excluding hydrometer analysis): ASTM D422

2. In-Place Density: ASTM D1556, D2167, or D2922

3. Moisture Content: ASTM D2216 or D4643

4. Laboratory Moisture-Density Relations: ASTM D698

C. Suitability of Materials: The suitability of materials for radon barrier will be determined by the Contractor. The materials shall be approved material meeting the requirements of this Specification and obtained from Contractor-approved borrow sources.

D. The Contractor may direct that inspection trenches or test pits be cut into the radon barrier to determine that the Specification requirements have been met. Such trenches or pits will be of limited depth and size, and shall be backfilled with the material excavated therefrom, or other material meeting the requirements for the radon barrier. Backfill shall be compacted to a density at least equal to that specified for radon barrier.

E. When the Contractor directs inspection trenches or test pits to be excavated into compacted radon barrier and materials are found to meet all Specification requirements, the excavation and refilling shall be paid for as additional work pursuant to the applicable provisions of the General Conditions. Inspection trenches or test pits, and the refilling of the same, shall be at the Subcontractor's expense when it is found that the materials do not meet the Specification requirements.

F. Tolerances: See Specification Section 01052, Article 1.8.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Radon barrier materials shall be a mixture of radon barrier soils and bentonite.

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B. Radon Barrier Soils: Radon barrier soils shall be produced by selective excavation of material from borrow areas RB-4 and RB-7. Materials unsuitable for use as radon barrier material which are produced due to over-excavation or removal of overburden shall be stockpiled at the borrow site in areas selected by the Subcontractor and subject to Contractor's approval. Stockpiled materials shall be used later for site grading or borrow area reclamation. The radon barrier soils shall meet the following criteria:

1. Radon barrier soil shall meet the following gradation limits prior to mixing with bentonite:

Sieve Size	% Passing by Weight
4-inch	100
3/4-inch	70-100
No. 4	50-100
No. 60	15-100
No. 200	5-100

2. Radon barrier soil shall not contain more than 5 percent by volume of organic material, roots more than 1/4 inch in diameter or other deleterious substances.

3. The Subcontractor shall perform testing as required to ensure that the materials meet the specification requirements.

4. Clod sizes in radon barrier materials shall be 1 inch or smaller. The Subcontractor shall screen or otherwise process materials as required.

C. Bentonite:

1. Bentonite shall be high swelling, unaltered, sodium montmorilonitic clay. High swelling is defined as the ability of two grams of bentonite, mechanically reduced to 100 mesh, to swell in water to an apparent volume of 10.0 cubic centimeters or more when added a little at a time, to 100 cubic centimeters of distilled water in a graduated cylinder.

2. Colloid content of the base bentonite, mechanically reduced to 100 mesh, shall exceed 33 percent as measured by evaporating the suspended portion of a 2 percent solution after 24 hours of sedimentation in a beaker.

3. Bentonite shall have the following physical properties determined in accordance with the requirements of A.P.I. Specification 13A, Section 4:

Grit Content (plus 200 Mesh wet sieve analysis)	55% maximum
Viscosity (600 RPM)	6 cps minimum
Filtrate (30 minutes)	30 mils maximum
Moisture Content	10% maximum

4. Dry fines of the bentonite shall be:

   100% passing Number 4 sieve by weight

   15% maximum passing Number 200 sieve by weight

5. Bentonite shall be protected from the weather during shipping and storage.

6. A certified material test report (CMTR) or Certificate of Compliance (C of C) shall be furnished with each lot number of bentonite delivered to the site. If a CMTR or C of C is not furnished, testing shall be performed by the Subcontractor to demonstrate that all physical properties required by API and the specifications have been met. All CMTR's, C of C's and/or test results shall verify that each lot of bentonite meets the specified requirements or the material shall be rejected. No bentonite material shall be mixed or placed prior to this verification.

PART 3 - EXECUTION

3.1 GENERAL

A. Protection of exposed surfaces shall be as specified in Article 3.1 of Section 02200.

B. Dust control measures shall be as specified in Section 01560.

C. Clearing and stripping shall conform to Section 02110.

3.2 BORROW AREA EXCAVATION

A. Only portions of the area within the designated borrow area contain material suitable for mixing with bentonite to produce radon barrier material. The material shall meet the requirements specified in Article 2.1.B. Subcontractor shall

identify the areas that contain material suitable for radon barrier material prior to the excavation.

B. Excavations shall not be within 50 feet of the shoulders of the existing Navajo Nation road that separates the borrow areas.

C. Excavations for radon barrier soils to be used for mixing with bentonite to produce radon barrier materials shall be carried out in the presence of a qualified technician employed by the Subcontractor.

D. Materials excavated for mixing with bentonite to produce radon barrier shall not be used for other purposes except as approved by the Contractor.

3.3 MIXING OF RADON BARRIER

A. The radon barrier soil shall be thoroughly mixed with bentonite. The bentonite content shall not be less than 10 percent by weight. The percentage shall be determined by dividing the dry weight of bentonite by the dry weight of soil without bentonite.

[B. Mixer: The mixer for mixing bentonite with the radon barrier material shall be capable of thoroughly mixing and controlling the percentage, by weight, of bentonite, soil and water. The mixer shall be the following, or approved equal:]*

1. Pug-mill, Pioneer Model 425P stabilizer plant.

[Text Deleted]*

C. Submittals: Sixty days after award of Subcontract, the Subcontractor shall submit, for approval, a narrative on how the radon barrier material will be mixed, placed and compacted. The narrative shall include the following:

1. Description of equipment used, including manufacturer's specifications.

2. Narrative of mixing operations, including how the bentonite, soil and water will be mixed; how quantities will be determined; and the duration of mixing.

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3. Procedures for calibrating the mixing equipment to show the proper mix is obtained and procedures for verifying calibration during operations. The plant shall be calibrated just before start of operation as well as during operation.

D. If stationary plant is used to mix the radon barrier material, the Subcontractor shall locate the plant so as not to interfere with other operations. At the end of the work, foundations shall be removed and disposed of by the Subcontractor, and the site restored as approved by the Contractor.

E. The Contractor may visually inspect the mixture for uniformity and consistency. Adjustments to mixing or procedures may be required by the Contractor to provide a uniform mix.

3.4 PLACEMENT AND COMPACTION OF RADON BARRIER

A. The radon barrier material shall be laid down in controlled lifts as specified in this Section.

B. Unless otherwise specified or indicated herein or elsewhere in the Subcontract Drawings, placement and compaction of the radon barrier material shall conform to the applicable provisions of Section 02200.

C. Unfavorable Weather: Placing, spreading, rolling or compacting fill material that is frozen or thawing, or during unfavorable weather conditions will not be permitted. If the work of placement of radon barrier material is interrupted by heavy rain or other unfavorable weather, such work shall not be resumed until ascertaining that the moisture content and density of the previously placed soil are acceptable to the Contractor.

D. The Subcontractor shall only work on an area that can be completed in one working day. Completion shall be defined as soil moisture adjustment, spreading of the bentonite, the mixing of the soil with the bentonite, and compaction of the soil bentonite layer.

E. Prior to placing radon barrier material, the final grade of the underlying contaminated materials shall be as shown in the Subcontract Drawings and specified in Section 02200.

F. In placing and working the first layer of radon barrier, care shall be taken to avoid mixing in any of the underlying radiologically contaminated soil.

G. Twenty-four inch thick radon barrier shall be placed in three lifts. The lifts shall be placed in a loose lift of approximately 10 inches to give a compacted thickness of 8 inches. The Subcontractor shall provide survey stakes verifying each 8-inch compacted lift.

H. Compaction of radon barrier shall be accomplished using tamping foot rollers.

I. The radon barrier material shall be compacted to at least 100 percent of maximum dry density as determined by ASTM D698. During compaction of radon barrier materials, moisture content shall be maintained between the optimum moisture content and plus three percent as determined by ASTM D698. The moisture content of the preceeding in-place radon barrier lift, with the exception of the top 2 inches shall be maintained at not less than optimum minus one percent moisture content until the succeeding lift of radon barrier or bedding material is placed.

J. Once minimum specified density is achieved for radon barrier, additional compaction shall not be performed.

K. Moisture added to the radon barrier materials shall be applied in a manner that prevents runoff onto contaminated materials.

L. The top surface of the underlying compacted radon barrier shall be scarified to a depth of 1 inch to 2 inches just prior to placement of the overlying loose lift. Scarification shall be accomplished by suitable equipment capable of accurate depth control.

M. If shrinkage cracks occur on top of each lift prior to placing the next lift, the surface should be scarified to the depths of the crack, moisture conditioned, and recompacted.

N. The top surface of the final layer of radon barrier shall be compacted with a tamping foot roller, then bladed and finished with a grader and a smooth drum roller. The top surface of the final layer of radon barrier shall be free of ruts, depressions, or low areas in which water can accumulate.

O. Upon completion of radon barrier placement and prior to the placement of bedding material, the Contractor will perform required radiological measurements. These measurements generally can be accomplished in 30 hours but may vary depending on atmospheric conditions. Measurements will be taken at approximately 100 evenly spaced locations as determined by the Contractor.

3.5 FIELD QUALITY CONTROL

A. The Contractor will perform the following tests on a regular basis. These tests are a minimum requirement:

1. In-Place Density and Moisture Content Tests: A minimum of one test will be performed per 500 cubic yards of the material placed. At least two tests will be performed for each day of material placement in excess of 150 cubic yards.

[2. Gradation Test: A minimum of one test per 1,000 cubic yards of material placed and a minimum of one test each day of material placement. The gradation tests will be performed on borrow material from RB-4 and RB-7 prior to mixing with bentonite. The Contractor may also do gradation testing on radon barrier materials after being mixed with bentonite.]*

3. Procedures and frequency for calibration of the mixing equipment shall be in accordance with the Contractor-approved plan.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement for payment for furnishing and placement of radon barrier material in the embankment cover will be by the cubic yards of compacted material in place. The quantities for payment will be computed by the average end area method from surveys conducted before and after placement and from lines and dimensions as shown on the Subcontract Drawings. (Bid Schedule Item 501)

B. Measurement for payment for furnishing bentonite will be by the ton delivered to the site and used in the radon barrier. (Bid Schedule Item 502)

C. Separate measurement for payment will not be made for the following items, and such work will be considered incidental to the related items of work:

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1. Dust control.
2. Stripping.
3. Temporary stockpiling of excavated materials.
4. Required rehandling of materials.
5. Borrow area grading for restoration.
6. Erosion protection of exposed surfaces.
7. Temporary storage of bentonite.

4.2 PAYMENT

A. Payment for the excavation and placement of radon barrier material in the embankment cover will be by the unit price per cubic yard quoted therefor in the Bid Schedule. The price quoted shall include full compensation for excavation of the radon barrier material from the specified borrow source and processing, mixing, placement and compaction of the material in its final location.

B. Payment for furnishing bentonite will be by the unit price per ton, delivered to the site and used in the radon barrier, quoted therefor in the Bid Schedule.

C. Separate payment will not be made for the items mentioned in Article 4.1.C above. All costs for such work will be considered to be included in the prices quoted for the applicable related items of Work specified in this Subcontract.

END OF SECTION 02228

SECTION 02278

EROSION PROTECTION

PART 1 - GENERAL

1.1 SCOPE

This Specification Section describes the requirements for furnishing and placing riprap and bedding materials for tailings embankment cover, drainage ditches, apron and gullies.

1.2 WORK NOT INCLUDED

Erosion protection related to the construction facilities specified in Section 01500 is not included in the scope of work of this Specification.

1.3 RELATED WORK

A. Section 01300 - Submittals

B. Section 02200 - Earthwork

C. Section 02228 - Radon Barrier

1.4 APPLICABLE PUBLICATIONS

A. The Publications listed below form a part of this Specification to the extent referenced. The Publications are referred to in the text by the basic designation only:

1. American Society for Testing and Materials (ASTM):

C88-90	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C117-90	Test Method for Materials Finer Than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
C127-88	Test Method for Specific Gravity and Absorption of Coarse Aggregate
C131-89	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

C136-84 Standard Method for Sieve Analysis of Fine and Coarse Aggregates, Rev. A

C295-90 Standard Guide for Petrographic Examination of Aggregates for Concrete

D75-87 Standard Practice for Sampling Aggregates

2. International Society for Rock Mechanics (ISRM), 1981

Rock Characterization Testing and Monitoring, ISRM Suggested Methods, E.T. Brown, Editor, Pergamon Press, New York:

Suggested Method for Determining Indirect Tensile Strength by the Brazil Test, pp. 120-121

Suggested Method for Determination of the Schmidt Rebound Hardness, PP. 101-102

1.5 PERMITS

The Contractor will provide permits for the use of borrow areas shown on the Subcontract Drawings as specified in Article SC-11 of Special Conditions. If the Subcontractor uses other sources for erosion protection materials, he shall be responsible for obtaining all required permits.

1.6 SUBMITTALS

A. During production of riprap and bedding materials, the Subcontractor shall submit gradation test results, in triplicate, in accordance with Article 2.1 below. For riprap and bedding materials, quality and gradation tests for each type material shall be performed a minimum of four times during production. An initial sample shall be obtained and tested during the early stages of production activities. Additional samples shall be obtained and tested when approximately one-third and two thirds of the total volume of material has been produced, and a final sample shall be obtained and tested near completion of the production activities. If the total volume of material for each riprap type or bedding material is greater than 30,000 cubic yards, quality and gradations tests shall be performed for each additional 10,000 cubic yards, or fraction thereof produced. The frequency for performing the quality and gradation tests shall be when approximately 10,000 cubic yards of material has been produced and near completion of production activities.

B. The Subcontractor shall submit, in writing, the name and qualifications of his proposed testing laboratory to the Contractor for approval.

C. The technical submittal covering the production of erosion protection materials shall include, but not be limited to, the following:

1. Narrative acknowledging permit stipulations for each rock borrow source.

2. Mining plan.

3. Use, handling and storage of explosives.

4. Expected quarry breakage or pit analysis.

5. Required combined product gradation.

6. Production analysis.

7. Flow diagram of production plant showing all products and wastage in tons per hour.

8. Plant layout showing individual pieces of equipment.

9. Complete list of equipment with manufacturers' models, capacities, horsepower and expected production curves.

10. Schedule.

11. Manpower required.

12. Handling of finished products.

13. Safety.

14. Maintenance of public and on site haul roads.

15. Dust control.

16. Protection of archaeological sites.

17. Quality control.

D. If the Subcontractor determines to use other sources for erosion protection materials, a site inspection report containing the information specified in Article 2.3 below shall be submitted, in triplicate, to the Contractor for review and approval of the source, in accordance with the requirements of Section 01300.

1.7 QUALITY ASSURANCE

Test Section: For placement control purposes, one test section for Riprap Types A and B each shall be constructed. The test sections shall be not less than 30 feet wide by 50 feet long in size, and shall be constructed either on or away from the embankment. Riprap material fully meeting the specified gradations shall be placed in the test sections by the same methods that will be used for production placement. The finished test sections, after testing to ensure that the in-place gradation requirements have been met, shall be used as a visual sample for comparison of production work. After completion of riprap installation, the test sections, if constructed away from the pile, shall be blended into the final grading contours, as approved by the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

[A. Material Sources: Erosion protection materials including riprap and bedding materials shall be obtained from sources approved by the Contractor. The approved source for Type A and B erosion protection and bedding materials is the Bluff Gravel Quarry near Bluff, Utah, located approximately 30 miles northeast of the tailings site.]*

B. Subcontractor may propose other sources of materials. The basis for approval of the Subcontractor-proposed sources shall be as specified in Article 2.3. The materials shall meet the requirements of this Specification.

C. Approval of source as a borrow area does not mean that all materials excavated will meet the requirements of this Specification. Processing or selective quarrying may be necessary to meet the quality requirements of this Section. The basis for approval of other sources proposed by the Subcontractor is specified in Article 2.3 below. The Subcontractor shall be responsible for providing the laboratory test results.

D. The materials shall be below the background radioactive level and free from other contamination.

E. Material shall be dense, sound, resistant to abrasion, and shall be free from cracks, seams, and other defects as shown during field inspection as per Article 3.3 below.

* P.I.D. 09-S-15

F. The shape of at least 75 percent of the material, by weight, shall be such that the minimum dimension is not less than one third of the maximum dimension.

G. Quality and Gradation Tests: For record purposes the following tests will be performed by the Contractor:

Test	Designation
Gradation	ASTM C117 ASTM C136
Specific Gravity (Saturated Surface Dry Basis)	ASTM C127
Absorption	ASTM C127
Sodium Sulfate Soundness Soundness (5 Cycles)	ASTM C88 Coarse Aggregate
Abrasion (Los Angeles Machine) (100 Cycles)	ASTM C131
Schmidt Hammer	ISRM Method
Splitting Tensile Strength (Modified-Loading rate shall cause failure in 1 to 3 minutes)	ISRM Method

The frequency of tests shall be in accordance with Article 1.6.A for the total amount produced at each quarry irregardless of number of types of materials produced.

2.2 QUALITY REQUIREMENTS

A. All riprap and bedding materials used shall meet the following requirements:

[1. Results of the tests specified in Table 02278-A on samples of each material shall be used to obtain rock quality scores using the criteria given in the table. The frequency of quality testing shall be as specified for gradation testing in Article 1.6.A. The score for each test is determined by multiplying the appropriate weighting factor by the score (0 to 10) based on the specific test result. The final score for each sample is the ratio of the sum of the individual test scores (six tests) to the maximum possible score, expressed as a

percentage. To be acceptable, the minimum final score shall be as follows:

65% for Bedding material and for Riprap Type A.

80% for Riprap Type B material from the Bluff quarry or if the material is rounded. 65% for Riprap Type B material if the material is angular.

65% for Riprap Type C material if the material is angular and 80% if the material is rounded.

The Schmidt Hammer Test and Splitting Tensile Strength Test will not be required on the bedding material or on Type A and Type B Riprap. The scoring of bedding material and Type A and Type B Riprap will be based on the four remaining tests.]*

2.3 SUBCONTRACTOR-PROPOSED SOURCES

A. The basis for approval of sources proposed by the Subcontractor shall be as follows:

1. A site inspection report by an engineering geologist which will include, as a minimum, an evaluation of soundness, hardness, and durability for three samples representative of the proposed source. The evaluation of durability shall be based in part on petrographic examination of rock types available from the source. The petrographic examination shall be in accordance with ASTM C295. In addition, the material shall meet the quality requirements of Article 2.2 above. Representativeness of samples shall be determined by the Contractor, based on precise location and source of sample taken in relation to the whole borrow area. The site inspection report shall include locations of all samples and methods of sampling.

2. If available, examples of successful uses of the material including riprap that has been in place on other project sites for more than 20 years, rock that has functioned satisfactorily as foundation stone or building facing for 50 years or more, and abandoned quarry faces which have maintained their integrity after not being worked for approximately 50 years or more. Durability shall be indicated by lack of significant weathering or loss of volume and strength over decades of exposure to natural weathering elements.

* P.I.D. 09-S-15

3. The Subcontractor shall have a qualified laboratory perform the six (6) types of tests listed in Table 02278-A on each sample (minimum of 6 samples) from the proposed source unless existing particle sizes are inadequate to perform Schmidt Hammer or Tensile Strength tests as specified. Special attention shall be given to ensure that the samples are representative of the proposed rock materials. Test samples shall be obtained from within the precise locations of rock deposits from which materials will be produced. To be approved as a source, the final score for each sample shall be obtained and evaluated as specified in Article 2.2.A.1.

4. If selected by the Subcontractor, the Sugarloaf riprap material shall consist of limestone and shall contain no more than 10 percent sandstone by weight.

2.4 GRADATION

[A. Riprap materials shall be reasonably well graded within the following limits, and the Contractor reserves the right of inspection while the samples are taken:

U.S. Standard Sieve Size (Square Openings)	Percent Passing (by weight)
Type A	
3-inch	100
2-inch	0-100
1-1/2-inch	0-40
1-inch	0-10
1/2-inch	0-5
Type B	
8-inch	100
6-inch	25-100
5-inch	0-100
4-inch	0-25
1-inch	0-5
Type C	
12-inch	100
9-inch	25-100
7-inch	5-50
5-inch	0-25
2-inch	0-5]*

* P.I.D. 09-S-15

B. Bedding Materials:

[1. Bedding materials shall be obtained from the Bluff quarry or other sources as approved by the Contractor. Rock for the bedding material shall meet the quality requirements for riprap materials in Articles 2.1 and 2.2. The Subcontractor shall process the materials to conform with the gradation requirements specified below.]*

2. Gradation: Bedding materials shall be reasonably well graded within the following limits:

U.S. Standard Sieve Size (Square Openings)	Percent Passing (by weight)
3-inch	100
1-1/2-inch	50-100
1-inch	35-70
No. 4	15-30
No. 30	0-5

2.5 SOURCE QUALITY CONTROL

The Subcontractor shall have a qualified, experienced person present at the quarry during production of rock materials to ensure that only suitable quality rock is processed. The materials may be inspected and tested by the Contractor at the borrow area prior to mining operations to ensure that they meet all requirements of this Specification with the exception of the gradation requirement. The Subcontractor shall assist the Contractor in obtaining samples. Gradation requirements will be tested at the placement location.

PART 3 - EXECUTION

3.1 PLACEMENT AND COMPACTION

A. General: Erosion protection materials shall be handled, loaded, transported, stockpiled and placed in a manner which avoids nonconformance with specifications due to segregation and degradation, including materials moved to and from stockpiles.

B. Subgrade preparation for apron, ditches and gullies shall conform to Specification Section 02200.

* P.I.D. 09-S-15

1. Prior to placement of bedding materials, the Contractor will take radiological measurements as described in Specification Section 02228.

C. Where the required bedding material thickness is 6 inches, the bedding material shall be spread and compacted in one layer.

D. Each layer of bedding material shall be track-walked with two passes of a D6 bulldozer or equivalent operating up and down the slope, over the entire area of placement.

E. Dumped riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the drainage material. The larger stones shall be well distributed throughout the mass. The finished riprap shall be free from pockets of small stones and clusters of larger stones. Placing stone in layers will not be permitted. Placing stone by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source, by controlled dumping of successive loads during final placing, or by other methods of placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified above.

F. Riprap material may be placed by end-dumping and may be spread by bulldozers or other suitable equipment.

G. Riprap layers placed upon bedding material shall be placed in such a manner which minimizes horizontal displacement of the bedding material.

H. Construction equipment carrying contaminated materials shall not be allowed to move over placed riprap and bedding layers except at equipment crossovers as designated by the Contractor. Each crossover shall be cleaned of all contaminating materials as approved by the Contractor before additional materials are placed in those areas. Other construction equipment may move over placed riprap and bedding layers. The Contractor may restrict such traffic to minimize damage to completed layers. Areas of riprap and bedding layers damaged by construction equipment shall be restored to meet the requirements of the Specifications.

3.2 TOLERANCES

A. The material layers shall be placed generally to the limits and thicknesses shown on the Subcontract Drawings within the following tolerances:

1. The top of the radon barrier or bedding subgrade shall be within ± 0.1 foot of the design grades shown on the Subcontract Drawings.

2. Bedding material shall be within ±0.1 foot of the design grades shown on the Subcontract Drawings.

3. The minimum in-place thickness of riprap material shall not be less than the minimum thickness shown.

4. The maximum in-place thickness of riprap material shall not be more than 135 percent of the thickness shown.

5. Local irregularities not exceeding the limits of Paragraphs 3 and 4 above will be permitted provided that such irregularities do not form noticeable mounds, ridges, swales or depressions which in the opinion of the Contractor could cause concentrations of surface runoff or form ponds or gullies.

3.3 FIELD QUALITY CONTROL

A. The placement of the materials will be inspected and tested by the Contractor during and after placement to ensure that the following requirements are met:

1. Material of the correct type and quality is being placed. Individual pieces or pockets of material greater than or equal to 8 inches in diameter not meeting the requirements noted in Article 2.1.E shall be removed per Paragraph D below. Individual pieces or pockets of material less than 8 inches in diameter not meeting the requirements of Article 2.1.E may be left in place provided that concentrations of such pieces do not exist as determined by the Contractor.

2. The material being placed is clean and free of unsuitable material.

3. The material is being stockpiled, loaded, transported and placed in a manner which minimizes segregation and degradation.

4. The material is being placed to line and grade within the tolerances and limits designated in Article 3.2 above.

5. The material placed meets the gradation requirements specified.

B. Materials segregated or not placed according to the above requirements shall be regraded or adjusted, using appropriate equipment, to conform with the tolerances and limits given above, at no additional cost to the Contractor.

C. The Subcontractor may place erosion protection material only at his own risk, if durability test results are not available and approved by the Contractor.

D. Materials not meeting the requirements of this Section shall be removed and replaced with specified materials at no additional cost to the Contractor. Rejected materials shall be disposed of offsite as Subcontractor's property at no additional cost to the Contractor. Materials not meeting the grading requirements shall be reprocessed or discarded. The Contractor may require modification of the processing and grading operations to ensure that the specified grading requirements are met.

E. During placement of Type A, B and C riprap materials and bedding materials, the Contractor will perform a minimum of four gradation tests in accordance with Article 2.4 above. An initial sample shall be obtained and tested during the early stages of placement activities. Additional samples shall be obtained and tested when approximately one-third and two-thirds of the total volume of material has been placed, and a final sample shall be obtained and tested near completion of placement activities. If the total volume of material placed for Type A and Type B Riprap and Bedding materials is greater than 30,000 cubic yards, a gradation test shall be performed for each additional 10,000 cubic yards, or fraction thereof placed.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement for payment for furnishing and placing the following materials will be by the cubic yards of material placed:

1. Riprap Material, Type A
2. Riprap Material, Type B
3. Riprap Material, Type C
4. Bedding Material

B. The quantities will be calculated from the lines and dimensions shown on the Subcontract Drawings and/or by using average end area methods from surveys conducted before and after placement for the areal extent of the placement.

4.2 PAYMENT

Payment for the items of Article 4.1.A above, will be by their applicable unit prices per cubic yard quoted therefor in the Bid Schedule. The prices quoted shall include full compensation for furnishing labor, materials, tools, equipment and incidentals and for performing specified work including development of the source (where applicable), obtaining required permits (where applicable), clearing, stripping and excavating; processing the materials; testing and evaluating the materials; transporting to placement locations; placing; compacting and consolidating complete in place.

END OF SECTION 02278

TABLE 02278-A
ROCK QUALITY SCORING CRITERIA

	Weighting Factor			Score										
	Lime-stone	Sand-stone	Igne-ous	10	9	8	7	6	5	4	3	2	1	0
Specific Gravity	12	5	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.30	< 2.3
Absorp-tion (%)	13	5	2	0.1	0.3	0.5	0.67	0.83	1.0	1.5	2.0	2.5	3.0	> 3.0
Sodium Sulfate (%)*	4	3	11	1	3	5	6.7	8.3	10	12.5	15	20	25	> 25
Abrasion (%)**	1	8	1	1	3	5	6.7	8.3	10	12.5	15	20	25	> 25
Schmidt Hammer	11	13	3	70	65	60	54	47	40	32	24	16	8	< 8
Tensile Strength(psi)	5	4	10	1400	1200	1000	833	666	500	400	300	200	100	< 100

1. Scores derived from Tables 6.2 and 6.7 of Ref. 1.

2. Any rock to be used must be qualitatively rated at least "fair" in a petrographic examination conducted by a geologist experienced in petrographic analysis.

3. Weighting Factors derived from Table 7 of Ref. 2, based on inverse of ranking of test methods for each rock type.

4. Test methods should be standardized (ASTM, e.g.) and should be those used in Ref. 2.

Ref. 1 Lindsey, C.G., Long, L.W., and Begej, C.W. (1982), Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review, U.S. Nuclear Regulatory Commission, NUREG/CR-2642.

Ref. 2 De Puy, G.W., "Petrographic Investigations of Rock Durability and Comparisons of Various Test Procedures," Engineering Geology, Vol. 2, No. 2, July 1965.

* 5 Cycles
** 100 Revolutions

SECTION 02935

SEEDING

PART 1 - GENERAL

1.1 SCOPE

This Specification Section covers seeding of final grades at the Monument Valley site. All disturbed exposed areas shall be seeded as required to control erosion. Areas with rock exposure or permanent roads will not be seeded.

1.2 MATERIAL STORAGE

A. Seeds shall be stored in sealed waterproof containers in a cool, dry location and shall be kept out of direct sunlight until ready for use.

B. Fertilizer, if required, shall be delivered and stored in waterproof containers that clearly show the chemical analysis and name of manufacturer.

PART 2 - MATERIALS

2.1 SEED MIX

A. The following seed mix shall be used for seeding of final grades except as noted in Article 1.1:

Seed Species	Variety	Seeding Rate (Pounds of Pure Live Seed Per Acre)
Western Wheatgrass	Arriba	2.5
Indian Ricegrass	Paloma	2.5
Alkali Saction	Salado	1.0
Four-Wing Saltbrush	Ricon	2.0
Sand Dropseed	Common*	1.0
Desert Globemallow	Common*	1.0
Total		10.0

* Common - Seed from regional sources.

B. The seeding rates shown are for seed applied by a rangeland drill.

2.2 ACCEPTANCE OF SEED

Final acceptance of seed will be made by the Contractor based on the following: Seed shall be furnished separately or in mixture in standard sealed containers with the following information provided by the seed vendor on each seed container label: (1) seed name; (2) lot number; (3) net weight; (4) percentages of purity and of germination; (5) seed coverage, in acres, on a pure live seed basis; and (6) percentage of maximum weed seed content clearly marked for each species of seed. Seeds shall be packaged by the vendor in even acre coverage containers. The Subcontractor shall furnish the Contractor duplicate copies of a statement by the vendor, certifying that each lot of seed has been tested by a recognized laboratory for seed testing within 6 months of date of delivery. This statement shall include: (1) name and address of laboratory, (2) date of test, (3) lot number for each kind of seed, and (4) results of tests as to name, percentages of purity and of germination, and percentage of weed content, for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed.

2.3 FERTILIZER

Fertilizer shall be a standard commercial grade that provides the minimum percentage of available nutrients specified. Fertilizer shall be furnished in new, clean, and sealed containers with the name, weight, and guaranteed analysis of contents clearly marked. A liquid form of fertilizer containing the minimum percentage of available nutrients may be used.

2.4 MULCH

Mulch shall consist of cereal straw or hay mulch. Cereal straw shall be from grain crops that are free from all viable seed, mold, or other objectionable material. Mulch shall be in an air-dry condition and suitable for placing with mulch blower equipment. Final acceptance of mulch will be by the Contractor.

2.5 WATER

Water used in the planting or care of vegetation shall be free of oils, acids, alkalis, salts, or any substance injurious to plant life.

PART 3 - EXECUTION

3.1 PREPARATION

A. Timing: All final grades shall be seeded as soon as practical after their completion or as directed by the Contractor. Seeding materials shall not be applied during windy weather, when the ground is excessively wet or frozen, or when snow is present.

B. Grading and Seedbed Preparation: Before applying seed, the area shall be graded with common fill as shown on the Subcontract Drawings, with surfaces sloping gradually towards drainage courses, with no enclosed low spots where water can accumulate. Areas to be seeded that have been damaged by erosion or other causes shall be restored prior to seeding and then cultivated to provide a reasonably firm but friable seedbed. A minimum of 6 inches of surface soil shall be in a loose condition at the time of fertilizer and seed application.

3.2 APPLICATION

A. Seed for final grades shall be applied by a rangeland drill to a depth of 0.5 to 0.75 inch. To the greatest extent possible, seeding shall be oriented along (parallel to) land contours.

B. Immediately following seeding, mulch shall be applied at a rate of 2 tons per acre to all areas seeded for permanent cover and the mulch shall be crimped with a mulch crimper.

3.3 CARE DURING CONSTRUCTION

The Subcontractor shall be responsible for protecting and caring for areas seeded before final acceptance of the work. The Subcontractor shall repair any damage to seeded areas caused by erosion or construction operations without additional compensation.

3.4 PLANT ESTABLISHMENT

The Subcontractor shall be responsible for watering and caring for seeded areas, as required, until adequate vegetative cover is established. Reseeding, if required, will be at no additional cost to the Contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Measurement for payment for seeding of final grades will be by the acres of surfaces actually seeded and approved.

4.2 PAYMENT

Payment for seeding of final grades will be by the unit price per acre quoted therefor in the Bid Schedule. The price quoted shall include full compensation for furnishing all materials, tools, equipment, incidentals, labor, and for performing all work specified herein for complete work.

END OF SECTION 02935

Subcontract Drawings

UNITED STATES
DEPARTMENT OF ENERGY

UMTRAP

URANIUM MILL TAILINGS REMEDIAL ACTION PROJECT

CONSTRUCTION DRAWINGS COMPLETION

MEXICAN HAT, UTAH
AND
MONUMENT VALLEY, ARIZONA

QA REVIEWED FOR QUALITY REQUIREMENTS BY [illegible] 02/03/92

REGISTERED PROFESSIONAL ENGINEER PATRICK M. GRIFFIN STATE OF UTAH

QA MK-F	NO.	DATE	REVISIONS	BY	CK	ERD MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	△								
	△								
	△								
	△								
[illegible]	△	1/31/92	ISSUED FOR CONSTRUCTION	–	–	–	–	–	–

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CW | DRAWN RBC | CHECKED [illegible] | INSPECTED [illegible] | RECOMMENDED [illegible]

MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

TITLE SHEET

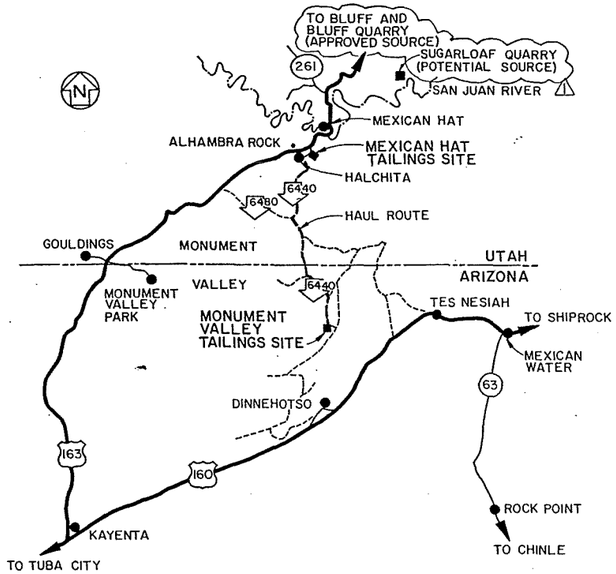
APPROVED [illegible] DATE 1/31/92 | [illegible] | DOE PROJECT ENGINEER [illegible] DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-GE-10-0201 | REV. 0

B50231 IQ0003600/UMTRAD



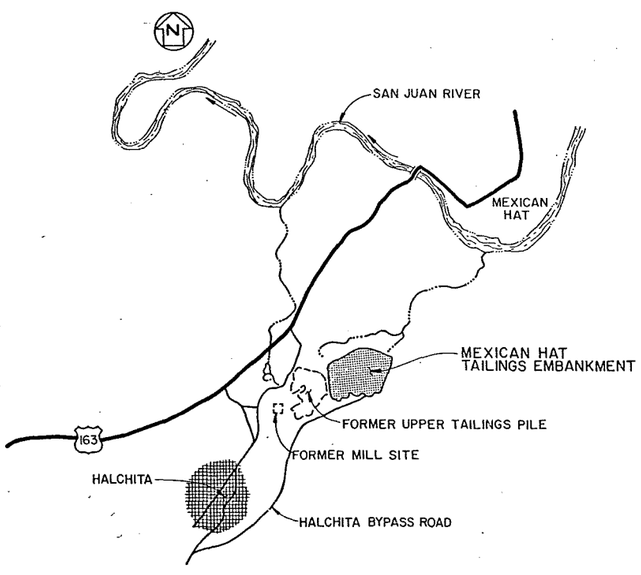
LOCATION MAP

5 0 5 10
SCALE MILES

SITE LOCATION MAP

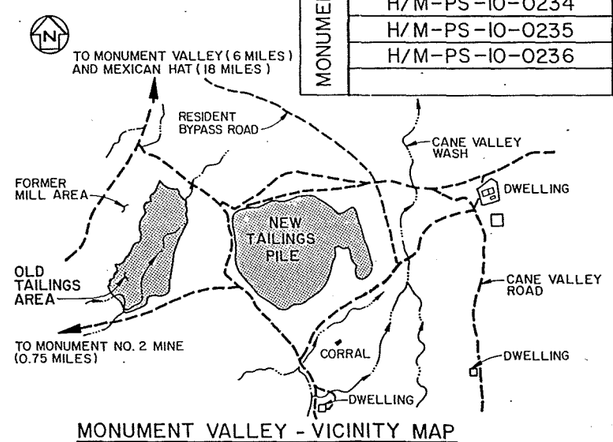
LEGEND:

- 163 U.S HIGHWAY
- 261 STATE HIGHWAY
- 6440 INDIAN SERVICE ROUTE
- 63 COUNTY ROAD



MEXICAN HAT - VICINITY MAP

0 1/2 1
SCALE MILE



MONUMENT VALLEY - VICINITY MAP

600 0 600 1200
SCALE FEET

LIST OF DRAWINGS

	DRAWING NO.	DRAWING TITLE
GENERAL	H/M-GE-10-0201	TITLE SHEET
	H/M-GE-10-0202	VICINITY MAPS, LOCATION MAP AND LIST OF DRAWINGS
	H/M-GE-10-0203	HAUL ROAD CORRIDOR AND BORROW AREA LOCATIONS
	H/M-GE-10-0204	RIPRAP BORROW AREAS
	H/M-GE-10-0205	RADON BARRIER MATERIAL BORROW AREAS AND GYPSUM WASH CROSSING
MEXICAN HAT	H/M-DS-10-0210	HAT-SITE PLAN
	H/M-DS-10-0211	HAT-CONTAMINATED MATERIAL EXCAVATION PLAN
	H/M-DS-10-0212	TAILINGS EMBANKMENT PLAN
	H/M-DS-10-0213	TAILINGS EMBANKMENT PLAN AND DITCH SECTIONS AND DETAILS
	H/M-DS-10-0214	HAT-FINAL SITE GRADING PLAN
	H/M-DS-10-0215	TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 1 OF 2)
	H/M-DS-10-0216	TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 2 OF 2)
	H/M-DS-10-0217	HAT-SITE DRAINAGE SECTIONS AND DETAILS (SHEET 1 OF 2)
	H/M-DS-10-0218	HAT-SITE DRAINAGE SECTIONS AND DETAILS (SHEET 2 OF 2)
	H/M-DS-10-0219	HAT-EROSION PROTECTION PLAN AND SECTIONS
	H/M-DS-10-0220	HAT-GULLY DETAILS
	H/M-DS-10-0221	HAT-BORING LOCATION PLAN
MONUMENT VALLEY	H/M-PS-10-0230	MON-SITE PLAN
	H/M-PS-10-0231	MON-CONSTRUCTION FACILITIES AND SITE DRAINAGE
	H/M-PS-10-0232	MON-CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 1 OF 2)
	H/M-PS-10-0233	MON-CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 2 OF 2)
	H/M-PS-10-0234	MON-FINAL SITE GRADING AND DRAINAGE (SHEET 1 OF 2)
	H/M-PS-10-0235	MON-FINAL SITE GRADING AND DRAINAGE (SHEET 2 OF 2)
	H/M-PS-10-0236	MON-BORINGS, TEST PITS AND MONITORING WELLS LOCATION PLAN

NO.	DATE	REVISIONS	BY	CK	EEO MGR.	CHIEF ENG.	QA MGR.	DOE APP.
3	3-3-92	REVISED AS PER P.I.D. NO. 09-S-15						
2	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/05/92

REGISTERED PROFESSIONAL ENGINEER No. 7344 PATRICK M. GRIFFIN STATE OF UTAH

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CW | DRAWN AOM | CHECKED ZAR | INSPECTED | RECOMMENDED

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

VICINITY MAPS, LOCATION MAP AND LIST OF DRAWINGS

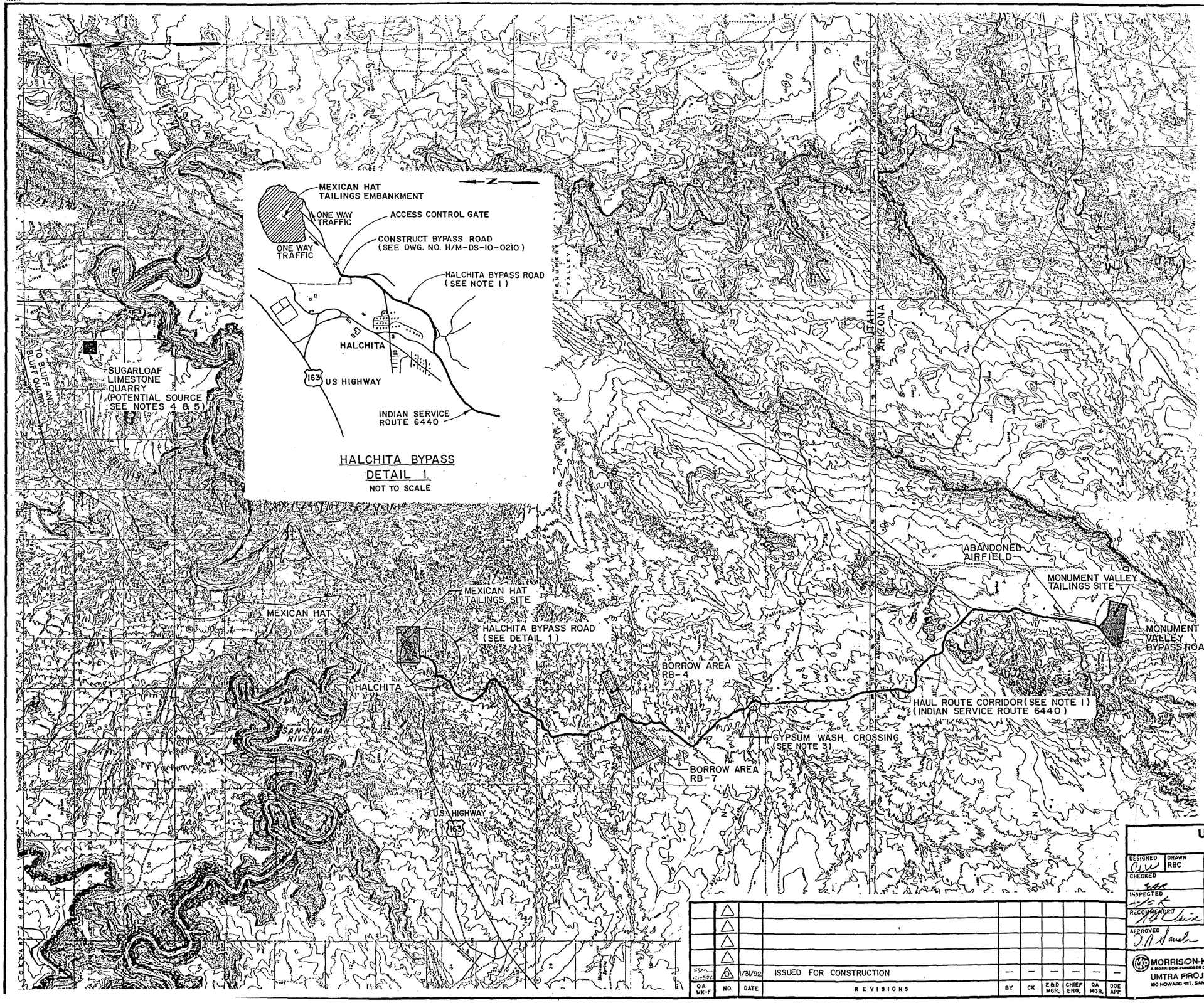
APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-GE-10-0202 | REV. 1

B50251 | G0003800/UMTRAD



HALCHITA BYPASS
DETAIL 1
NOT TO SCALE

NOTES

1. NO CONSTRUCTION RELATED TRAFFIC WILL BE PERMITTED THROUGH HALCHITA. ACCESS TO THE SITE WILL BE VIA THE PROJECT ACCESS ROADS AND THE HALCHITA BYPASS ROAD.
2. FOR DETAILED MAPS OF BORROW SITE AREAS, SEE DWG. NO. H/M-GE-10-0204 AND 0205.
3. FOR GYPSUM WASH CROSSING DETAILS, SEE DWG. NO. H/M-GE-10-0205.
4. SUBCONTRACTOR IS RESPONSIBLE FOR LOCATING A SOURCE FOR RIPRAP TYPE C MATERIAL.
5. SUGARLOAF QUARRY HAS BEEN IDENTIFIED AS A POTENTIAL SOURCE OF RIPRAP TYPE C MATERIAL. THE QUARRY IS ON BLM LAND. SUBCONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS BEFORE USING THIS SOURCE.

REFERENCE DRAWINGS

H/M-GE-10-0204	RIPRAP BORROW AREAS
H/M-GE-10-0205	RADON BARRIER MATERIAL BORROW AREAS AND GYPSUM WASH CROSSING
H/M-DS-10-0210	HAT-SITE PLAN

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK M GRIFFIN STATE OF UTAH

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/02/92

5000 0 5000 10,000
SCALE FEET

NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

QA MK-F

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

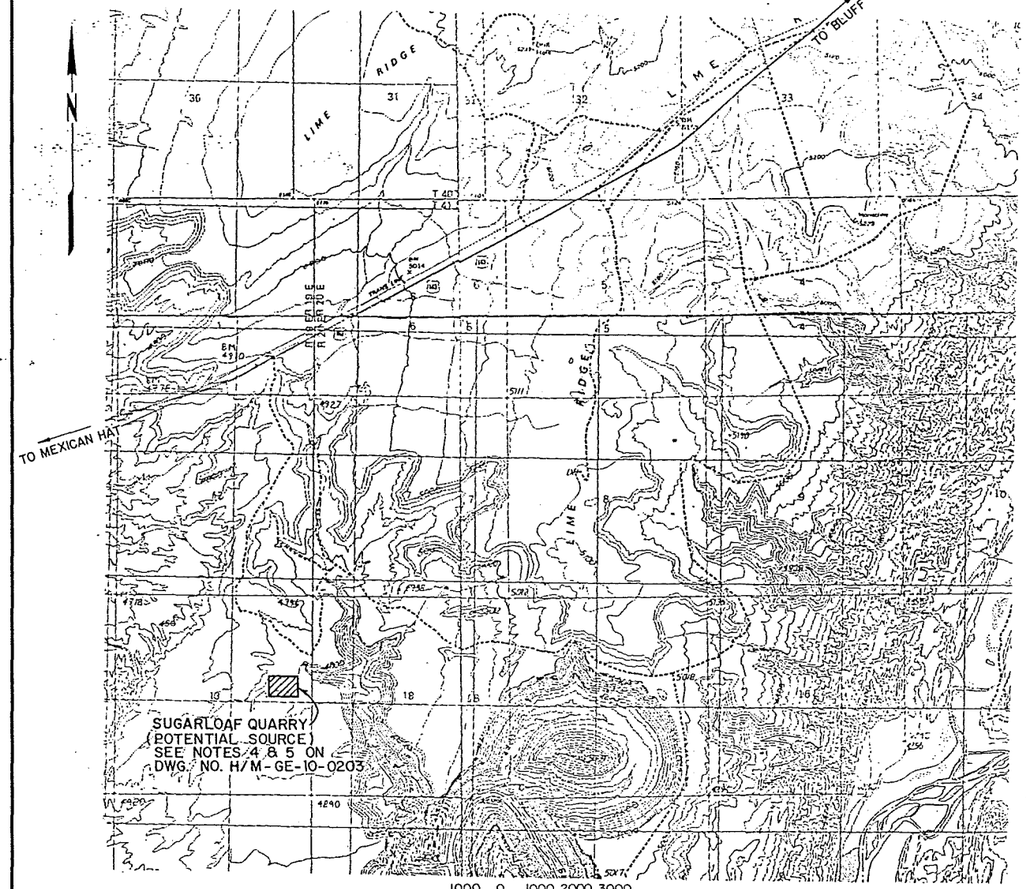
DESIGNED CW | DRAWN RBC | CHECKED | INSPECTED | RECOMMENDED | APPROVED J.A. Sanchez DATE 1/31/92 | DOE PROJECT ENGINEER Steve Hump DATE 2/3/92

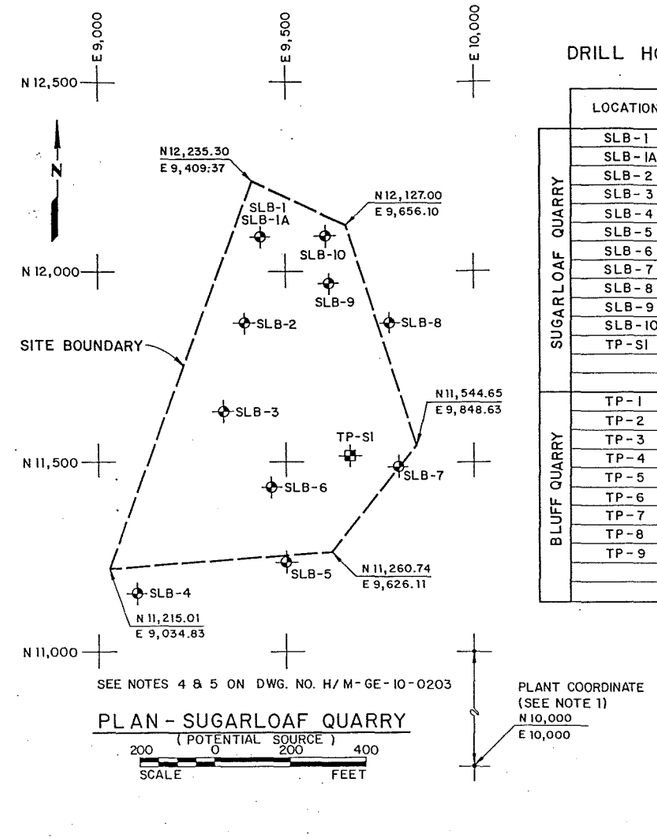
MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

HAUL ROAD CORRIDOR AND BORROW AREA LOCATIONS

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. H/M-GE-10-0203
REV. 0





PLAN - SUGARLOAF QUARRY

(POTENTIAL SOURCE)

200 0 200 400
SCALE FEET

DRILL HOLE AND TEST PIT LOCATIONS

	LOCATION	COORDINATE	
		NORTHING	EASTING
SUGARLOAF QUARRY	SLB-1	12,091.40	9,429.00
	SLB-1A	12,088.90	9,431.10
	SLB-2	11,862.40	9,390.90
	SLB-3	11,632.30	9,333.10
	SLB-4	11,149.80	9,107.30
	SLB-5	11,232.30	9,497.40
	SLB-6	11,434.50	9,461.70
	SLB-7	11,486.10	9,800.00
	SLB-8	11,865.80	9,770.30
	SLB-9	11,970.00	9,614.80
	SLB-10	12,095.30	9,605.00
	TP-S1	11,516.80	9,670.00
BLUFF QUARRY	TP-1	11,212.0	6,897.0
	TP-2	10,950.0	6,657.0
	TP-3	10,896.0	6,429.0
	TP-4	10,194.0	7,390.0
	TP-5	10,598.0	8,547.0
	TP-6	10,627.0	8,348.0
	TP-7	10,214.0	8,391.0
	TP-8	10,413.0	8,065.0
	TP-9	10,564.0	7,980.0

NOTES:

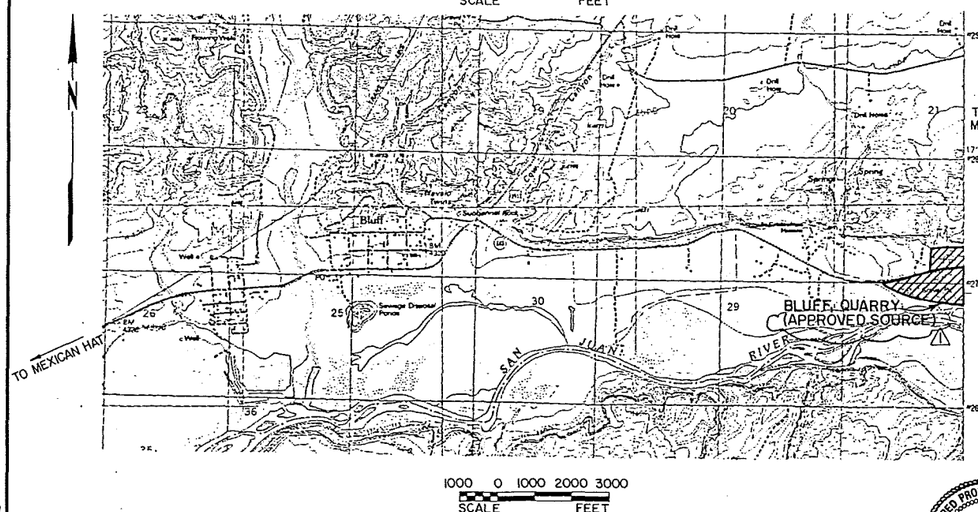
1. THE PLANT COORDINATE N 10,000, E 10,000 ON THE SUGARLOAF QUARRY PLAN CORRESPONDS TO THE SE CORNER OF SECTION 13, TOWNSHIP 41 S, RANGE 19 E.
2. HAUL DISTANCES FROM THE RIPRAP BORROW SOURCES TO THE MEXICAN HAT SITE ARE AS FOLLOWS:
   SUGARLOAF QUARRY - 15 MILES
   BLUFF QUARRY - 30 MILES
3. THE PLANT COORDINATE OF N 10,000, E 10,000 ON THE BLUFF QUARRY PLAN CORRESPONDS TO THE SE CORNER OF THE NE 1/4 OF SECTION 28, TOWNSHIP 40 S, RANGE 22 E.
4. SITE BOUNDARIES FOR THE BLUFF QUARRY ARE DESCRIBED IN THE PERMIT APPLICATIONS.
5. SITE RESTORATION OF THE BORROW SITES SHALL COMPLY WITH THE PERMIT PROVISIONS.

REFERENCE DRAWINGS:

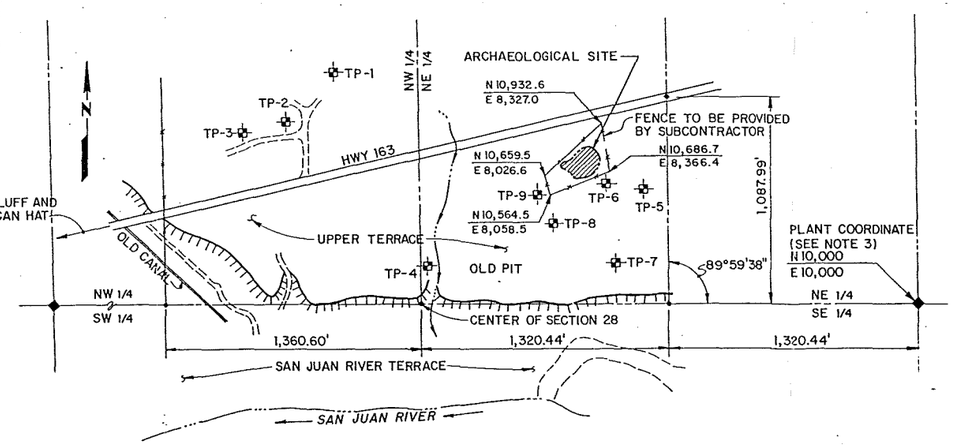
H/M-GE-10-0203 HAUL ROAD CORRIDOR AND BORROW AREA LOCATIONS

LEGEND:

- DRILL HOLE
- TEST PIT
- ROAD/TRAIL
- WASH
- FENCE
- EDGE OF TERRACE



RIPRAP QUARRIES — VICINITY MAPS



PLAN - BLUFF QUARRY

(APPROVED SOURCE)

400 0 400 800
SCALE FEET

QA REVIEWED FOR QUALITY REQUIREMENTS BY: 02/03/92

REGISTERED PROFESSIONAL ENGINEER — PATRICK M. GRIFFIN — STATE OF UTAH

NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
1	8-3-92	REVISED AS PER P.I.D. NO. 09-S-15						
0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

QA MK-F

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT-MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

RIPRAP BORROW AREAS

DESIGNED CLW | DRAWN KBC | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-GE-10-0204 | REV. 1

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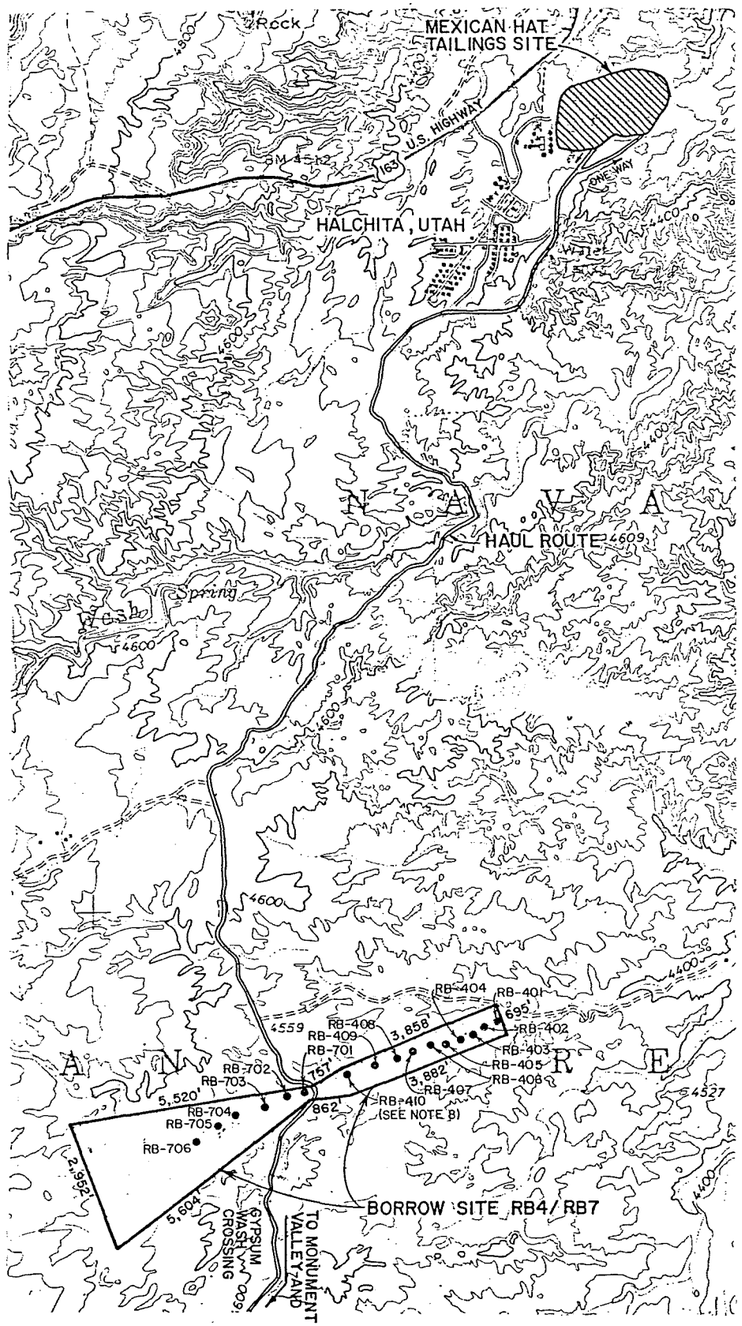
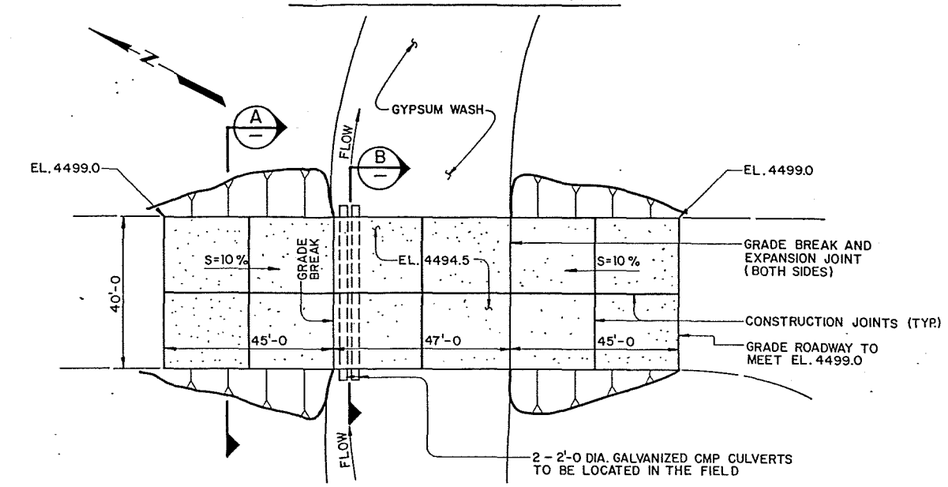


RB4/RB7 BORROW AREA

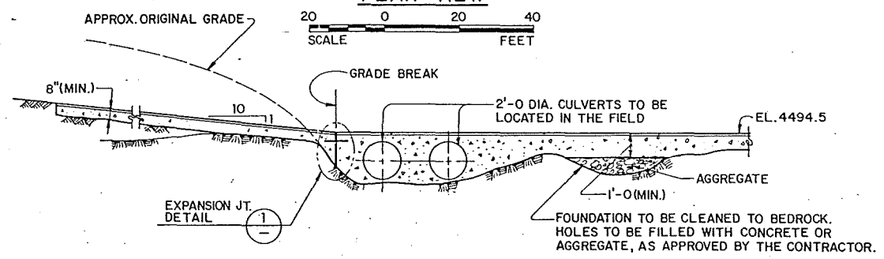
2000 0 2000 4000
SCALE FEET

GYPSUM WASH CROSSING



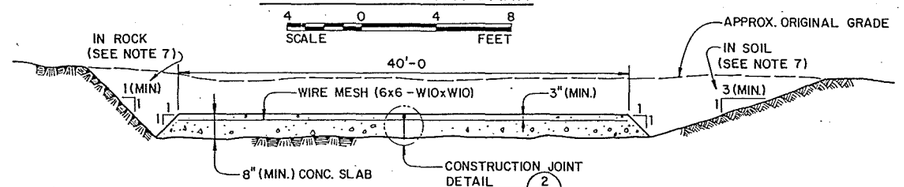
PLAN VIEW

20 0 20 40
SCALE FEET

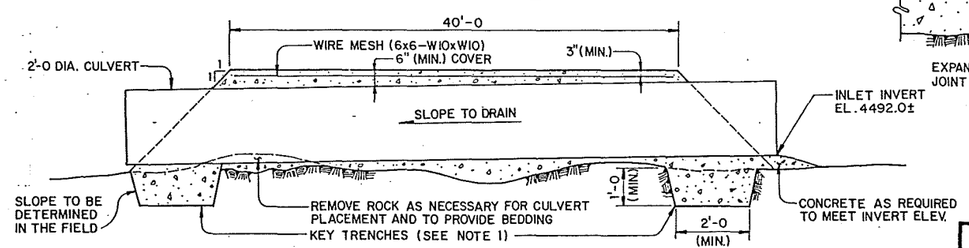


PROFILE AT NORTH BANK

4 0 4 8
SCALE FEET



SECTION A
NOT TO SCALE



SECTION B
NOT TO SCALE

NOTES:

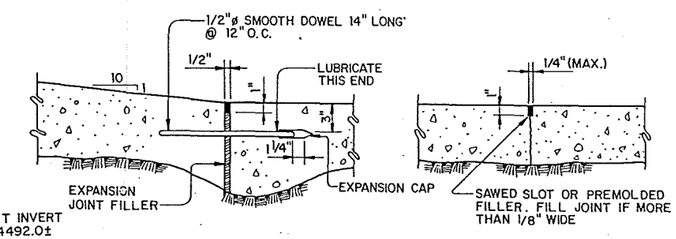
1. INSTALL KEY TRENCHES IN RIPPABLE ROCK IN ARROYO BOTTOM. KEY TRENCHES NOT REQUIRED IN NONRIPPABLE ROCK.
2. PORTLAND CEMENT CONCRETE MATERIALS SHALL MEET THE REQUIREMENTS FOR PORTLAND CEMENT CONCRETE PAVEMENT, SUBSECTIONS 408.02 THROUGH 408.12 OF THE UTAH STATE STANDARD SPECIFICATIONS, 1979 EDITION. COMPRESSIVE STRENGTH OF THE CONCRETE SHALL BE 4,000 PSI IN 28 DAYS.
3. THE CONCRETE CONSTRUCTION OF THE CROSSING SHALL BE IN ACCORDANCE WITH SECTION 408 OF THE UTAH STATE STANDARD SPECIFICATIONS, 1979 EDITION, AND AS APPROVED BY THE CONTRACTOR.
4. REQUIREMENTS OF SUBSECTIONS 408.13, 408.16, 408.26, 408.27 AND 408.28 OF THE UTAH STATE STANDARD SPECIFICATIONS, 1979 EDITION, SHALL NOT APPLY.
5. SUBCONTRACTOR SHALL CONSTRUCT A TEMPORARY CROSSING DOWNSTREAM OF THE PERMANENT CROSSING. VEHICULAR TRAFFIC SHALL BE DIVERTED FROM THE PERMANENT CROSSING FOR AT LEAST 7 DAYS AFTER FINAL POUR OR AS DIRECTED BY THE CONTRACTOR.
6. FOR LOCATION OF GYPSUM WASH CROSSING, SEE DWG. NO. H/M-GE-10-0203.
7. SIDESLOPES CUT IN ROCK SHALL BE 1:1 OR FLATTER. SIDESLOPES CUT IN SOIL SHALL BE 3:1 OR FLATTER.
8. AT RB-410 ROCK WAS ENCOUNTERED AT ONE FOOT DEPTH, HOLE WAS NOT LOGGED.

REFERENCE DRAWING:

H/M-GE-10-0203 HAUL ROAD CORRIDOR AND BORROW AREA LOCATIONS

LEGEND:

- TEST PIT
- TOP OF ROCK
- TOP OF SOIL
- TOP OF CUT



EXPANSION JOINT DETAIL 1
NOT TO SCALE

CONSTRUCTION JOINT DETAIL 2
NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK M. GRIFFIN STATE OF UTAH

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/03/92

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
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02/03/92	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

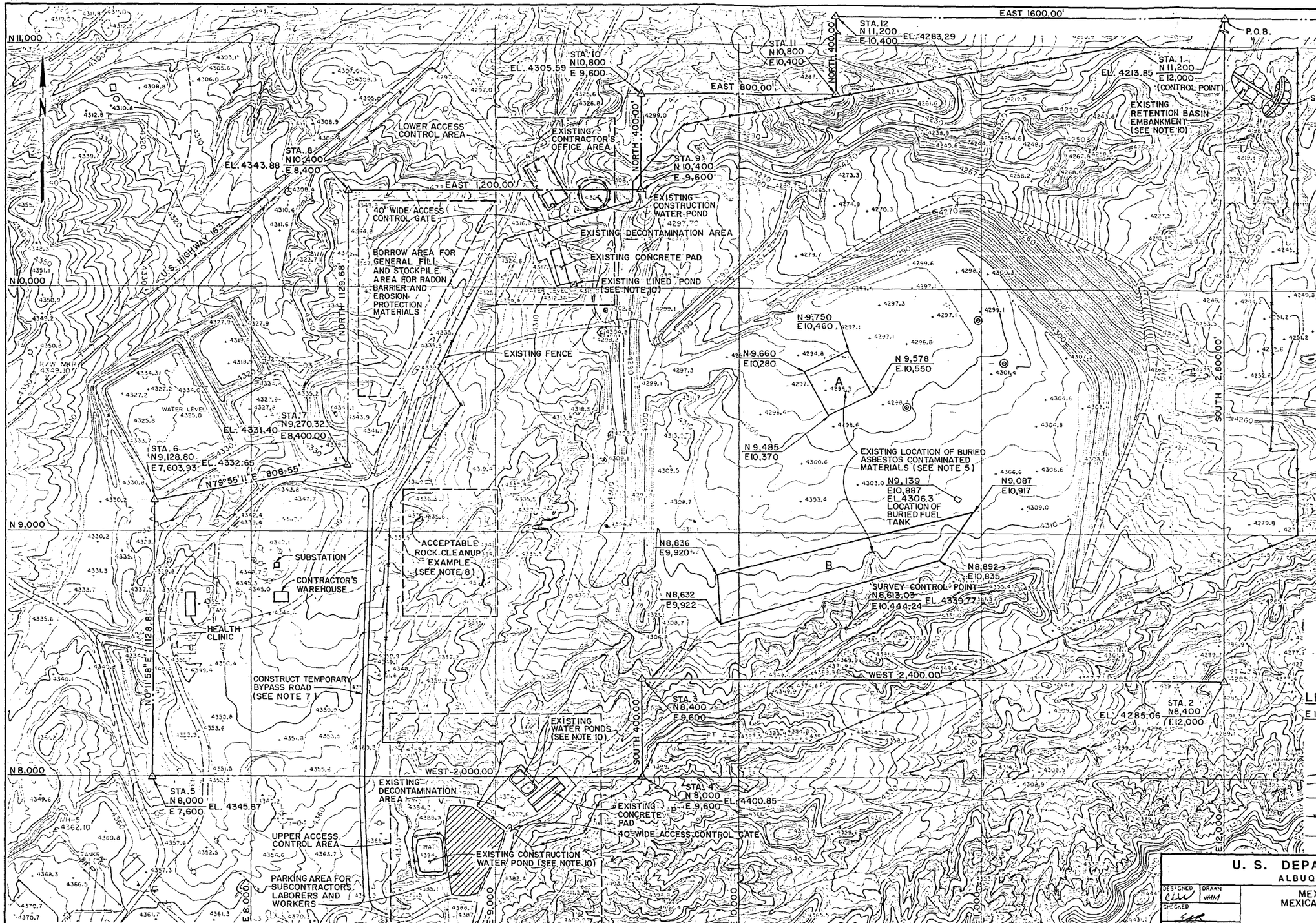
DESIGNED CW | DRAWN E.C.G.
CHECKED SAR
INSPECTED
RECOMMENDED
APPROVED — DATE 1/31/92

MEXICAN HAT-MONUMENT VALLEY SITES
MEXICAN HAT, UTAH-MONUMENT VALLEY, ARIZONA
COMPLETION
RADON BARRIER MATERIAL BORROW AREAS AND GYPSUM WASH CROSSING

DOE PROJECT ENGINEER — DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST SAN FRANCISCO CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO H/M-GE-10-0205 REV 0



NOTES:

1. HORIZONTAL AND VERTICAL CONTROL POINTS ESTABLISHED BY WESTERN DESIGN CONSULTANTS OF SALT LAKE, UTAH. CONTOURS BASED ON AERIAL PHOTOGRAPHY TAKEN JULY 1990. ADDITIONAL FILL HAS BEEN PLACED ON TOP OF PILE SINCE THEN. THEREFORE, EXISTING CONTOURS WILL VARY SLIGHTLY FROM WHAT IS SHOWN.
2. FOR HORIZONTAL AND VERTICAL CONTROL THE SUBCONTRACTOR SHALL USE POINTS MARKED THUSLY: △ (BRASS CAP IN CONCRETE). SUB-CONTRACTOR MAY USE OTHER CONTROL POINTS AFTER VERIFICATION BY SURVEY.
3. SECTION CORNER TIE SHOWN IN PARENTHESIS IS PER CONTROL FOUND ON STAKE OUT OF HALCHITA HOUSING DEVELOPMENT.
4. COORDINATES SHOWN ARE THE PROJECT CO-ORDINATES. STATE COORDINATES FOR STA. 4 ARE X=2,473,150.34 AND Y=172,750.12, SURVEYED BY SAN JUAN ENGINEERS OF FARMINGTON N.M., JUNE 1987.
5. IN AREA A THE ASBESTOS IS APPROXIMATELY AT ELEVATION 4288.0 AND BELOW. IN AREA B THE LOWER LIMIT OF ASBESTOS IS APPROXIMATELY AT ELEVATION 4300.0. ANY ASBESTOS CONTAMINATED MATERIAL AT MONUMENT VALLEY SHALL BE PLACED WITHIN AREA B.
6. ELEVATIONS AT THE SURVEY MONUMENTS ARE AT THE TOP OF GROUND NOT THE TOP OF THE MONUMENTS.
7. SUBCONTRACTOR SHALL CONSTRUCT TEMPORARY BYPASS ROAD AS APPROVED BY CONTRACTOR.
8. THE FINAL SURFACE OF OFF-PILE CONTAMINATED MATERIALS CLEANUP SHALL BE SIMILAR TO THE ACCEPTABLE ROCK CLEANUP EXAMPLE AREA OR AS APPROVED BY CONTRACTOR.
9. FOR EXISTING ACCESS CONTROL AREA DETAILS SEE INFORMATION FOR BIDDERS.
10. EXISTING PONDS AND LINED DITCHES SHALL BE CLEARED OF EXISTING DEBRIS AND SEDIMENTS AND LINERS REPAIRED BEFORE USE.

LEGEND:

E 10,000	CONSTRUCTION GRID COORDINATE
◎	EXISTING SETTLEMENT MONUMENT
△	BOUNDARY MARKERS (BRASS CAP IN CONCRETE)
4290	EXISTING SITE FEATURES AND CONTOURS
	EXISTING WOVENWIRE FENCE
	EXISTING CHAINLINK FENCE
	SITE BOUNDARY

REGISTERED PROFESSIONAL ENGINEER — PATRICK N. GRIFFEN — STATE OF UTAH

QA APPROVED FOR QUALITY REQUIREMENTS BY 02/05/92

NO.	DATE	REVISIONS	BY	CK	ECO MGR.	CHIEF ENG.	QA MGR.	DOE APP.
0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

QA MK-F

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT-MONUMENT VALLEY SITES
MEXICAN HAT, UTAH-MONUMENT VALLEY, ARIZONA
COMPLETION

HAT-SITE PLAN

DESIGNED CLW | DRAWN WHM | CHECKED | INSPECTED | RECOMMENDED | APPROVED 1/31/92 | DATE | DOE PROJECT ENGINEER Steve Hoag | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-DS-10-0210 | REV. 0

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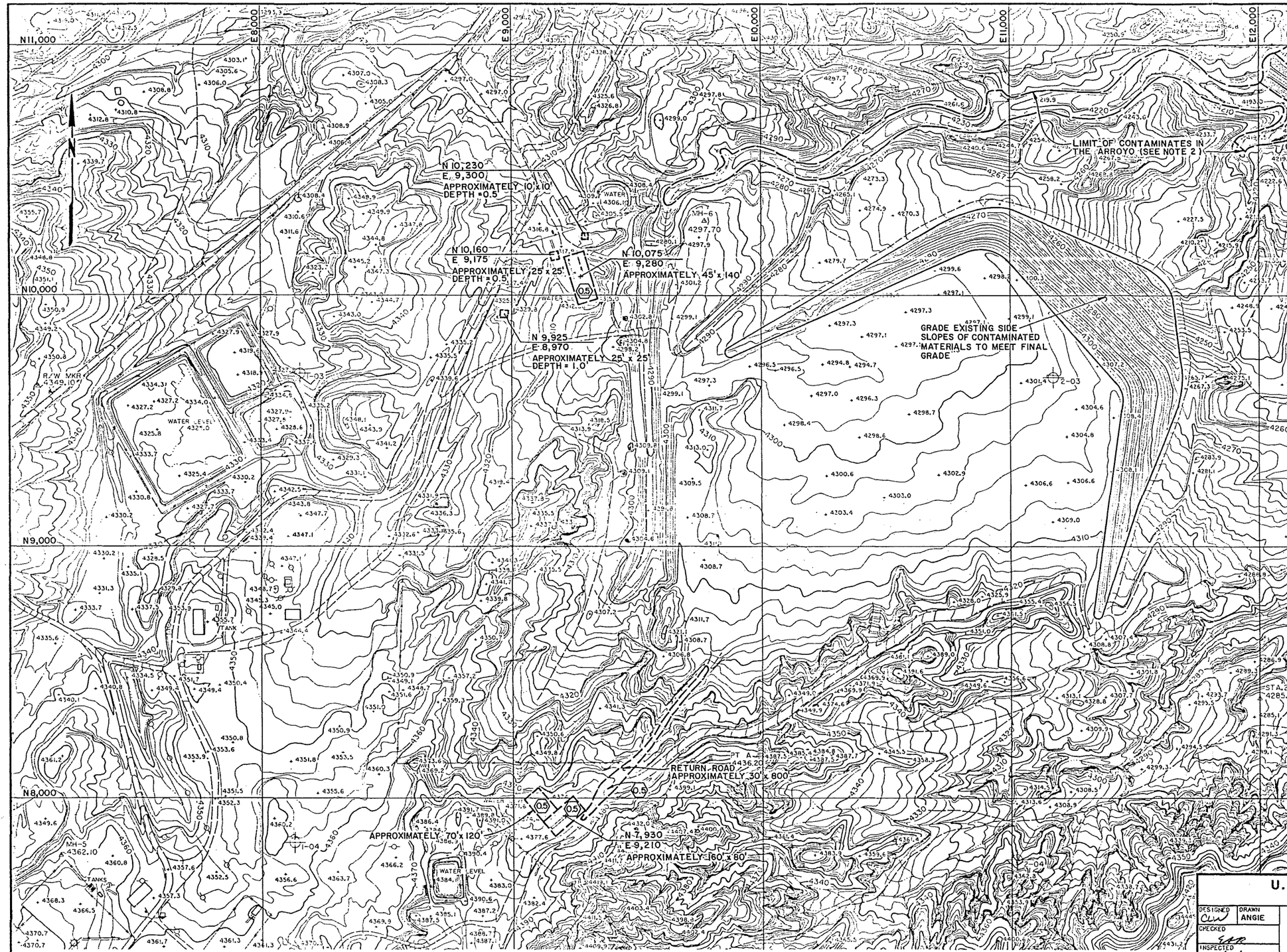

NOTES:

1. DEPTHS AND LIMITS OF CONTAMINATED MATERIALS SHOWN ARE APPROXIMATE AND WILL BE CONFIRMED BY THE CONTRACTOR DURING CONSTRUCTION.
2. WORK WILL CONSIST OF OVERBURDEN REMOVAL. NO RIPPABLE EXCAVATIONS ARE REQ'D. THE DEPTH OF CONTAMINATION VARIES ALONG THE ARROYO FROM 2'-0 WITH A FEW AREAS NEAR THE RETENTION BASIN EMBANKMENT REACHING A DEPTH OF 3'-0.
3. THE RETENTION BASIN EMBANKMENT MATERIAL ALONG WITH UNDERLYING CONTAMINATED MATERIAL WILL BE EXCAVATED AND DISPOSED OF IN THE TAILINGS EMBANKMENT PRIOR TO PLACEMENT OF THE RADON BARRIER.
4. DURING REMEDIAL ACTION THE SUBCONTRACTOR SHALL MAINTAIN SITE DRAINAGE TO PREVENT RUNOFF FROM CONTAMINATED AREAS FROM LEAVING THE SITE.
5. THERE MAY BE ADDITIONAL AREAS OF OFF PILE CONTAMINATION THAT REQUIRE REMOVAL THAT ARE NOT SHOWN ON THE DRAWING. ANY SUCH AREAS WILL BE DESIGNATED BY THE CONTRACTOR.

REFERENCE DRAWINGS:

LEGEND:

ESTIMATED LIMITS OF OFF-PILE CONTAMINATES

(0.5) DEPTH OF EXCAVATION IN FEET (UNLESS NOTED OTHERWISE)

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK M. GRIFFIN 31 Jan 92 STATE OF UTAH

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/03/92

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
SPA 2/05/92	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CW | DRAWN ANGIE | CHECKED | INSPECTED | RECOMMENDED

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

HAT-CONTAMINATED MATERIAL EXCAVATION PLAN

APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER Steve Hoop | DATE 2/5/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-DS-10-0211 | REV. 0

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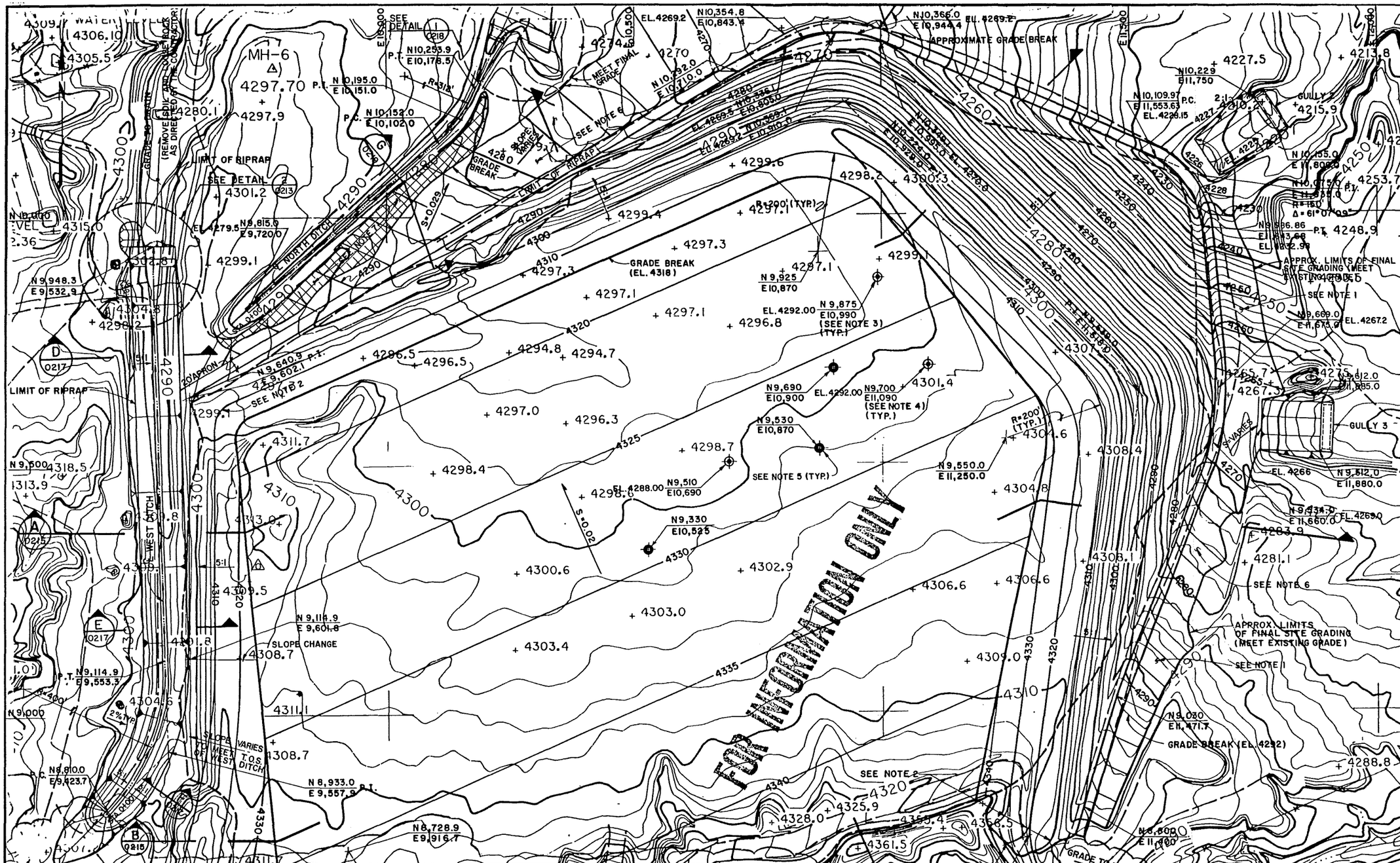

NOTES:

1. GRADE APRON AREA TO ELIMINATE HIGH SPOTS AND PREVENT FLOW CONCENTRATIONS AS DIRECTED BY THE CONTRACTOR. EXISTING FILL IN APRON AREA CONTAINS PIECES OF SHOT ROCK.
2. CORNER CONTOURS ON THE TAILINGS EMBANKMENT SHALL BE ROUNDED WITH A 50' RADIUS IN THE PLAN VIEW UNLESS NOTED OTHERWISE.
3. EXISTING AND NEW DISPLACEMENT MONUMENT RODS AND PIPES SHALL BE EXTENDED TO FINAL SURFACE.
4. SEE THE INFORMATION FOR BIDDERS FOR DATA ON THE EXISTING SETTLEMENT MONUMENTS.
5. FOR A NEW TYPICAL DISPLACEMENT MONUMENT INSTALLATION DETAIL, SEE DWG. NO. H/M-DS-10-0216.
6. FINAL GRADES SHOWN IN THE APRON AREA MAY BE ADJUSTED BY THE CONTRACTOR TO FACILITATE SURFACE DRAINAGE AND REDUCE FLOW CONCENTRATIONS.
7. ROCK SHALL BE CHIPPED OR PLANED. NO BLASTING OR RIPPING WILL BE PERMITTED.

REFERENCE DRAWINGS:

H/M-DS-10-0215	TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 1 OF 2)
H/M-DS-10-0216	TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 2 OF 2)
H/M-DS-10-0217	HAT-SITE DRAINAGE SECTIONS AND DETAILS (SHEET 1 OF 2)
H/M-DS-10-0218	HAT-SITE DRAINAGE SECTIONS AND DETAILS (SHEET 2 OF 2)
H/M-DS-10-0219	HAT-EROSION PROTECTION PLAN AND SECTIONS
H/M-DS-10-0213	TAILINGS EMBANKMENT PLAN AND DITCH SECTIONS AND DETAILS

LEGEND:

- AREA OF ROCK CHIPPING
- 4300 — EXISTING CONTOURS
- 4320 — FINAL CONTOURS
- DRAINAGE DITCH
- N10,000 — CONSTRUCTION GRID COORDINATE
- TOP OF CUT
- TOP OF FILL
- LIMIT OF CONTAMINATED MATERIAL
- EXISTING DISPLACEMENT MONUMENT LOCATION & ELEVATION OF BASE PLATE AS OF MARCH 1989.
- NEW DISPLACEMENT MONUMENT LOCATION

QA MK-F	NO.	DATE	REVISIONS	BY	CK	EED MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	0	1/30/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

QA REVIEWED FOR QUALITY REQUIREMENTS BY

REGISTERED PROFESSIONAL ENGINEER — PATRICK H. GRIFFITH — STATE OF UTAH

FOR INFORMATION ONLY

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

TAILINGS EMBANKMENT PLAN

DESIGNED CLW | DRAWN JMM | CHECKED EER | INSPECTED | RECOMMENDED | APPROVED | DATE 1/1/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A BRAUN-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. H/M-DS-10-0212
REV. 0

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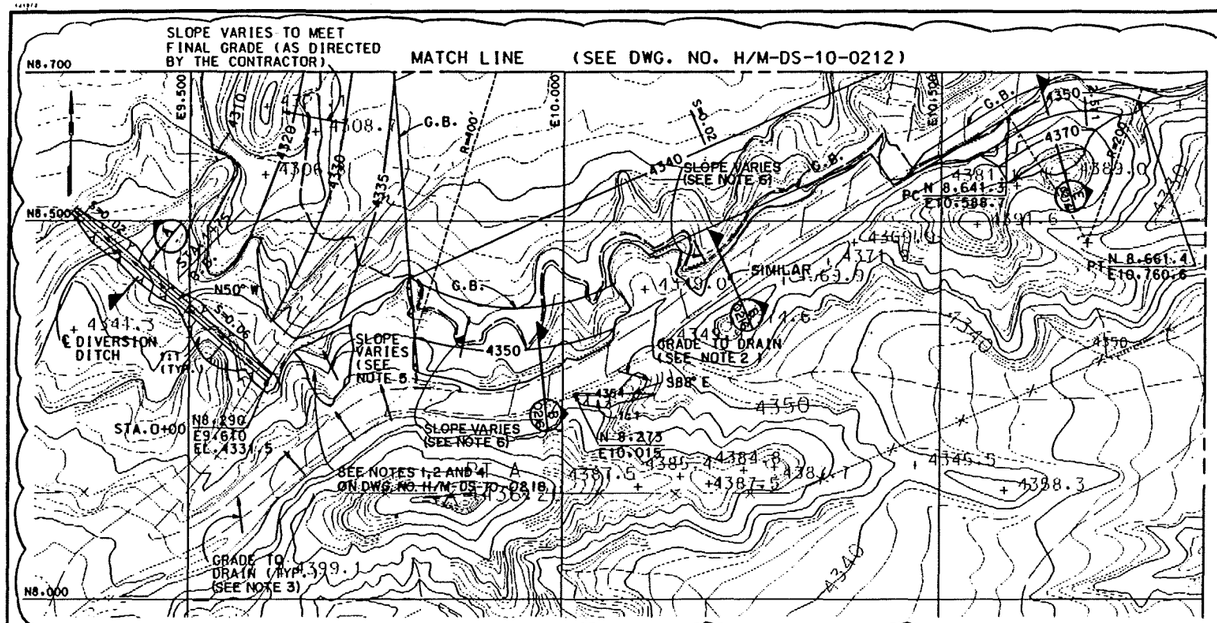

TAILINGS EMBANKMENT PLAN (SEE NOTE 1)

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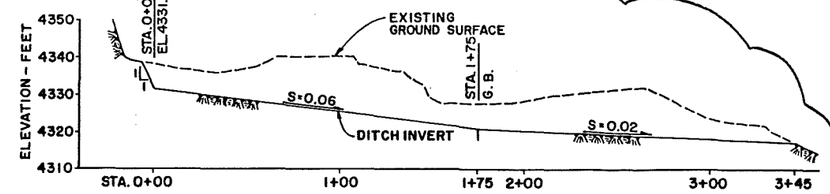
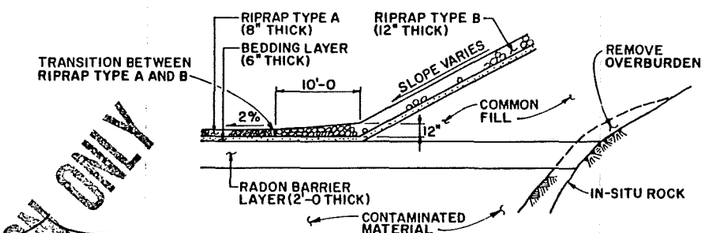
SCALE FEET



DIVERSION DITCH - PROFILE



DETAIL 1 / 0216
NOT TO SCALE

NOTES:

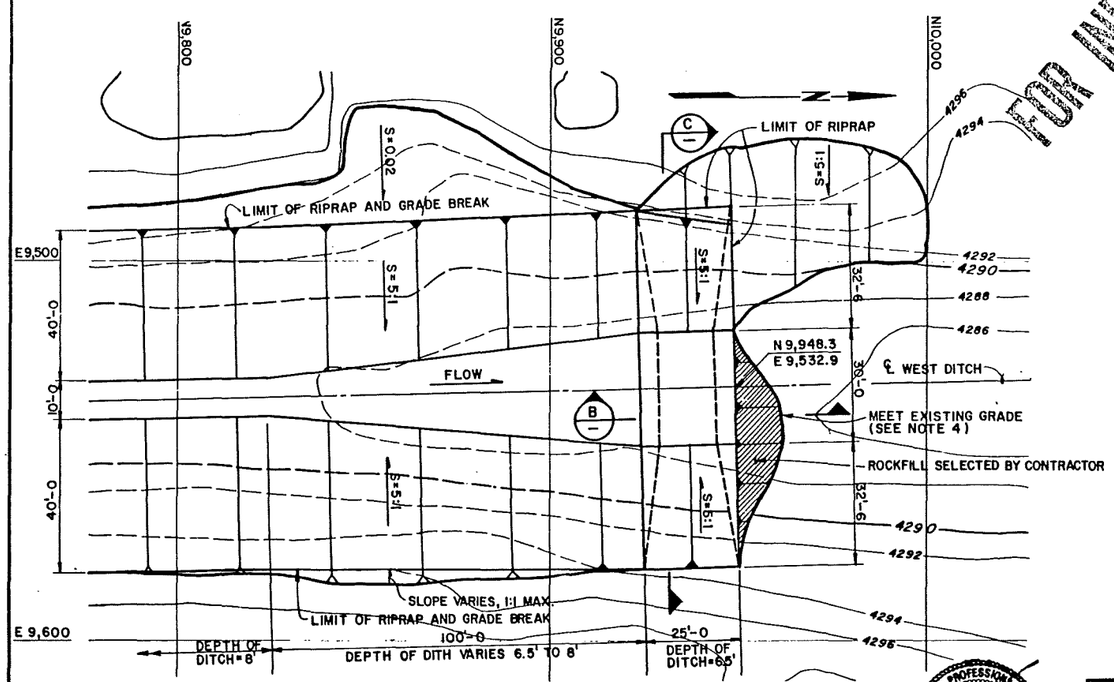
1. SEE DWG. H/M-DS-10-0212 FOR ADDITIONAL NOTES AND LEGEND.
2. GRADE EXISTING TERRAIN SOUTH OF PILE AS DIRECTED BY THE CONTRACTOR TO AVOID FLOW CONCENTRATIONS ONTO THE PILE.
3. GRADE EXISTING TERRAIN SOUTHWEST OF PILE AS DIRECTED BY CONTRACTOR.
4. ROCKFILL BELOW TOE OF WEST DITCH TO MEET EXISTING GRADE AS DIRECTED BY CONTRACTOR.
5. BACKFILL EXISTING GILLIES AS DIRECTED BY CONTRACTOR WITH ROCKFILL SELECTED BY THE CONTRACTOR.
6. SLOPE SHALL BE UNIFORM BETWEEN EDGE OF EXISTING HAUL ROAD AND TOP OF THE EMBANKMENT. SLOPE SHALL BE AS DIRECTED BY THE CONTRACTOR BUT SHALL BE NO STEEPER THAN 7:1.

REFERENCE DRAWINGS:

H/M-DS-10-0212 TAILINGS EMBANKMENT PLAN
H/M-DS-10-0216 TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 2 OF 2)
H/M-DS-10-0218 ~~HAT SITE DRAINAGE~~ SECTIONS AND DETAILS (SHEET 2 OF 2)

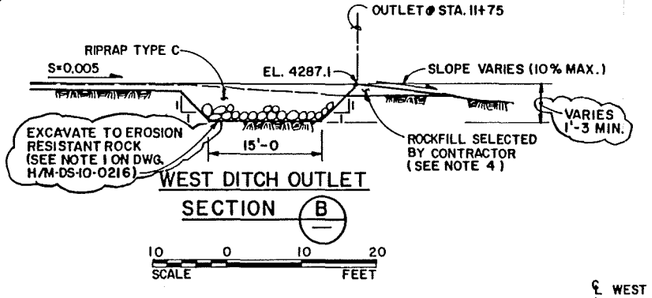
LEGEND:

TOP OF ROCK
LIMITS OF ROCKFILL SELECTED BY THE CONTRACTOR
G.B. GRADE BREAK



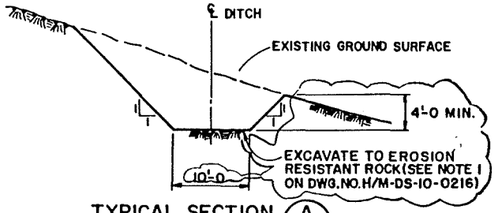
WEST DITCH TOE OUTLET
DETAIL 2 / 0212

20 0 20 40
SCALE FEET

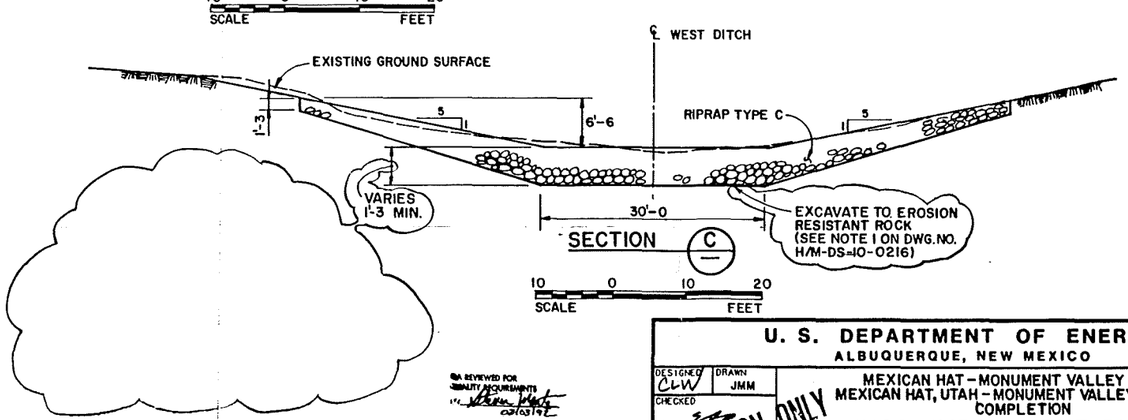


WEST DITCH OUTLET
SECTION B

10 0 10 20
SCALE FEET



TYPICAL SECTION A
NOT TO SCALE



SECTION C

10 0 10 20
SCALE FEET

QA REVIEWED FOR QUALITY REQUIREMENTS

FOR INFORMATION ONLY

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	△								
	△								
	△								
	△								
	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CLW | DRAWN JMM | CHECKED | INSPECTED | RECOMMENDED

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

TAILINGS EMBANKMENT PLAN AND DITCH SECTIONS AND DETAILS

APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

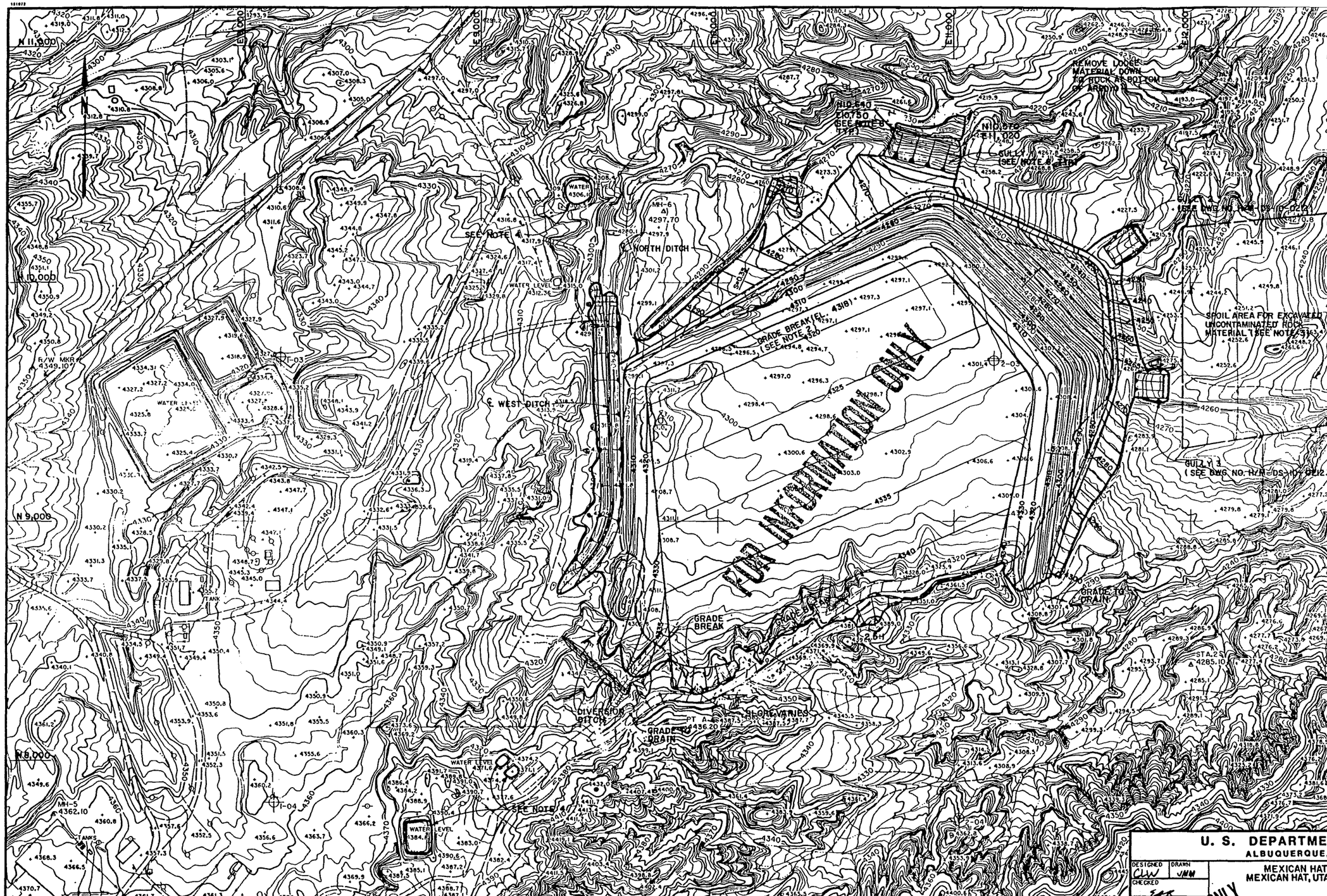
MORRISON-KNUDSEN ENGINEERS, INC.
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-DS-10-0213 | REV. 0

REGISTERED PROFESSIONAL ENGINEER PATRICK H. GONTHIER STATE OF UTAH

B50251 1 G0003800/UMTRAD



NOTES:

1. SEE DWG. NO. H/M-DS-10-0212 AND H/M-DS-10-0213 FOR FINAL SITE GRADING REQUIREMENTS AROUND DISPOSAL CELL.
2. THE ACTUAL LOCATION OF THE GRADE BREAK BETWEEN THE EMBANKMENT TOP AND THE 5:1 SIDESLOPES WILL VARY BASED ON THE VOLUME OF CONTAMINATED MATERIAL PLACED IN THE EMBANKMENT.
3. ALTERNATIVE SPOIL AREA MAY BE SELECTED BY CONTRACTOR.
4. ALL DEPRESSIONS AND LOW SPOTS INCLUDING WATER PONDS SHALL BE BACKFILLED WITH COMMON FILL AND SLOPED TO DRAIN AS DIRECTED BY THE CONTRACTOR.
5. FOR LEGEND, SEE DWG. NO. H/M-DS-10-0212
6. FOR GULLY DETAILS, SEE DWG. NO. H/M-DS-10-0220.
7. REMOVE TEMPORARY ACCESS ROADS AND PARKING AREAS AS DIRECTED BY THE CONTRACTOR.
8. FINAL GRADES MAY BE ADJUSTED BY THE CONTRACTOR TO MEET THE FIELD CONDITIONS

REFERENCE DRAWINGS:

H/M-DS-10-0212 TAILINGS EMBANKMENT PLAN

H/M-DS-10-0213 TAILINGS EMBANKMENT PLAN AND DITCH SECTIONS AND DETAILS

H/M-DS-10-0220 HAT - GULLY DETAILS

LEGEND:

TOP OF CUT

TOP OF FILL

FLOWPATH

QA ALVERWILD FOR QUALITY REQUIREMENTS BY [signature] 2/10/92

200 0 200 400
SCALE FEET

REGISTERED PROFESSIONAL ENGINEER PATRICK D. GRIFFITH STATE OF UTAH

FOR INFORMATION ONLY

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

HAT-FINAL SITE GRADING PLAN

DESIGNED CLW | DRAWN JMM | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/6/92

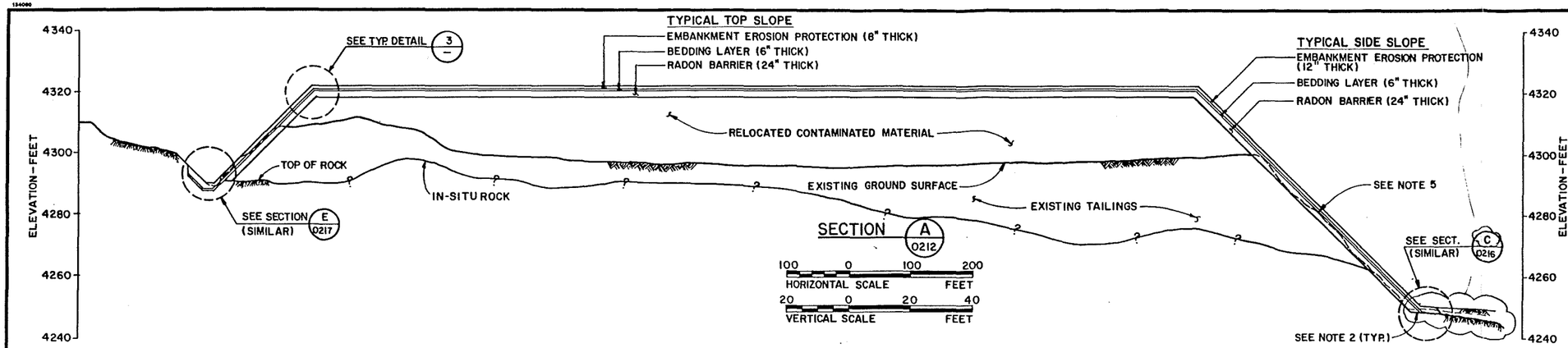
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-DS-10-0214 | REV. 0

B50251 I 02003800/UMTRAD

9



NOTES:

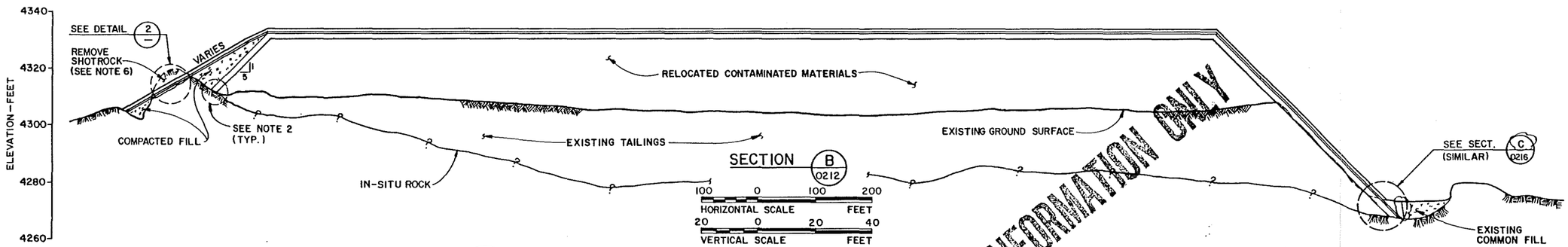
1. THICKNESS OF THE RADON BARRIER MAY BE REVISED BY THE CONTRACTOR BASED ON RADIOLOGICAL MEASUREMENT OF CONTAMINATED FILL MATERIALS PLACED ON THE EMBANKMENT.
2. EXTEND RADON BARRIER AND EROSION PROTECTION TO TIE INTO UNCONTAMINATED EROSION RESISTANT ROCK. ALL OVERBURDEN AND LOOSE ROCK SHALL BE REMOVED PRIOR TO PLACING RADON BARRIER AND EROSION PROTECTION. (1)
3. NOT USED.
4. NOT USED.
5. REGRADE EXISTING SLOPE TO MATCH FINAL GRADE OF CONTAMINATED MATERIALS.
6. SHOTROCK IS ROCK PREVIOUSLY BLASTED BY OTHERS BUT NOT EXCAVATED.

REFERENCE DRAWINGS:

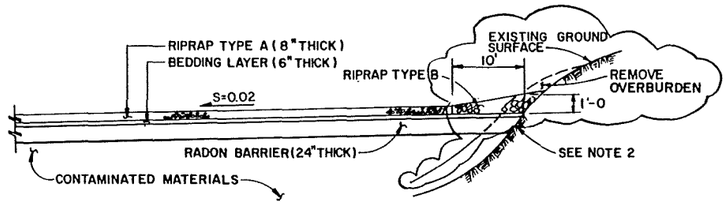
H/M-DS-10-0212 TAILINGS EMBANKMENT PLAN

H/M-DS-10-0216 TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 2 OF 2)

H/M-DS-10-0217 HAT-SITE DRAINAGE SECTIONS AND DETAILS (SHEET 1 OF 2)

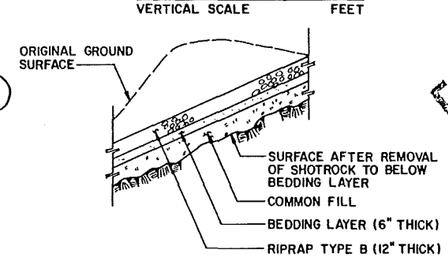


FOR INFORMATION ONLY

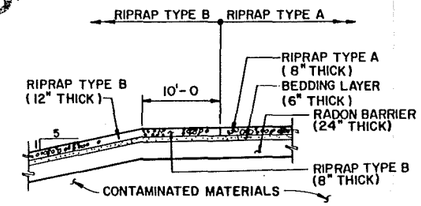


TYPICAL KEY FOR SOUTH TOE

DETAIL 1
NOT TO SCALE



DETAIL 2
NOT TO SCALE

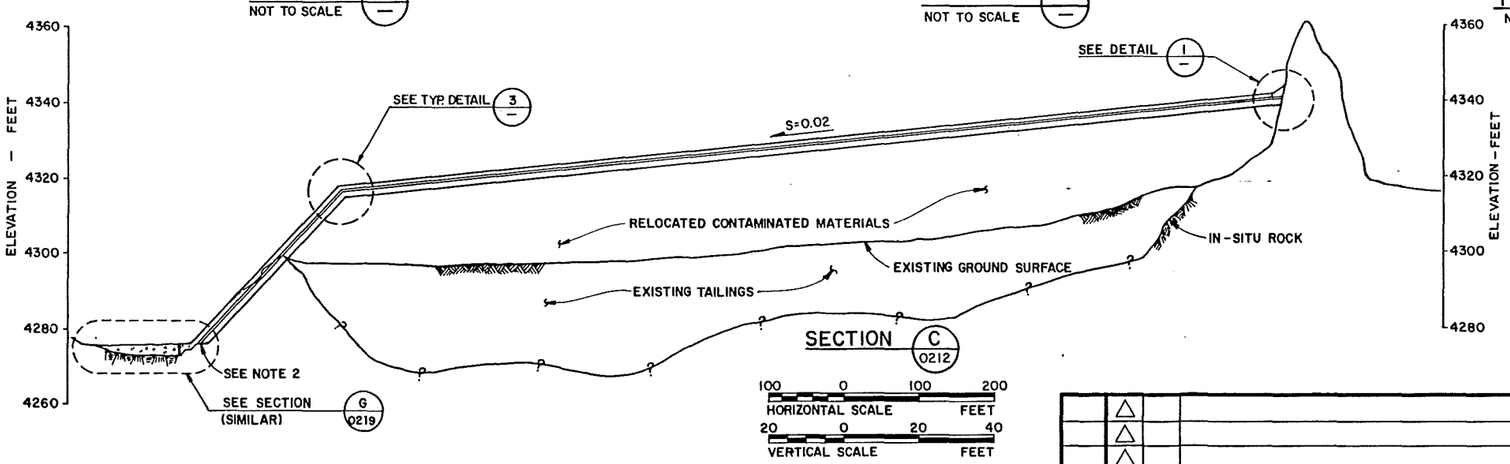


TYPICAL TRANSITION FROM RIPRAP TYPE A TO TYPE B

TYP. DETAIL 3
NOT TO SCALE

LEGEND:

TOP OF ROCK



QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/03/92

REGISTERED PROFESSIONAL ENGINEER No. 7396 PATRICK M. GOWTHIE 31 JAN 92 STATE OF UTAH

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	1	8-3-92	REVISED AS PER P.I.D. NO. 09-S-15						
	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

FOR INFORMATION ONLY

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CLW | DRAWN JMM | CHECKED | INSPECTED | RECOMMENDED | APPROVED

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

TAILINGS EMBANKMENT SECTIONS AND DETAILS
(SHEET 1 OF 2)

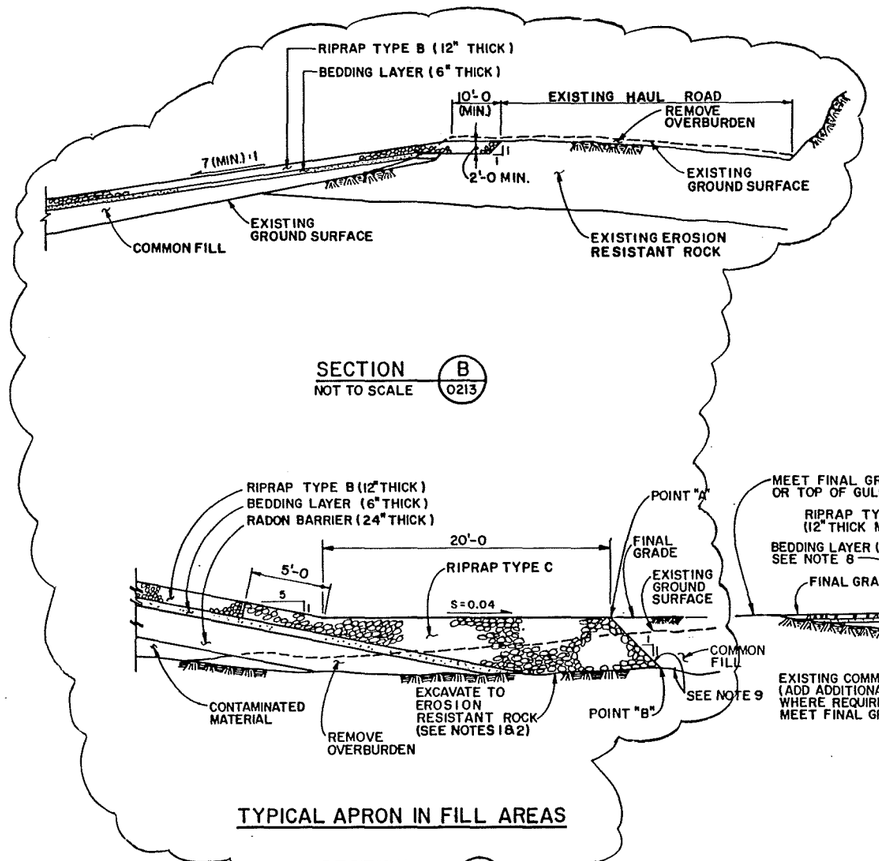
DATE 11-11-92 | DOE PROJECT ENGINEER | DATE 2/3/92

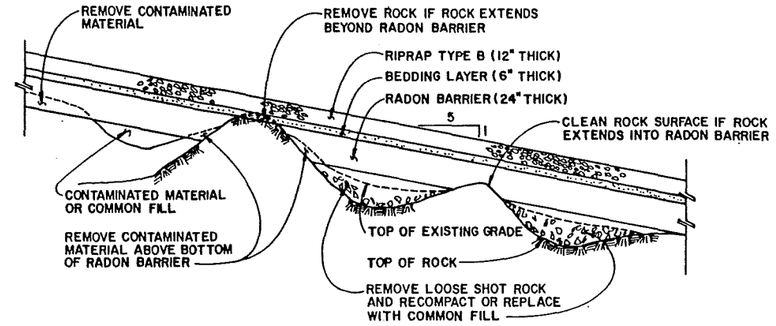
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

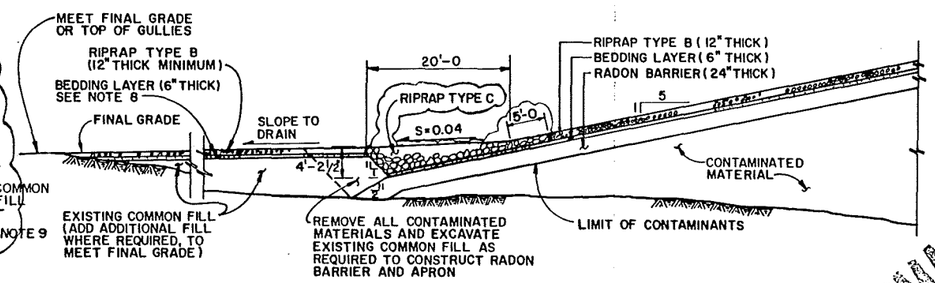
DRAWING NO. H/M-DS-10-0215 | REV. 1

B5025110G003800/UMTRAD





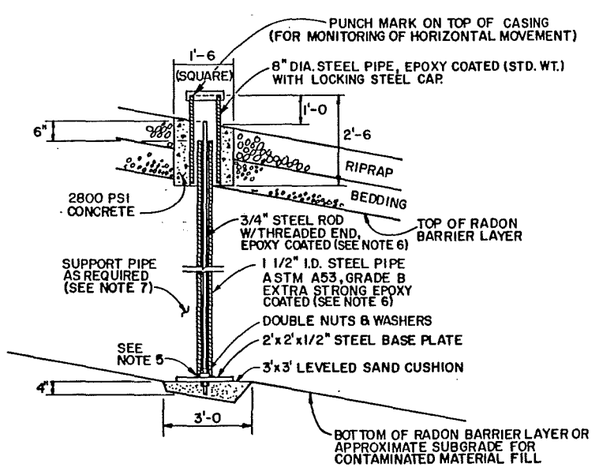
SIDESLOPE GRADING DETAIL
(SEE NOTE 10)
SCALE 5 0 5 10 FEET



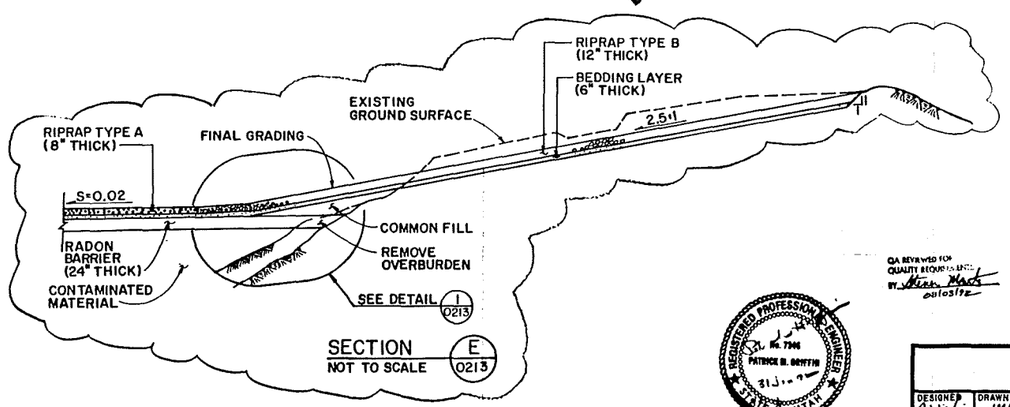
TYPICAL APRON IN FILL AREAS
WITH RIPRAP PROTECTION BEYOND 20' APRON

SECTION D 0219
(SEE NOTE 11)
SCALE 10 0 10 20 FEET

FOR INFORMATION ONLY



TYPICAL NEW DISPLACEMENT MONUMENT DETAIL
(H/M-DS-10-0212)
NOT TO SCALE



QA REVIEWED FOR QUALITY REQUIREMENTS BY 01/05/92

REGISTERED PROFESSIONAL ENGINEER PATRICK B. DEVITT R. No. 7306 31 Jan 92 STATE OF UTAH

NOTES:

1. EROSION RESISTANT ROCK IS DETERMINED BY REFUSAL OF A POWER AUGER, DRILLING VERTICALLY, USING A CARBIDE STEEL BIT. TRENCH BOTTOMS WILL BE TESTED ON MAXIMUM OF 20 FOOT CENTERS. GENERALLY EROSION RESISTANT ROCK IS NATURAL, UNDISTURBED, INTACT ROCK WHICH CANNOT BE READILY RIPPED OR LOOSENED OR BROKEN BY A BACKHOE DURING NORMAL EXCAVATION AND RINGS WHEN STRUCK WITH A GEOLOGIST'S ROCK HAMMER.
2. WHERE EXCAVATIONS ARE TO GO TO EROSION RESISTANT ROCK, THE SUBCONTRACTOR SHALL EXPOSE THE EROSION RESISTANT ROCK FOR INSPECTION AND LOGGING BY THE CONTRACTOR'S GEOLOGIST. ALL LOOSE MATERIAL SHALL BE REMOVED AND THE ROCK SURFACE CLEANED TO THE ACCEPTABLE ROCK CLEANUP SURFACE. BACKFILL SHALL NOT BE PLACED UNTIL CONTRACTOR APPROVES THE ROCK SURFACE AT THE BOTTOM OF THE EXCAVATION.
3. FOR APRON AREAS REQUIRING RIPRAP PROTECTION SEE DWG. NO. H/M-DS-10-0219.
4. LENGTH OF PIPE AND ROD OF EXISTING DISPLACEMENT MONUMENT VARY ACCORDING TO ELEVATION OF BASE PLATE AS SHOWN ON DWG. NO. H/M-DS-10-0212.
5. WHERE THE BASE PLATE IS LOCATED AT THE TOP OF THE RELOCATED TAILINGS (UNDERNEATH THE RADON BARRIER) THE PIPE SHALL BE PLACED DIRECTLY ON THE PLATE. PIPES SHALL NOT BE ATTACHED TO PLATES OR RODS.
6. PIPES AND RODS WITH TOTAL LENGTH GREATER THAN FOUR FEET SHALL BE INSTALLED IN 4-FOOT SECTIONS AS FILL CONSTRUCTION PROGRESSES. RODS SHALL BE SECURELY FLUSH-COUPLED AS REQUIRED. PIPES SHALL BE SECURELY COUPLED SUCH THAT INSIDE DIAMETER IS NOT LESS THAN 1 1/2" AT ANY POINT. SUBCONTRACTOR SHALL MAKE ELEVATION MEASUREMENTS OF TOP OF ROD IMMEDIATELY BEFORE AND AFTER ADDITION OF EACH ROD SECTION. PIPES SHALL BE CAPPED AT ALL TIMES TO PREVENT ENTRANCE OF FOREIGN MATTER.
7. PIPES SHALL BE SUPPORTED BY FILL COMPACTED BY LIGHT WEIGHT TAMPERS WITHIN FIVE FEET OF PIPES TO MEET SAME COMPACTION REQUIREMENTS AS FOR ADJACENT FILL. CARE SHALL BE TAKEN TO ENSURE THAT PIPES REMAIN NOMINALLY CENTERED AROUND RODS.
8. BEYOND THE EMBANKMENT APRON, BEDDING LAYER IS NOT REQUIRED IF RIPRAP IS IN CONTACT WITH IN-SITU BEDROCK.
9. THE DEPTH TO EROSION RESISTANT ROCK BELOW POINT "A" WILL VARY. THE MINIMUM DEPTH IS 15 INCHES BELOW FINAL GRADE. THE LOCATION OF POINT "A" IS FIXED. THE 1:1 SLOPE OF RIPRAP TYPE C EXTENDS TO TOP OF THE EROSION RESISTANT ROCK. LOCATION OF POINT "B" WILL VARY.
10. SIDE SLOPE DETAIL APPLIES TO AREAS OF EXISTING SIDE SLOPE WHERE ROCK IS AT OR NEAR THE SURFACE.
11. SECTION D - APPLIES BETWEEN THE GULLIES AND THE EMBANKMENT AND OTHER AREAS WHERE DEPTH TO COMPETENT ROCK BELOW FINAL GRADE IS GREATER THAN 4'-2 1/2".

REFERENCE DRAWINGS:

H/M-DS-10-0212	TAILINGS EMBANKMENT PLAN
H/M-DS-10-0213	TAILINGS EMBANKMENT PLAN AND DITCH SECTIONS AND DETAILS
H/M-DS-10-0215	TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 1 OF 2)
H/M-DS-10-0219	HAT-EROSION PROTECTION PLAN AND SECTIONS

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	1	8-3-92	REVISED AS PER P.I.D. NO. 09-S-15						
	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

FOR INFORMATION ONLY

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CW | DRAWN JMM | CHECKED | INSPECTED | RECOMMENDED | APPROVED

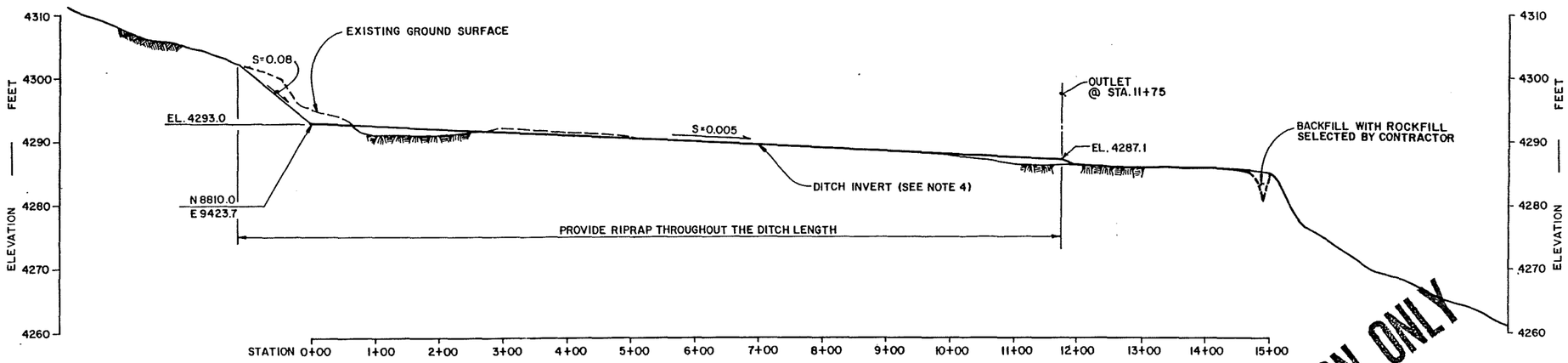
MEXICAN HAT-MONUMENT VALLEY SITES
MEXICAN HAT, UTAH-MONUMENT VALLEY, ARIZONA
COMPLETION

TAILINGS EMBANKMENT SECTIONS AND DETAILS
(SHEET 2 OF 2)

DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

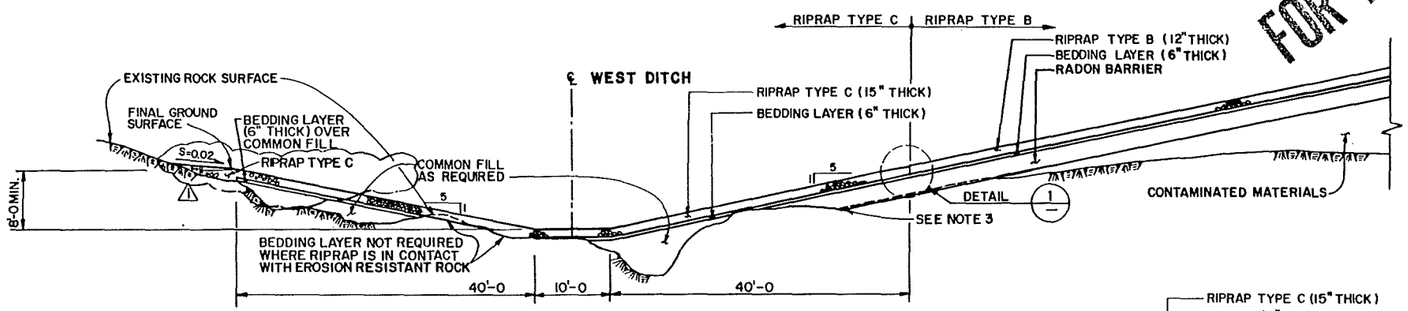
PROJECT NO. DE-AC04-83AL18796
DRAWING NO. H/M-DS-10-0216 | REV. 1



WEST DITCH PROFILE

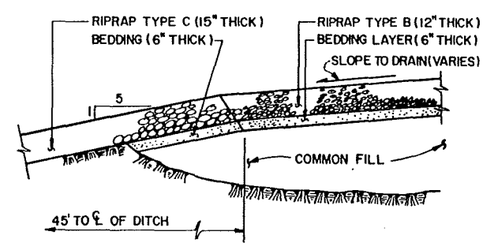
HORIZONTAL SCALE 100 0 100 200 FEET

VERTICAL SCALE 10 0 10 20 FEET



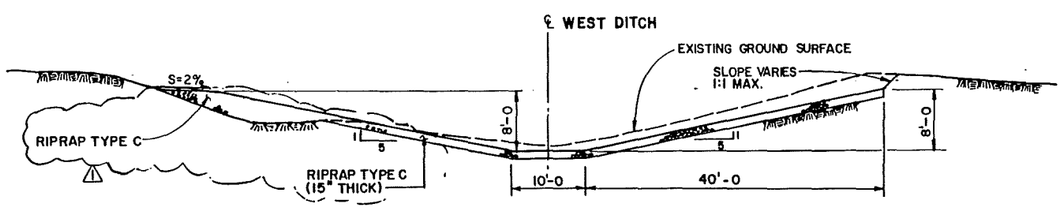
SECTION E 0212/0215

SCALE 10 0 10 20 FEET



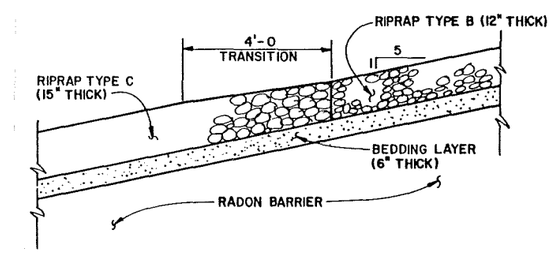
SECTION F 0212

NOT TO SCALE



SECTION D 0212

SCALE 10 0 10 20 FEET



DETAIL 1

NOT TO SCALE

NOTES:

1. SECTION E APPLIES BETWEEN STATION 0+00 AND STATION 9+75, SECTION D APPLIES DOWNSTREAM OF STATION 9+75.
2. SEE DWG. NO. H/M-DS-10-0212 FOR PLAN OF WEST DITCH.
3. EXTEND RADON BARRIER BEYOND LIMITS OF CONTAMINATED MATERIAL TO ROCK.
4. DITCH INVERT SHOWN IS TOP OF RIPRAP.

REFERENCE DRAWINGS:

H/M-DS-10-0212 TAILINGS EMBANKMENT PLAN

H/M-DS-10-0215 TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 1 OF 2)

LEGEND:

TOP OF ROCK

FOR INFORMATION ONLY

QA REVIEWED FOR QUALITY REQUIREMENTS BY 2/03/92

	3								
	2								
	1	3-3-92	REVISED AS PER P.I.D. NO. 09-S-15	JCK					
	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—
QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CLW | DRAWN JMM | CHECKED | INSPECTED | RECOMMENDED

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

HAT-SITE DRAINAGE SECTIONS AND DETAILS
(SHEET 1 OF 2)

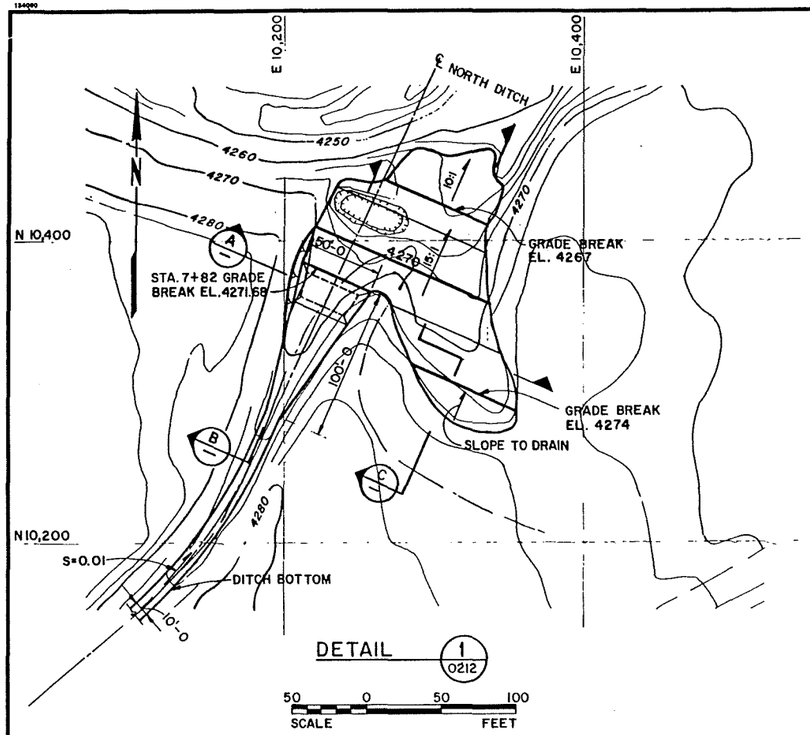
APPROVED | DATE 1/1/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

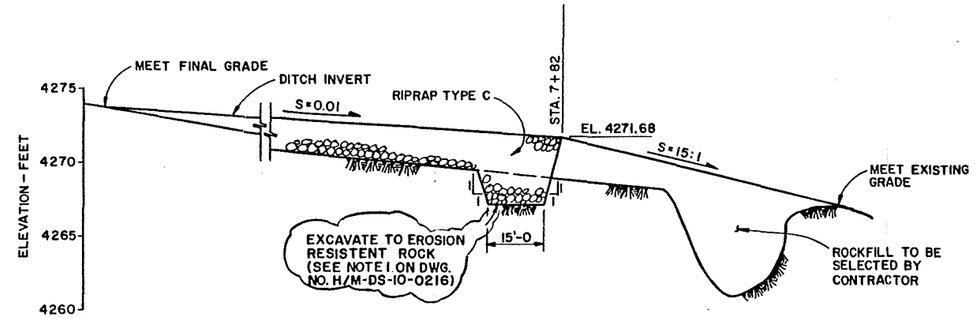
DRAWING NO. H/M-DS-10-0217 | REV. 1

12



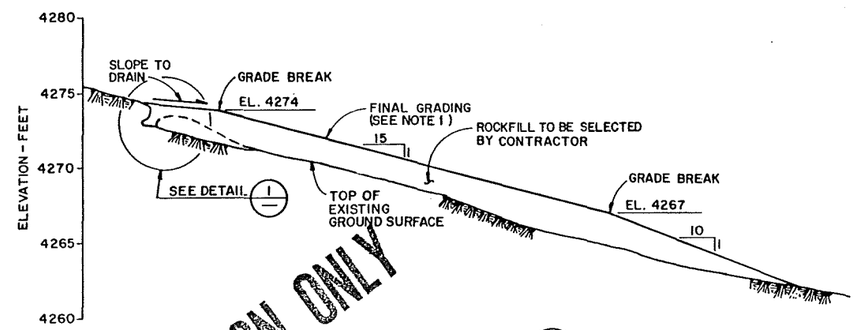
DETAIL 1/0212

50 0 50 100
SCALE FEET



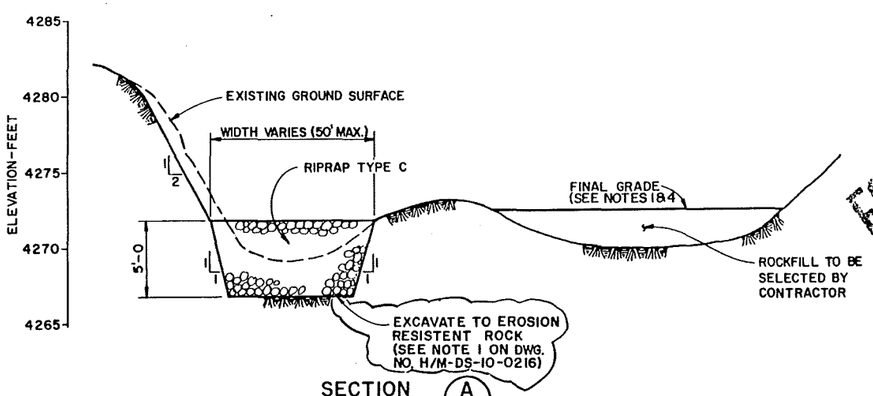
SECTION B

20 0 20 40
HORIZONTAL SCALE FEET
5 0 5 10
VERTICAL SCALE FEET



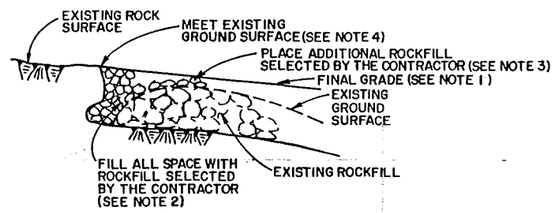
SECTION C

20 0 20 40
HORIZONTAL SCALE FEET
5 0 5 10
VERTICAL SCALE FEET



SECTION A

20 0 20 40
HORIZONTAL SCALE FEET
5 0 5 10
VERTICAL SCALE FEET



DETAIL 1
NOT TO SCALE

NOTES:

1. FINAL SURFACE OF ROCKFILL TO BE SELECTED BY CONTRACTOR WILL BE GRADED TO PROMOTE SHEET FLOW. THE SURFACE SHOULD HAVE NO NOTICABLE MOUNDS, RIDGES, SWALES OR DEPRESSIONS AS DETERMINED BY THE CONTRACTOR.
2. ROCKFILL SIZES SHALL BE SELECTED TO FILL ALL SPACES AND TO AVOID NESTING. ROCKFILL SMALLER THAN 1' PIECES SHOULD BE PLACED AND COMPACTED ACCORDING TO PROCEEDURES APPROVED BY THE CONTRACTOR. ROCKFILL LARGER THAN 1' SHOULD BE INDIVIDUALLY PLACED.
3. LARGER PIECES OF ROCKFILL SHALL BE PLACED NEAR THE SURFACE.
4. ROCKFILL SHOULD BE PLACED TO MEET EXISTING GRADE AND AVOID FLOW CONCENTRATIONS BETWEEN ROCKFILL SURFACE AND EXISTING TERRAIN.

REFERENCE DRAWINGS:

H/M-DS-10-0212 TAILINGS EMBANKMENT PLAN
H/M-DS-10-0216 TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 2 OF 2)

FOR INFORMATION ONLY

QA REVIEWED FOR QUALITY REQUIREMENTS BY [illegible] 2/10/92

REGISTERED PROFESSIONAL ENGINEER PATRICK M. DOYLE No. 7246 31 Jan 92 STATE OF UTAH

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	△								
	△								
	△								
	△								
2/10/92	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CW | DRAWN JMM | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MEXICAN HAT-MONUMENT VALLEY SITES
MEXICAN HAT, UTAH-MONUMENT VALLEY, ARIZONA
COMPLETION

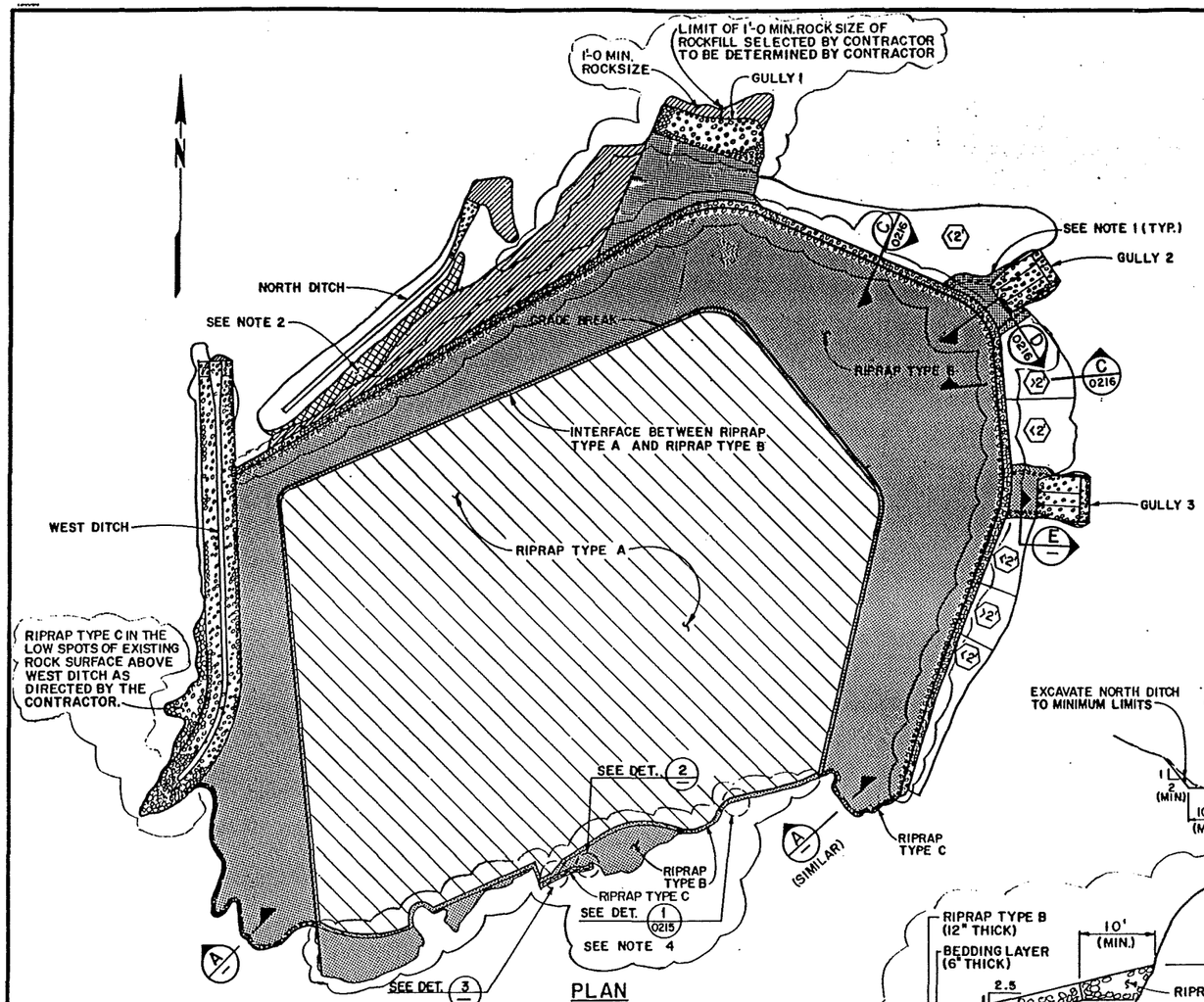
HAT-SITE DRAINAGE SECTIONS AND DETAILS
(SHEET 2 OF 2)

FOR INFORMATION ONLY

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

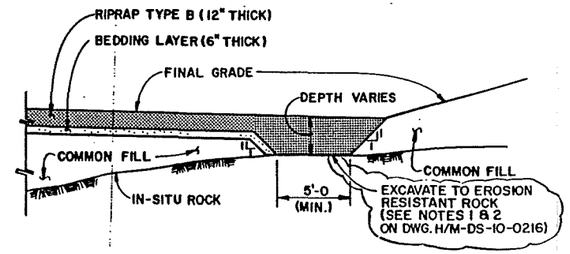
PROJECT NO. DE-AC04-83AL18796
DRAWING NO. H/M-DS-10-0218 REV. 0

13 B50251 | (2)003800/UMTRAD

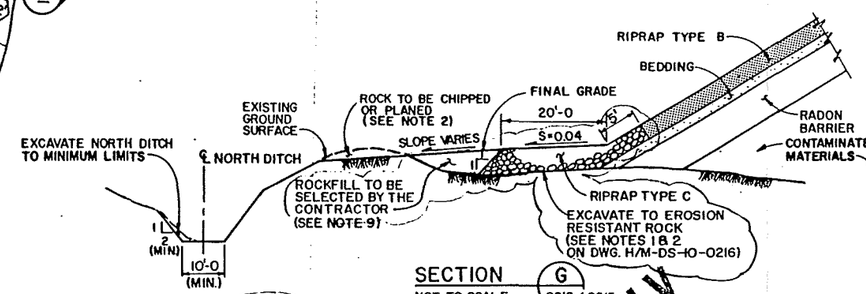


PLAN
EROSION PROTECTION

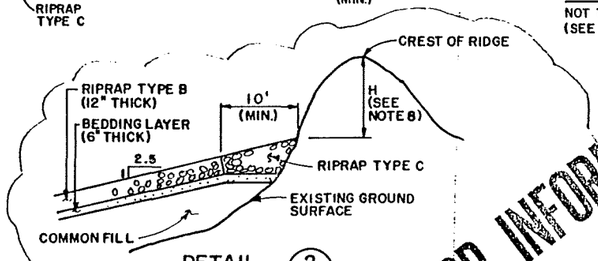
SCALE 200 0 200 400 FEET



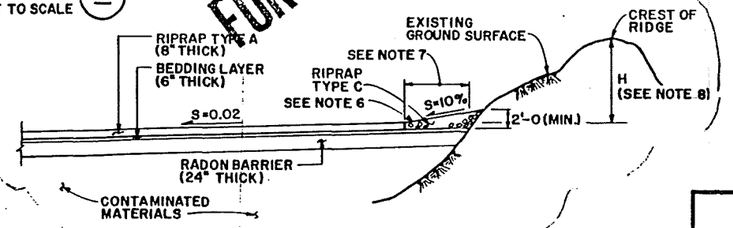
TYPICAL SECTION E
NOT TO SCALE
SEE NOTE 5



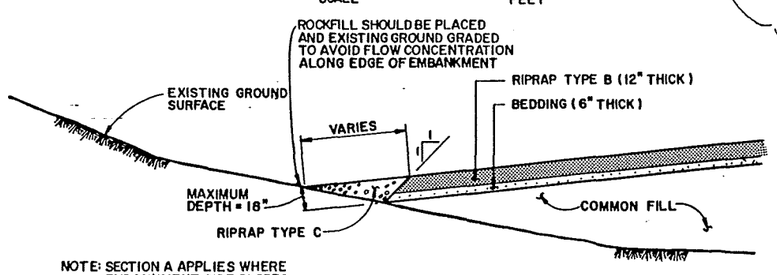
SECTION G
NOT TO SCALE
(SEE NOTE 3)
0212 / 0215



DETAIL 2
NOT TO SCALE



DETAIL 3
NOT TO SCALE



NOTE: SECTION A APPLIES WHERE EMBANKMENT SIDE SLOPES MEET EXISTING GRADE BETWEEN TOP SLOPE AND TOE OF SIDE SLOPE

SECTION A
SEE NOTE 4

SCALE 5 0 5 10 FEET

NOTES:

1. THE OUTER LIMIT OF RIPRAP COVER SHOWN IS APPROXIMATE FINAL LIMIT SHALL BE DETERMINED IN THE FIELD DURING CONSTRUCTION.
2. ROCK TO BE CHIPPED OR PLANED SHALL NOT BE RIPPED OR BLASTED
3. SECTION G APPLIES WHERE DEPTH TO ROCK BELOW FINAL GRADE IS 3 FEET OR LESS OR AS DIRECTED BY THE CONTRACTOR. WHERE DEPTH TO ROCK BELOW FINAL GRADE IS MORE THAN 3 FEET THE AREA BELOW 3 FEET SHOULD BE BACKFILLED WITH RIPRAP SELECTED BY THE CONTRACTOR.
4. SECTION A APPLIES WHERE THE EMBANKMENT SIDE SLOPE COMES IN CONTACT WITH GROUND SURFACE. DETAIL 1 ON DWG. H/M-DS-10-0215 APPLIES WHERE THE EMBANKMENT TOP SLOPE COMES IN CONTACT WITH GROUND SURFACE.
5. SECTION E APPLIES WHEREVER THERE IS A TRANSITION BETWEEN EROSION PROTECTION AND COMMON FILL BETWEEN THE EMBANKMENT APRON AND THE GULLIES
6. TOP OF RIPRAP TYPE C SHALL BE GRADED TO PROVIDE SMOOTH TRANSITION TO TOP OF RIPRAP TYPE A.
7. WIDTH IS 13.3' MINIMUM. ACTUAL WIDTH WILL BE DETERMINED BY THE CONTRACTOR DEPENDING ON LOCAL TOPOGRAPHY.
8. PLACE RIPRAP TYPE C ALONG UPSTREAM APRON OF THE EMBANKMENT, AS SHOWN ON DETAILS 2 AND 3, WHEREVER THE TOP SLOPE CONTACT WITH THE INSITU SLOPE IS ABOVE THE EXISTING HAUL ROAD AND THE VERTICAL DISTANCE TO THE CREST OF THE RIDGE IS GREATER THAN 20 FEET.
9. ROCKFILL TO BE PLACED IN 1 FOOT LIFTS AND COMPACTED BY TRACK WALKING.

REFERENCE DRAWINGS:

H/M-DS-10-0212	TAILINGS EMBANKMENT PLAN
H/M-DS-10-0215	TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 1 OF 2)
H/M-DS-10-0216	TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 2 OF 2)
H/M-DS-10-0218	HAT-SITE DRAINAGE SECTIONS AND DETAILS (SHEET 2 OF 2)

LEGEND:

- TOP OF CUT
- TOP OF FILL
- TOP OF ROCK
- ROCK TO BE CHIPPED OR PLAN
- RIPRAP TYPE A
- RIPRAP TYPE B
- RIPRAP TYPE C
- ROCKFILL (TO BE SELECTED BY CONTRACTOR)
- >2 APPROXIMATE DEPTH OF EXISTING FILL IN APRON IS LESS THAN 4' BUT GREATER THAN 2'
- <2 APPROXIMATE DEPTH OF EXISTING FILL IN APRON IS LESS THAN 2'

FOR INFORMATION ONLY

QA REVIEWED FOR QUALITY REQUIREMENTS BY 01/31/92

REGISTERED PROFESSIONAL ENGINEER No. 7398 PATRICK H. SMITH STATE OF UTAH

QA MK-1	NO.	DATE	REVISIONS	BY	CK	FLD MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

FOR INFORMATION ONLY

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CLW | DRAWN JMM | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE 1/31/92

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

HAT - EROSION PROTECTION PLAN AND SECTIONS

DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A BRIDGESTONE MORRISON SERVICE COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-DS-10-0219 | REV. 0

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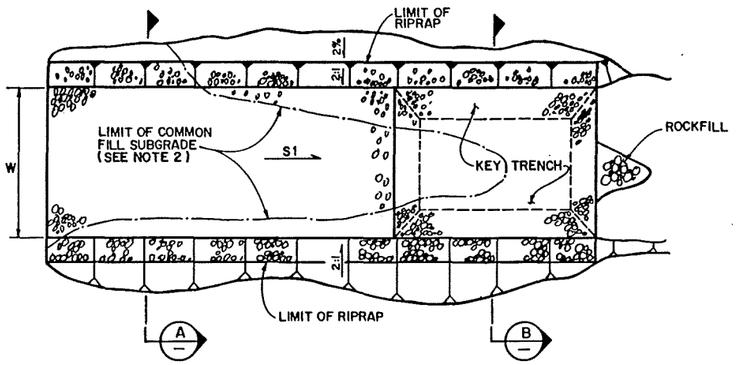
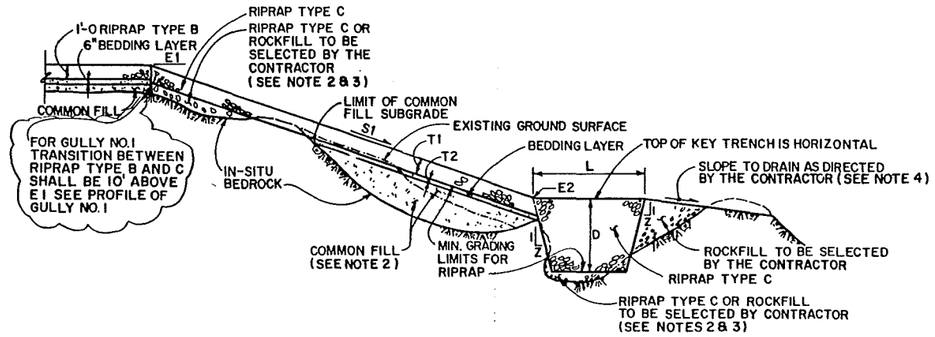


PLAN

TYPICAL EROSION PROTECTION AT GULLIES

(H/M-DS-10-0219)
NOT TO SCALE



TYPICAL PROFILE AT GULLIES

(SEE TABLE 1 FOR DIMENSIONS)
NOT TO SCALE

TABLE 1—SETTINGS AND DIMENSIONS OF GULLIES

GULLY	GULLIES						KEY TRENCH			SIDE-SLOPE DEPTH (FT.)
	WIDTH (FT.)	ELEVATION (FT.)		SLOPE	THICKNESS (FT.)		LENGTH (FT.)	THICKNESS (FT.)	SIDE-SLOPE	
	W(MIN.)*	E1	E2	S1	T1(MIN)	T2	L	D(MIN.)**	Z (MIN.)	H
1	292	4262	4244	0.15	1.25	0.5	VARIES	1.25	1	2
2	90	4225	4218	0.049	1.25	0.5	25	1.25	1	2
3	100	4266	4253	0.108	1.25	0.5	25	1.25	1	2

* WIDTH MAY BE WIDER IF EXPOSED SIDE SLOPE EXCAVATIONS ARE ON EROSION RESISTANT ROCK.
**KEY TRENCH SHOULD EXTEND DOWN TO EROSION RESISTANT ROCK.

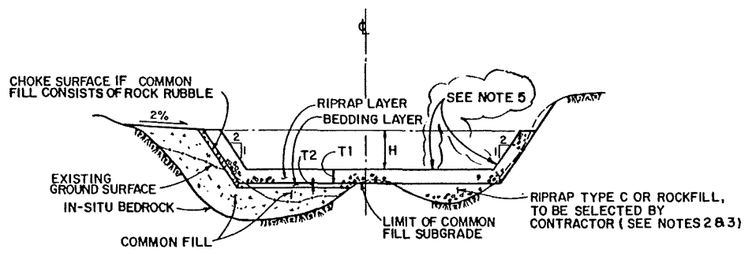
NOTES:

1. THE OUTER LIMIT OF RIPRAP COVER SHOWN IS APPROXIMATE. FINAL LIMIT SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD DURING CONSTRUCTION.
2. WHERE EXISTING SUBGRADE CONSISTS OF COMMON FILL A BEDDING LAYER SHALL BE PLACED BETWEEN THE RIPRAP AND THE FILL. WHERE EXISTING SUBGRADE CONSISTS OF IN-SITU ROCK OR ROCKFILL SELECTED BY THE CONTRACTOR, NO BEDDING LAYER IS REQUIRED.
3. IN AREAS WHERE EXISTING GRADE IS ABOVE THE MINIMUM GRADING LIMIT, THE AREA SHALL BE EXCAVATED TO OR BELOW THE MINIMUM LIMIT. WHERE EXISTING GRADE IS BELOW THE MINIMUM LIMIT, THE AREA SHALL BE BACKFILLED WITH TYPE C RIPRAP OR ROCKFILL TO BE SELECTED BY THE CONTRACTOR AS SHOWN.
4. SLOPE SHALL BE 10% MAX.
5. ALONG GULLY BOTTOM AND SIDESLOPE SURFACES, THERE SHOULD BE NO TRANSITION BETWEEN RIPRAP AND INSITU ROCK.
6. ROCKFILL SELECTED BY CONTRACTOR PLACED BELOW GULLY NO. 1. SHALL BE 1' MINIMUM ROCK SIZE. ROCK PIECES SHALL BE PLACED INDIVIDUALLY TO MINIMIZE VOIDS. IRREGULARITIES IN THE FINISHED SURFACE, CONSISTANT WITH THE ROCK SIZES, WILL BE ALLOWED.

REFERENCE DRAWINGS:

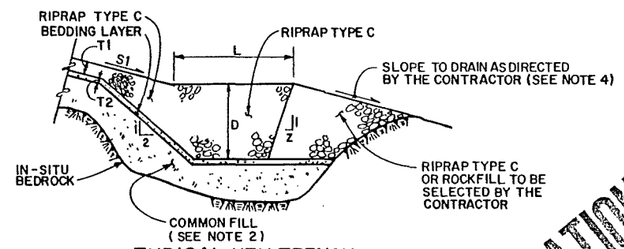
H/M-DS-10-0216 TAILINGS EMBANKMENT SECTIONS AND DETAILS (SHEET 2 OF 2)

H/M-DS-10-0219 HAT-EROSION PROTECTION PLAN AND SECTIONS



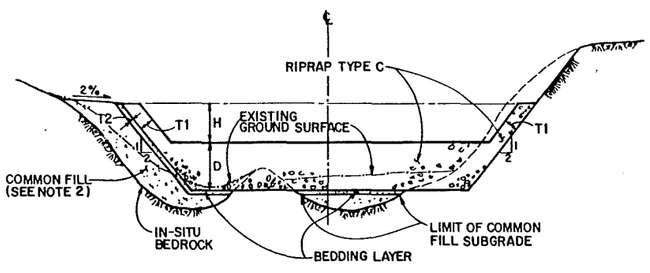
TYPICAL GULLIES SECTION (A)

(SEE NOTE 2)
NOT TO SCALE



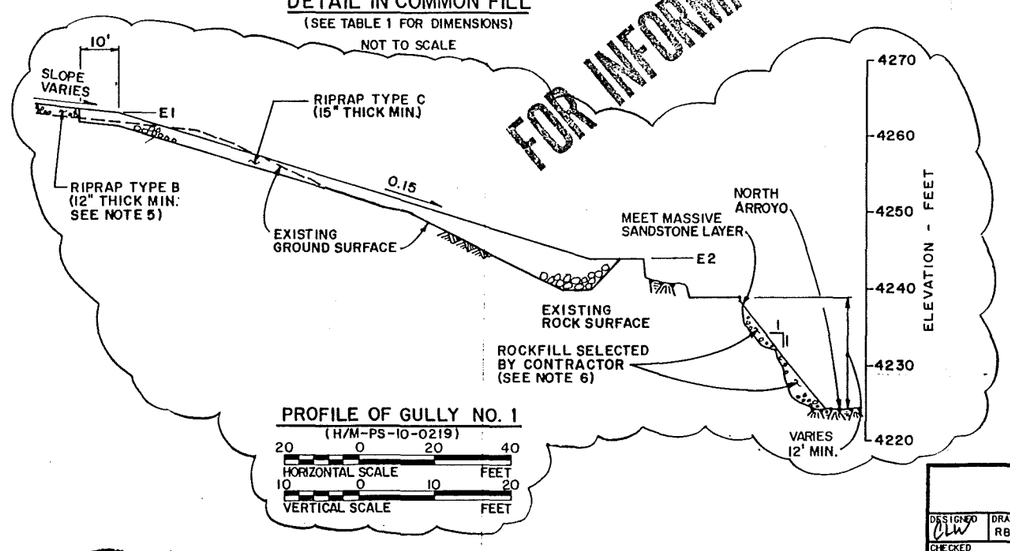
TYPICAL KEY TRENCH DETAIL IN COMMON FILL

(SEE TABLE 1 FOR DIMENSIONS)
NOT TO SCALE



TYPICAL KEY TRENCH SECTION (B)

(SEE NOTE 2 AND TABLE 1 FOR DIMENSIONS)
NOT TO SCALE



PROFILE OF GULLY NO. 1

(H/M-PS-10-0219)
HORIZONTAL SCALE 20 0 20 40 FEET
VERTICAL SCALE 10 0 10 20 FEET

LEGEND:

TOP OF CUT
TOP OF FILL
TOP OF ROCK

QA REVIEWED FOR QUALITY REQUIREMENTS BY [signature] 02/03/92

FOR INFORMATION ONLY

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK H. GRIFFITH STATE OF UTAH

DA	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	1	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CLW | DRAWN RBC | CHECKED | INSPECTED | RECOMMENDED | APPROVED D.M. Sands

MEXICAN HAT-MONUMENT VALLEY SITES
MEXICAN HAT, UTAH-MONUMENT VALLEY, ARIZONA
COMPLETION

HAT- GULLY DETAILS

FOR INFORMATION ONLY

DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. H/M-DS-10-0220 | REV. 0

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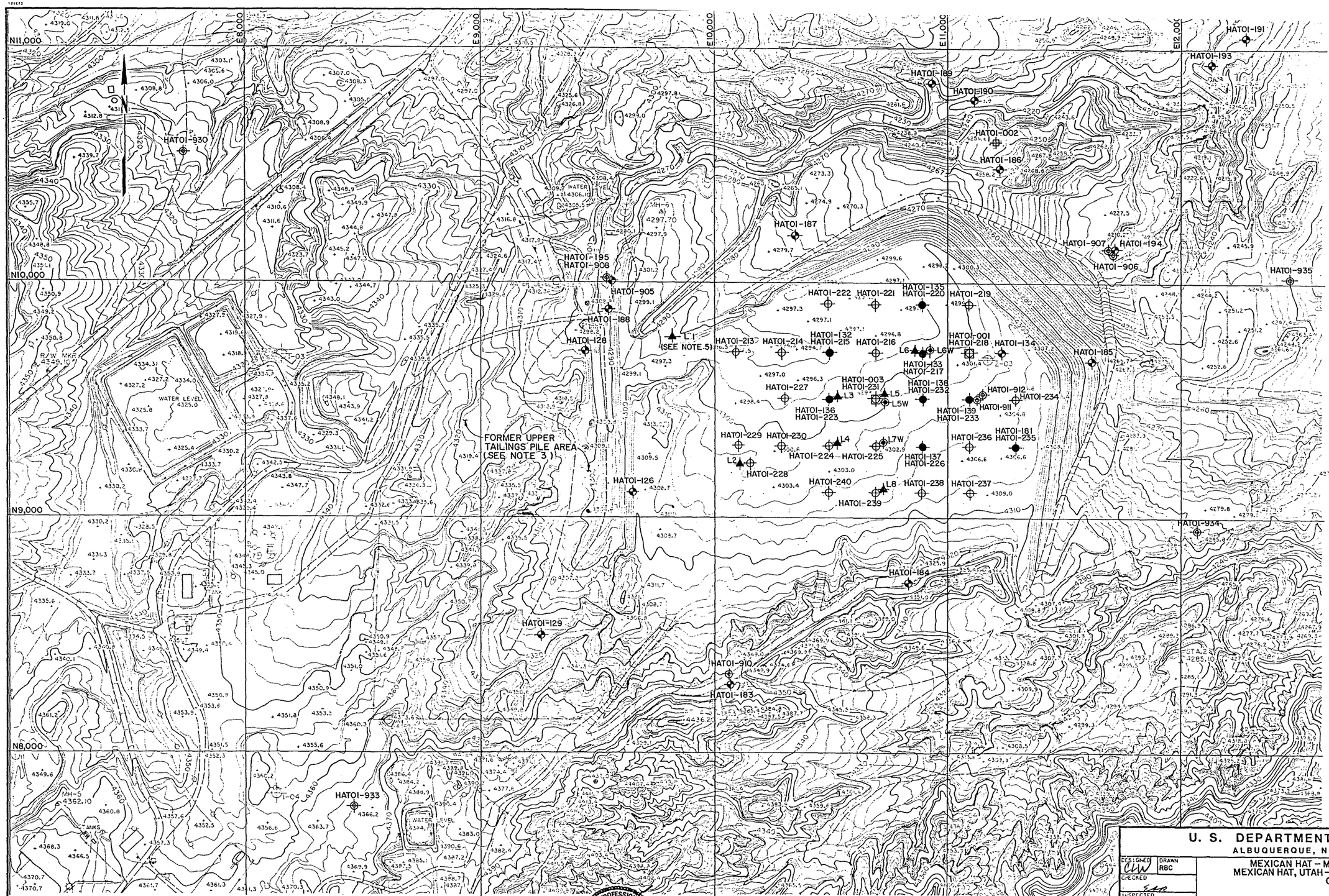

NOTES:

1. GEOTECHNICAL INVESTIGATIONS WERE CONDUCTED BY DOE IN LATE 1984 AND EARLY 1985. A TOTAL OF 40 PIEZOCONE SOUNDINGS, 17 BORINGS AND FOUR TESTS PITS WERE MADE ON THE EXISTING TAILINGS PILES. ADDITIONAL 27 BORINGS AND ONE TEST PIT WERE MADE IN THE VICINITY OF THE PILES. FOURTEEN OF THE BORINGS WERE CASED AND COMPLETED AS MONITORING WELLS. THREE BORINGS AND FOUR MONITORING WELLS WHICH ARE LOCATED AWAY FROM THE TAILINGS PILE AREA ARE NOT SHOWN.
2. LOCATION COORDINATES OF WELLS THAT HAVE BEEN SEALED AND ABANDONED ARE AS FOLLOWS:

HATOI-905	N10,019	E9,558
HATOI-906	N10,137	E11,703
HATOI-907	N10,154	E11,692
HATOI-908	N10,019	E9,539
HATOI-910	N 8,336	E10,067
HATOI-911	N 9,508	E11,114
HATOI-912	N 9,527	E11,133
HATOI-930	N10,550	E 7,733

3. CONTAMINATED MATERIALS IN THE FORMER UPPER TAILINGS PILE AREA HAVE BEEN REMOVED AND PLACED ON TOP OF THE DISPOSAL EMBANKMENT. BORINGS AND PIEZOCONES IN THIS AREA THAT WERE ABOVE EXISTING GRADE ARE NOT SHOWN.
4. THE LYSIMETERS AND WELLS INSTALLED IN 1990 HAVE BEEN ABANDONED.
5. AT LOCATION L1 NO LYSIMETER OR WELL WAS INSTALLED.

LEGEND:

- PIEZOCONE SOUNDINGS
- BORINGS
- BORING AND PIEZOCONE SOUNDING IN SAME LOCATION
- TEST PITS
- TEST PIT AND PIEZOCONE SOUNDING IN SAME LOCATION
- MONITOR WELLS
- 2"DIA. PVC WELL (1990)
- LYSIMETER HOLE (1990)

QA REVIEWED FOR QUALITY REQUIREMENTS BY: 02/03/92

200 0 200 400
SCALE FEET

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK M. GRIFFIN STATE OF UTAH

QA MR-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
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SPA 02/03/92	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY

ALBUQUERQUE, NEW MEXICO

MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

HAT-BORING LOCATION PLAN

DESIGNED CLW | DRAWN RBC | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE 1/31/92

DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UHTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-DS-10-0221 | REV. 0

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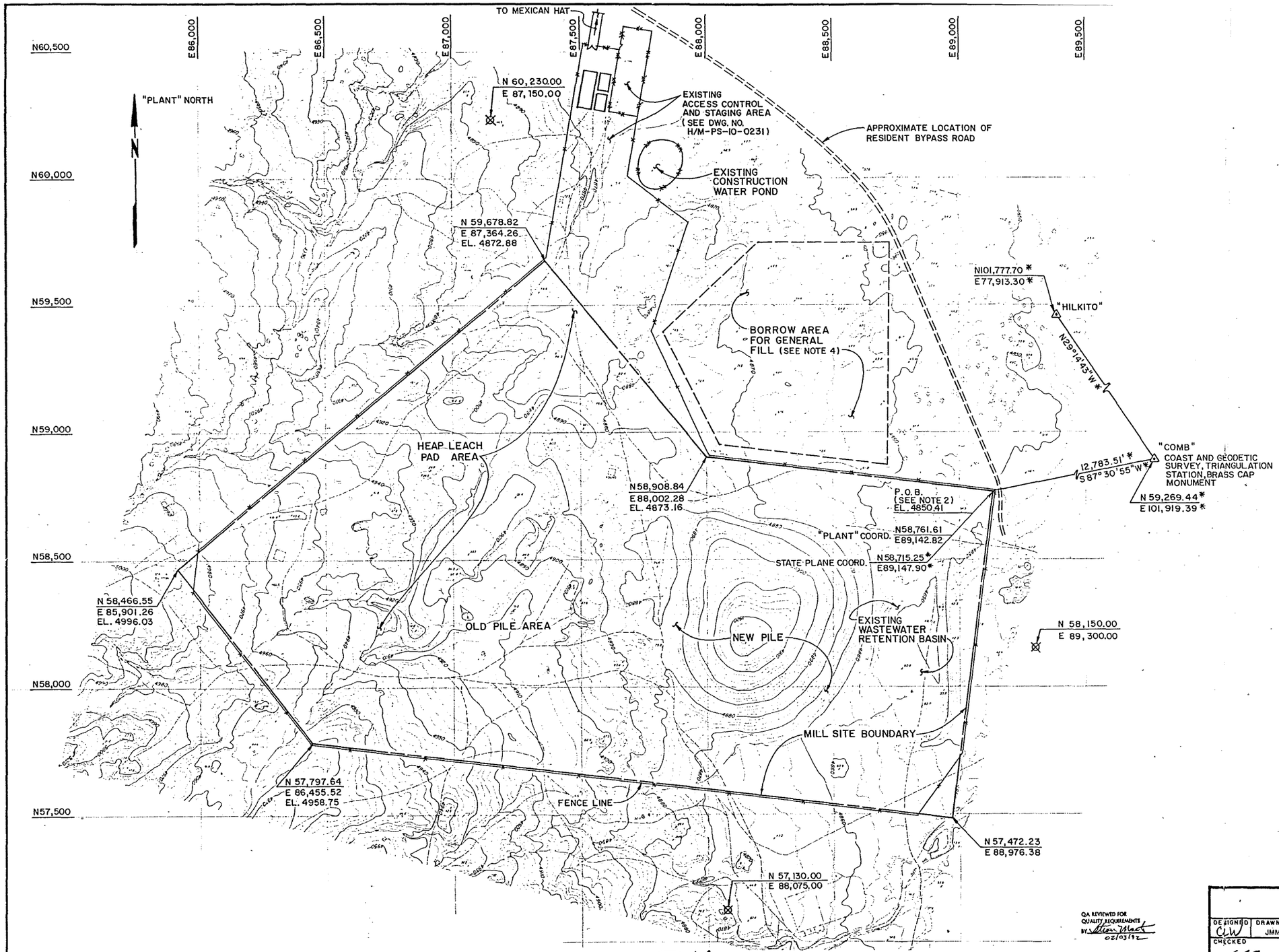
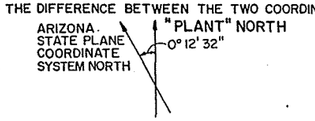


NOTES:

1. ALL INFORMATION SHOWN IS BASED ON "PLANT" COORDINATES UNLESS NOTED OTHERWISE WITH AN ASTERISK (*). INFORMATION SHOWN WITH AN ASTERISK (*) IS BASED ON ARIZONA STATE PLANE COORDINATES.
2. THE DIFFERENCE BETWEEN THE TWO COORDINATE SYSTEMS IS:



3. TOPOGRAPHIC FEATURES, GRID SYSTEM AND PROPERTY OWNERSHIP ARE TAKEN FROM THE RECORD OF SURVEY FURNISHED BY JACOBS ENGINEERING GROUP, INC. IN MARCH 1984.
4. BEFORE USING COMMON FILL FROM BORROW AREA, SUBCONTRACTOR SHALL USE COMMON FILL AVAILABLE WITHIN THE SITE BOUNDARY AS DIRECTED BY THE CONTRACTOR.

REFERENCE DRAWINGS:

H/M-PS-10-0231 MON-CONSTRUCTION FACILITIES AND SITE DRAINAGE

LEGEND:

- 4690 — EXISTING SITE FEATURES AND CONTOURS
- N61,000 — CONSTRUCTION GRID-"PLANT" COORDINATE SYSTEM
- EXISTING WOVEN WIRE FENCE
- EXISTING CHAIN LINK FENCE
- MILL SITE BOUNDARY
- SURVEY MONUMENT
- AIR MONITORING STATION

200 0 200 400
SCALE FEET

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/03/92

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK M. GRIFFIN STATE OF UTAH

QA MX-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

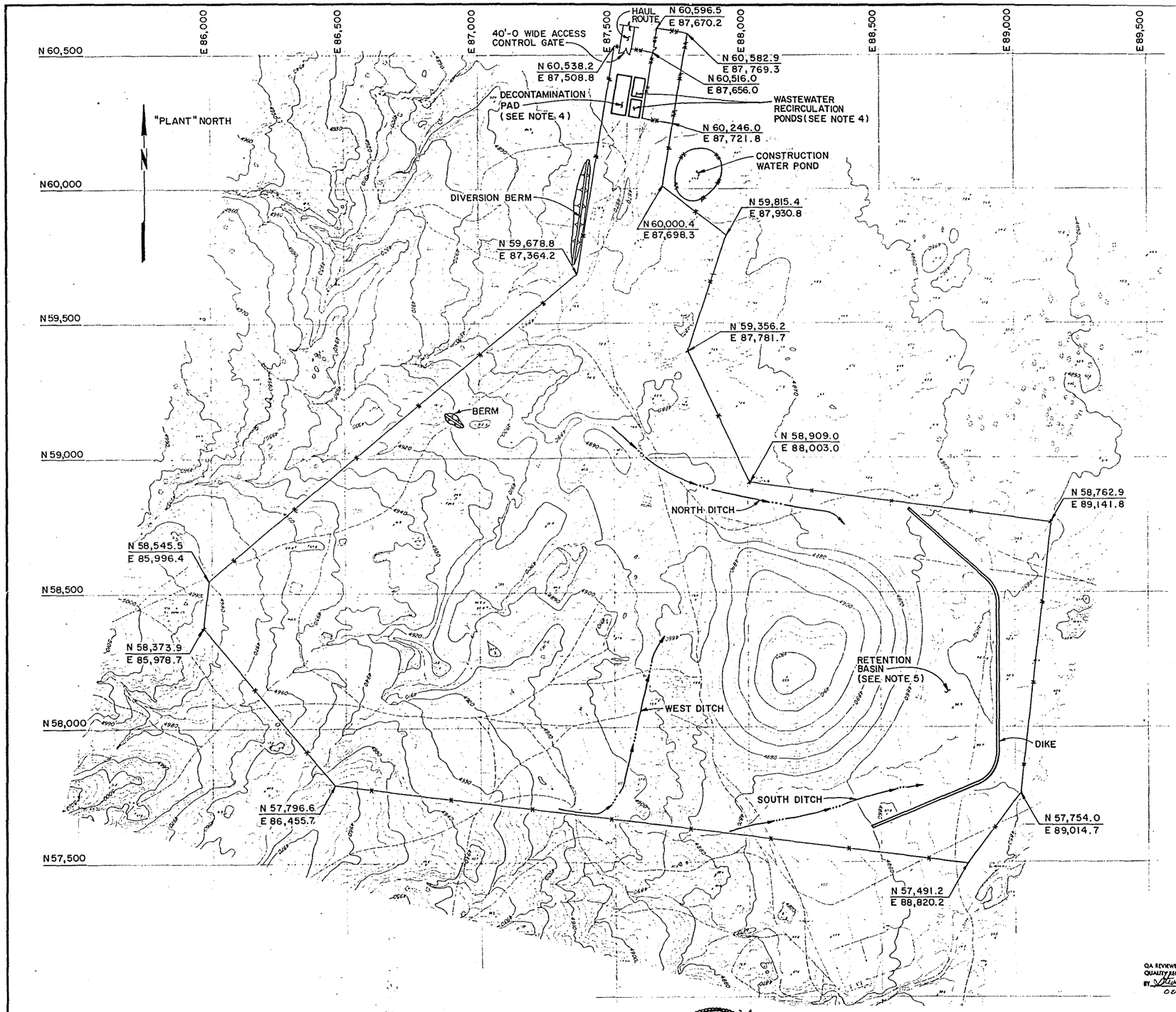
MON-SITE PLAN

DESIGNED CLW | DRAWN JMM | CHECKED SAR | INSPECTED | RECOMMENDED | APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-PS-10-0230 | REV 0



NOTES:

1. ALL COORDINATES SHOWN ARE "PLANT" COORDINATES UNLESS NOTED OTHERWISE.
2. ALL RUNOFF FROM DISTURBED CONTAMINATED AREAS OF THE SITE SHALL BE DIRECTED TO THE WASTEWATER RETENTION BASIN AND CATCHMENT AREAS. THE SUBCONTRACTOR SHALL MAINTAIN EXISTING OR ESTABLISH A NEW DRAINAGE PATTERN WITHIN ALL WORK AREAS.
3. THE CATCHMENT AREAS ARE EXISTING LOW SPOTS THAT SHALL BE UTILIZED AS RETENTION BASINS. SEE SECTION 02141, ARTICLE 1.3 PARAGRAPH A OF THE SPECIFICATIONS. WATER IN THE CATCHMENT AREA MAY BE USED FOR DUST CONTROL IN CONTAMINATED AREAS.
4. SEE THE INFORMATION FOR BIDDERS FOR THE DECONTAMINATION PAD AND WASTEWATER RECIRCULATION POND DETAILS.
5. FOR DETAILS OF RETENTION BASIN SEE INFORMATION FOR BIDDERS.
6. ALL FACILITIES SHOWN ARE EXISTING.
7. OFF SITE PARKING SHALL BE ON THE ABANDONED AIRSTRIP ADJACENT TO THE HAUL ROAD OR AS APPROVED BY THE CONTRACTOR.

REFERENCE DRAWINGS:

LEGEND:

- 4690 — EXISTING SITE FEATURES AND CONTOURS
- N61,000 — CONSTRUCTION GRID "PLANT" COORDINATE SYSTEM
- EXISTING WOVEN WIRE FENCE
- EXISTING CHAIN LINK FENCE
- TEMPORARY DRAINAGE DITCH
- TOP OF CUT

200 0 200 400
SCALE FEET

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/03/92

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK F. GRIFFIN 31 JAN 1992 STATE OF UTAH

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP
	△								
	△								
	△								
	△								
SPM 02/03/92	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CLW | DRAWN JMM | CHECKED | INSPECTED JCK | RECOMMENDED

MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

MON-CONSTRUCTION FACILITIES AND SITE DRAINAGE

APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-PS-10-0231 | REV 0

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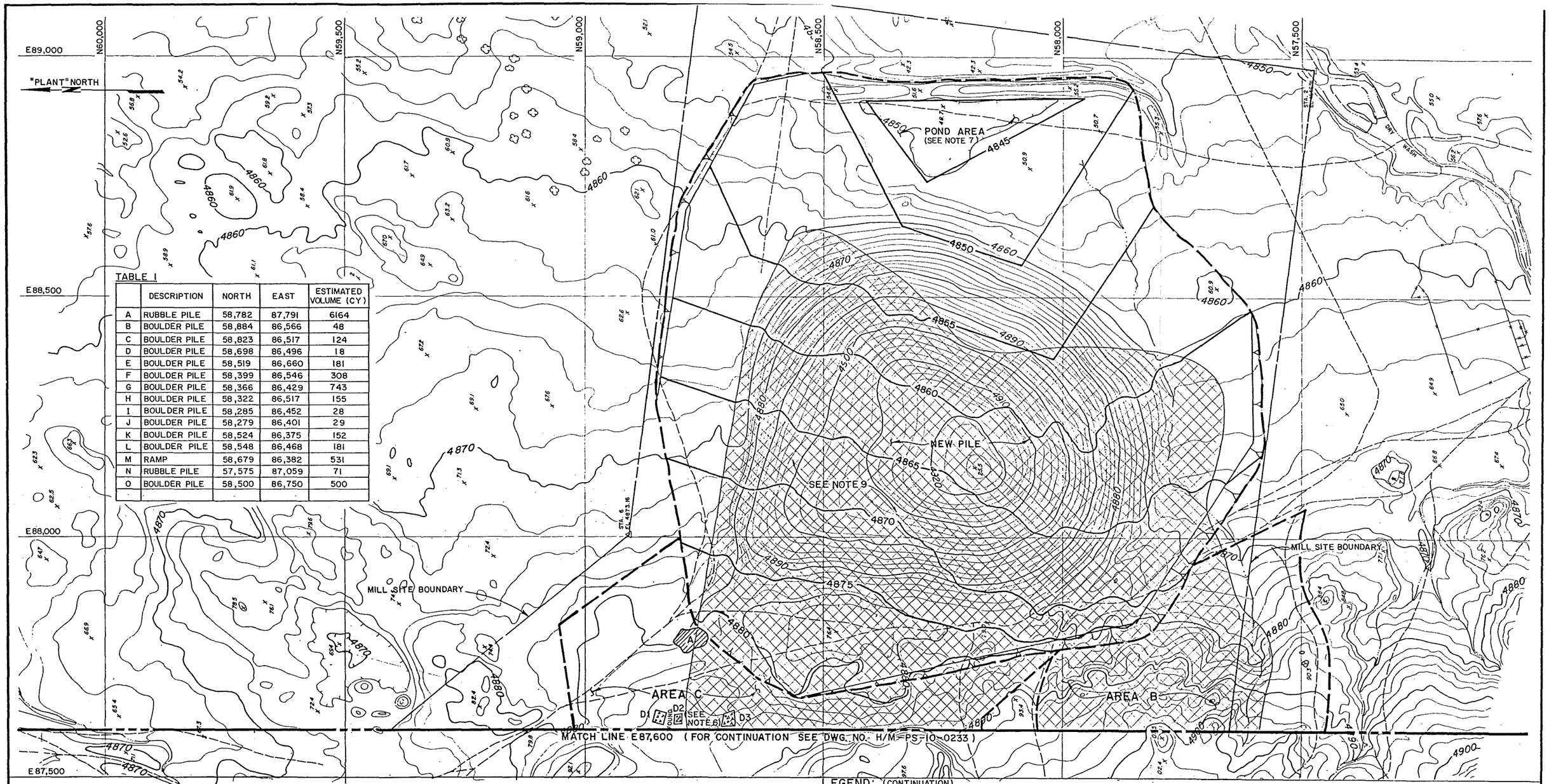


TABLE I

	DESCRIPTION	NORTH	EAST	ESTIMATED VOLUME (CY)
A	RUBBLE PILE	58,782	87,791	6164
B	BOULDER PILE	58,884	86,566	48
C	BOULDER PILE	58,823	86,517	124
D	BOULDER PILE	58,698	86,496	18
E	BOULDER PILE	58,519	86,660	181
F	BOULDER PILE	58,399	86,546	308
G	BOULDER PILE	58,366	86,429	743
H	BOULDER PILE	58,322	86,517	155
I	BOULDER PILE	58,285	86,452	28
J	BOULDER PILE	58,279	86,401	29
K	BOULDER PILE	58,524	86,375	152
L	BOULDER PILE	58,548	86,468	181
M	RAMP	58,679	86,382	531
N	RUBBLE PILE	57,575	87,059	71
O	BOULDER PILE	58,500	86,750	500

NOTES:

1. EXCAVATION OF CONTAMINATED MATERIAL IN AREAS A, B, C, E AND THE OLD PILE WILL BE AT THE DIRECTION OF THE CONTRACTOR IN THE FIELD. DEPTHS OF CONTAMINATION IN AREAS C, E AND THE OLD PILE AVERAGE 1 FOOT; HOWEVER THE ROCKY TERRAIN MAY PROHIBIT LEVEL EXCAVATION.
2. EXCAVATION PLAN SHOWN IS APPROXIMATE. FINAL EXCAVATION LIMITS WILL BE AS DETERMINED BY THE CONTRACTOR.
3. EXCAVATED SLOPES SHALL NOT EXCEED 2(H):1(V) FOR CUTS IN SOIL. ROCK SLOPES SHALL BE AS DIRECTED BY THE CONTRACTOR.
4. THE AREAS SHOWN ARE BASED ON THE BENDIX REPORT WHICH IS INCLUDED IN THE INFORMATION FOR BIDDERS.
5. LOCATIONS AND QUANTITIES FOR RUBBLE AND BOULDER PILES (SEE TABLE 1) SUPERCEDE THE VALUES GIVEN IN THE BENDIX REPORT.
6. LOCATION OF FACILITIES TO BE DEMOLISHED ARE APPROXIMATE AND WILL BE VERIFIED IN THE FIELD.
7. THE POND LINER AND ANY UNDERLYING CONTAMINATED MATERIAL SHALL BE REMOVED AFTER ALL OTHER CONTAMINATED MATERIALS AT THE MONUMENT VALLEY SITE HAVE BEEN REMOVED.
8. ALL COORDINATES SHOWN ARE "PLANT" COORDINATES UNLESS NOTED OTHERWISE.
9. SURFACE AND CONDITION OF ROCK UNDER CONTAMINATED MATERIALS ARE IRREGULAR AND VARY WIDELY.

REFERENCE DRAWINGS:

H/M-PS-10-0233 MON-CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 2 OF 2)

LEGEND:

TOP OF CUT

REGISTERED PROFESSIONAL ENGINEER — PATRICK M. GRIFFIN — 31 Jan 92 — STATE OF UTAH

LEGEND: (CONTINUATION)

—4870— APPROX. BOTTOM CONTOURS OF EXCAVATIONS

LIMIT OF CONTAMINATED AREA

MILL SITE BOUNDARY

(A) NOT TO SCALE RUBBLE OR BOULDER PILE (SEE NOTE 5 AND TABLE 1)

D1 FACILITY TO BE DEMOLISHED AND ID NUMBERS SEE INFORMATION FOR BIDDERS FOR DETAILS

AREA OF ROCK CLEANUP

CA REVIEWED FOR QUALITY REQUIREMENTS BY Steven Marks 02/05/92

SCALE 100 0 100 200 FEET

QA MK+F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
SPM 2/1/92	0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

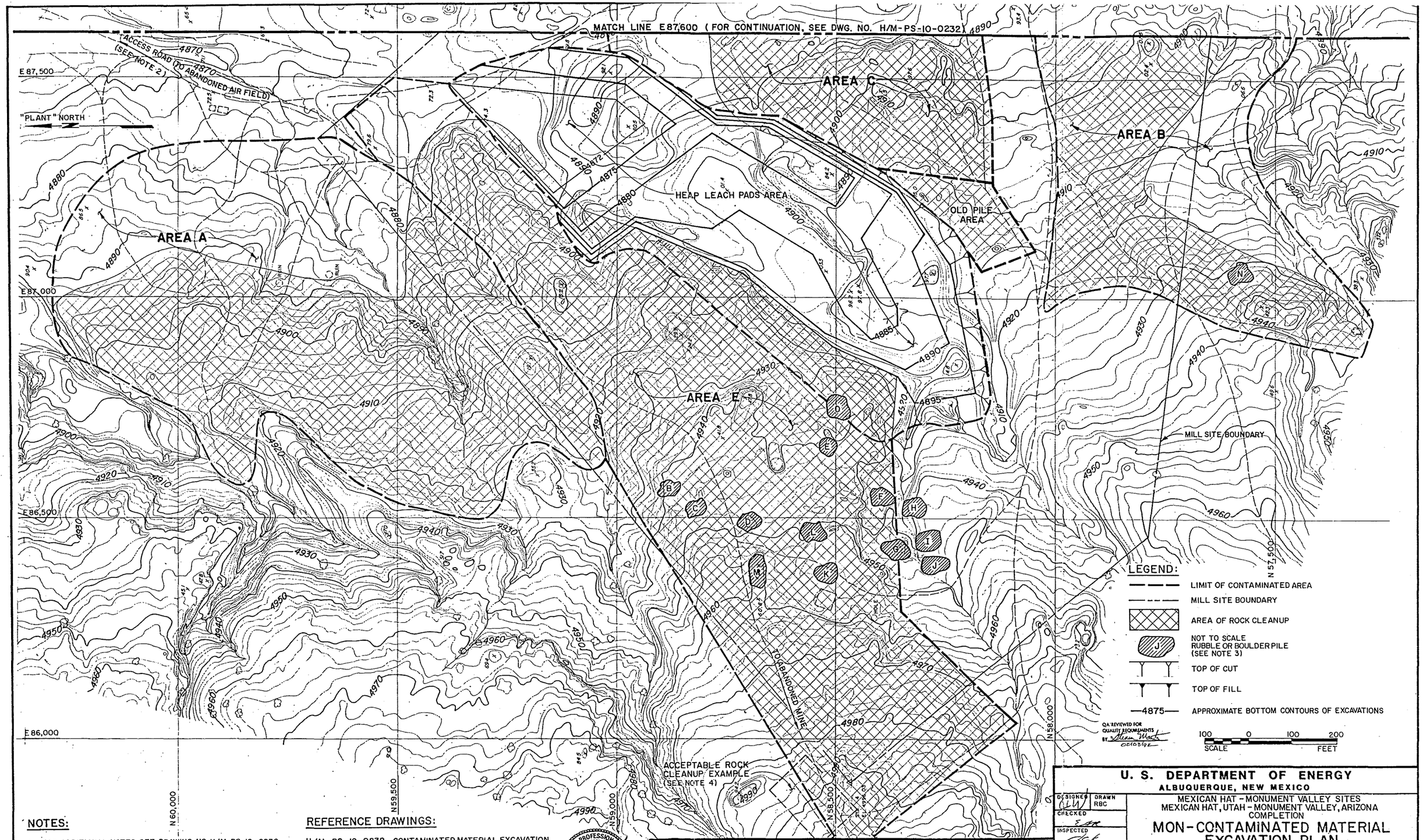
MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

MON-CONTAMINATED MATERIAL EXCAVATION PLAN
(SHEET 1 OF 2)

DESIGNED CW | DRAWN RBC | CHECKED EAB | INSPECTED PK | RECOMMENDED JP Clem | APPROVED JH Sud | DATE 1/31/92 | Pat Griffin | DOE PROJECT ENGINEER Steve Hemp | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. H/M-PS-10-0232
REV. 0



NOTES:

1. FOR ADDITIONAL NOTES SEE DRAWING NO. H/M-PS-10-0232.
2. CONTAMINATED MATERIALS SHALL BE REMOVED WITHIN 100' FROM THE CENTERLINE OF THE ACCESS ROAD TO THE ABANDONED AIRFIELD TO NORTHING 63,400.
3. SEE TABLE I ON DWG. NO. H/M-PS-10-0232 FOR THE COORDINATES AND VOLUMES OF THE RUBBLE AND BOULDER PILES.
4. THE FINAL ROCK SURFACE OF OFF-PILE CLEANUP SHALL BE SIMILAR TO THE ACCEPTABLE ROCK CLEANUP EXAMPLE AREA OR AS APPROVED BY THE CONTRACTOR.

REFERENCE DRAWINGS:

H/M-PS-10-0232 CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 1 OF 2)

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK M. GRIFFIN STATE OF UTAH

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
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U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT - MONUMENT VALLEY SITES
MEXICAN HAT, UTAH - MONUMENT VALLEY, ARIZONA
COMPLETION

MON-CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 2 OF 2)

DESIGNED GLW | DRAWN RBC | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
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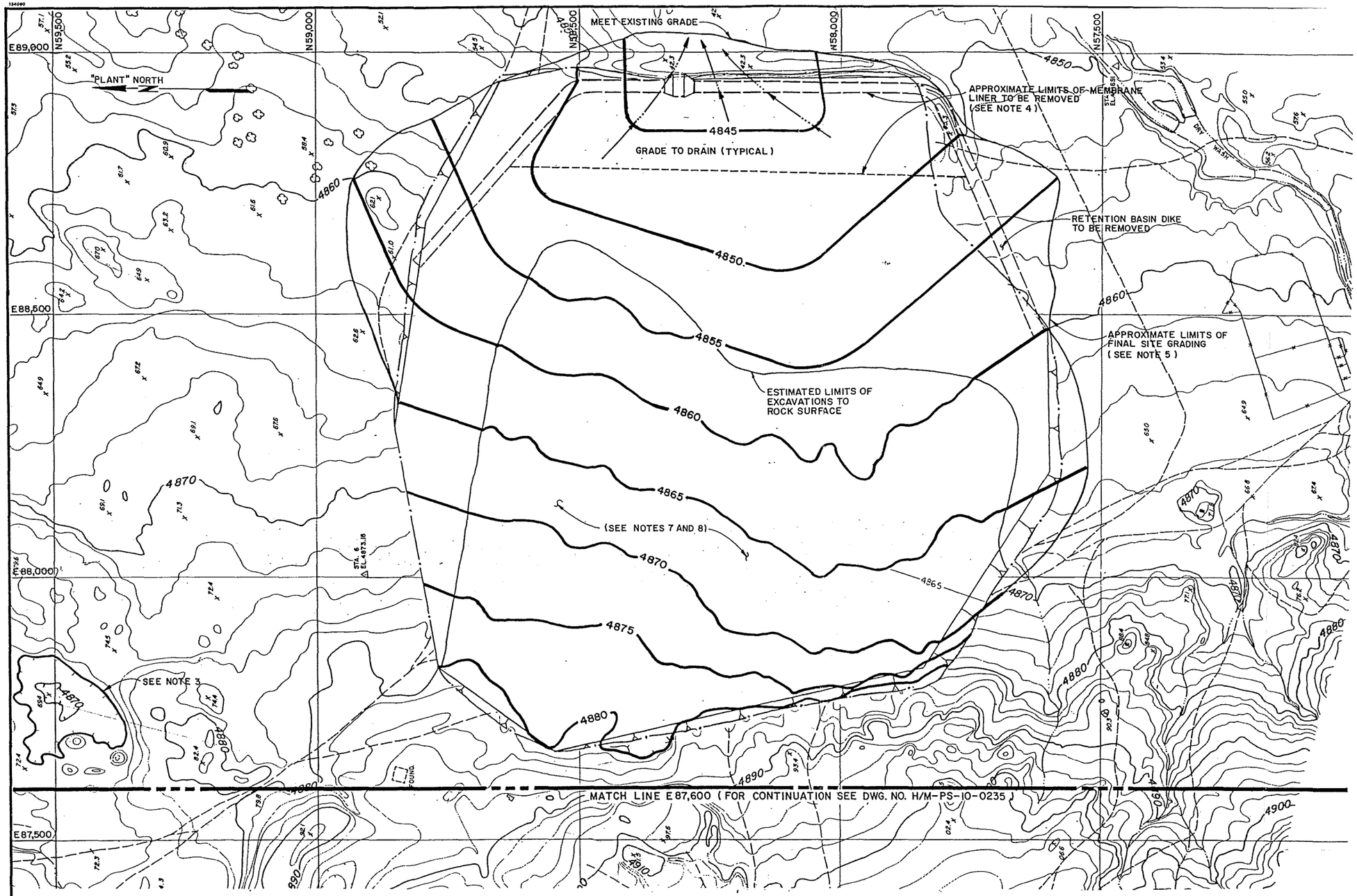
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-PS-10-0233 REV. 0



NOTES:

1. FINAL GRADES MAY BE ADJUSTED BY THE CONTRACTOR BASED ON THE FINAL EXCAVATION DEPTHS.
2. SLOPES IN THE FINAL GRADES SHALL NOT BE STEEPER THAN 5(H):1(V) IN SOIL. ROCK SLOPES SHALL BE AS DIRECTED BY THE CONTRACTOR.
3. FILL IN DEPRESSIONS (e.g. CONSTRUCTION WATER POND) AND GRADE TO DRAIN AS DIRECTED BY THE CONTRACTOR.
4. SEE INFORMATION FOR BIDDERS FOR RETENTION BASIN DETAILS.
5. LIMITS OF FINAL SITE GRADING WILL BE DETERMINED BY THE CONTRACTOR. ACTUAL LIMIT WILL DEPEND ON LIMITS OF CONTAMINATED MATERIAL REMOVAL, TERRAIN AND TYPE OF GROUND SURFACE.
6. ALL COORDINATES SHOWN ARE "PLANT" COORDINATES UNLESS NOTED OTHERWISE.
7. WHERE CONTAMINATED MATERIAL IS REMOVED DOWN TO ROCK SURFACE, FINAL SURFACE WILL BE UNEVEN AND VARY WIDELY. SEE EXAMPLE AREA OF ACCEPTABLE ROCK ON DWG. NO. H/M-PS-10-0233.
8. WHERE CONTAMINATED MATERIAL IS REMOVED DOWN TO ROCK SURFACE, FINAL GRADING WILL BE LIMITED TO PROVIDING POSITIVE DRAINAGE AS DIRECTED BY THE CONTRACTOR.
9. ALL TEMPORARY BERMS SHALL BE REMOVED AND ALL TEMPORARY DITCHES FILLED IN. EXCAVATED AREAS IN SOIL SHALL BE REGRADED TO DRAIN AS DIRECTED BY THE CONTRACTOR.

REFERENCE DRAWINGS:

H/M-PS-10-0233	MON-CONTAMINATED MATERIAL EXCAVATION PLAN (SHEET 2 OF 2)
H/M-PS-10-0235	MON-FINAL SITE GRADING AND DRAINAGE PLAN (SHEET 2 OF 2)

LEGEND:

- 4860 — FINAL CONTOURS
- TOP OF SLOPE
- 4690 — EXISTING CONTOURS
- TOP OF CUT
- TOP OF FILL
- 4865 — ESTIMATED EXCAVATION CONTOUR
- SURFACE WATER FLOWPATH

SCALE 100 0 100 200 FEET

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/05/92

REGISTERED PROFESSIONAL ENGINEER No. 7346 PATRICK M. GRIFFIN STATE OF UTAH

NO.	DATE	REVISIONS	BY	CK	E&D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
0	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

QA MK-F

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CW DRAWN JMM
CHECKED
INSPECTED
RECOMMENDED

MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

MON-FINAL SITE GRADING AND DRAINAGE

(SHEET 1 OF 2)

APPROVED 1/31/92 DOE PROJECT ENGINEER DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-PS-10-0234 REV. 0

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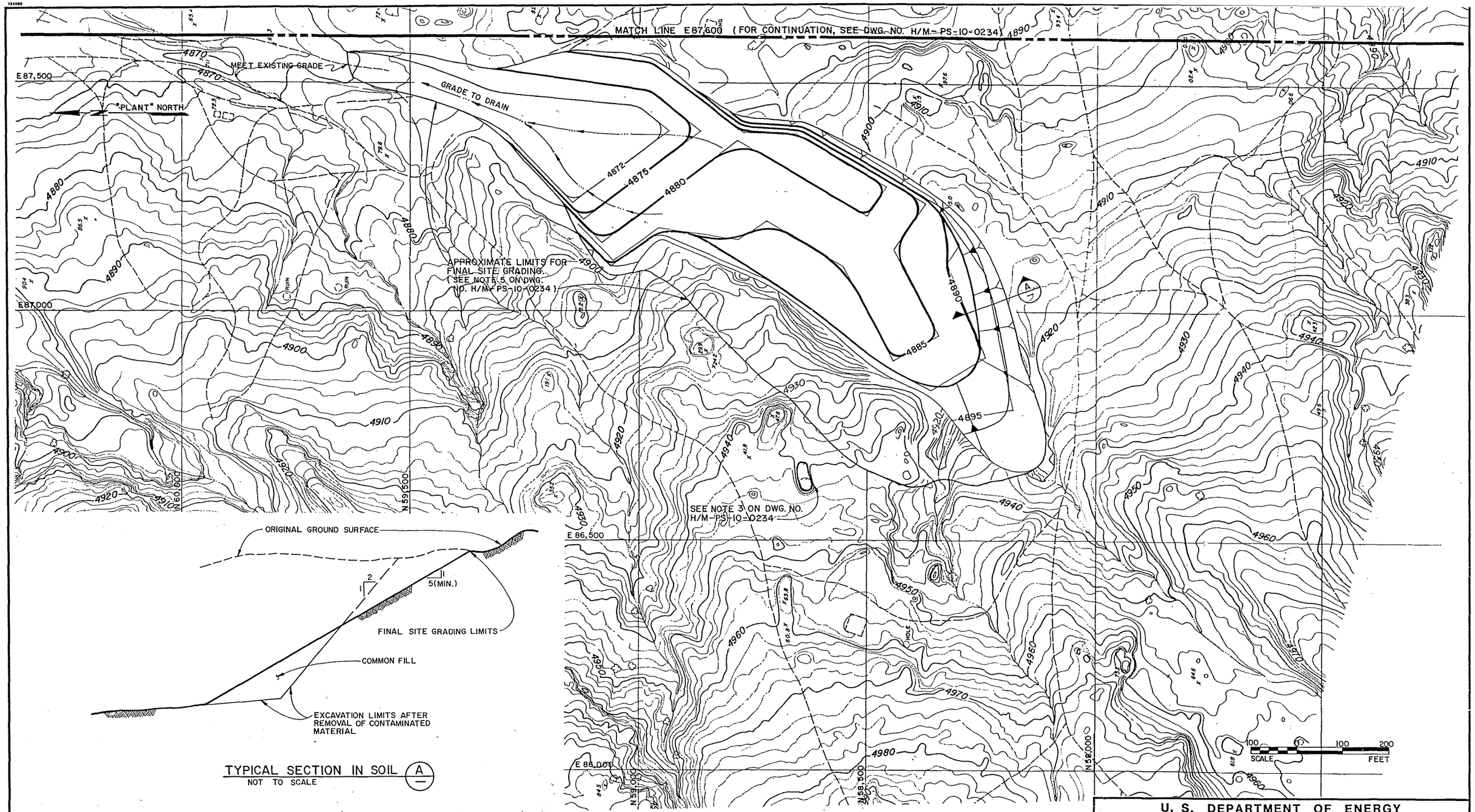

TYPICAL SECTION IN SOIL (A/—)
NOT TO SCALE

NOTE:

FOR NOTES AND LEGEND SEE DWG. NO. H/M-PS-10-0234

REFERENCE DRAWING:

H/M-PS-10-0234 MON-FINAL SITE GRADING AND DRAINAGE PLAN (SHEET 1 OF 2)

REGISTERED PROFESSIONAL ENGINEER — No. 7346 — PATRICK H. GRIFFEN — 31 Jan 92 — STATE OF UTAH

QA REVIEWED FOR QUALITY REQUIREMENTS BY: 02/03/92

QA MK-F	NO.	DATE	REVISIONS	BY	CK	EGD MGR.	CHIEF ENG.	QA MGR.	DOE APP.
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	△	1/31/92	ISSUED FOR CONSTRUCTION	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

MON-FINAL SITE GRADING AND DRAINAGE
(SHEET 2 OF 2)

DESIGNED CLW	DRAWN JMM		
CHECKED			
INSPECTED			
RECOMMENDED			
APPROVED J. A. Saul	DATE 1/31/92	DOE PROJECT ENGINEER	DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796
DRAWING NO. H/M-PS-10-0235
REV. 0

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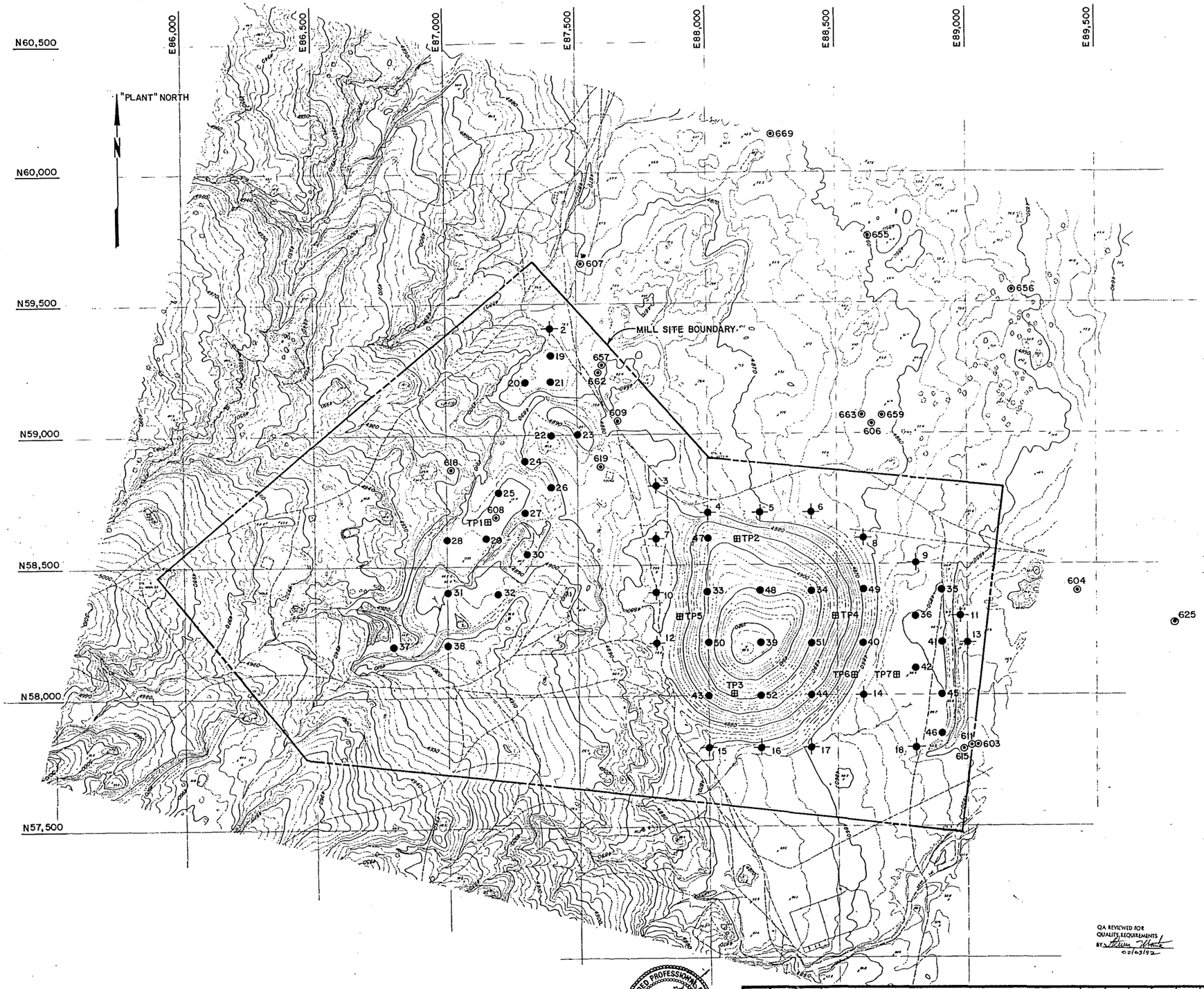

NOTES:

1. THE LOCATIONS SHOWN ON THIS DRAWING ARE APPROXIMATE.
2. WELL NOS. 678, 619 AND 625 WERE IDENTIFIED AS FORMER PRODUCTION WELLS FOR THE MILL.
3. ALL COORDINATES SHOWN ARE "PLANT" COORDINATES UNLESS NOTED OTHERWISE.
4. MONITOR WELL 608 HAS BEEN SEALED.

REFERENCE DRAWINGS:

LEGEND:

●19	BOREHOLE BY JACOBS ENGINEERING GROUP, INC. (1985)
⊙603	MONITOR WELL BY JACOBS ENGINEERING GROUP, INC. (1985)
⊞TP1	TEST PIT BY JACOBS ENGINEERING GROUP, INC. (1984)
✦18	RADIOLOGICAL HOLES (1985)

200 0 200 400
SCALE FEET

QA REVIEWED FOR QUALITY REQUIREMENTS BY 02/03/92

REGISTERED PROFESSIONAL ENGINEER NO. 7346 PATRICK M. GRIFFIN STATE OF UTAH

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E & D MGR.	CHIEF ENG.	QA MGR.	DOE APP.
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U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED CW | DRAWN RBC/ | CHECKED | INSPECTED | RECOMMENDED | APPROVED

MEXICAN HAT – MONUMENT VALLEY SITES
MEXICAN HAT, UTAH – MONUMENT VALLEY, ARIZONA
COMPLETION

MON-BORINGS, TEST PITS AND MONITORING WELLS LOCATION PLAN

DATE 1/31/92 | DOE PROJECT ENGINEER | DATE 2/3/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. H/M-PS-10-0236 | REV. 0

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United States Department of Energy

SURF008884

Remedial Action Plan for the Codisposal and Stabilization of the Monument Valley and Mexican Hat Uranium Mill Tailings at Mexican Hat, Utah

Appendices C, D, and E

Final

February 1993

UMTRA Project Document
Control Center
FILE COPY

Appendix B of the
Cooperative Agreement
No. DE-FC04-83AL16258

Uranium Mill Tailings Remedial Action Project

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SMON 13.1.1

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APPENDIX C

RADIOLOGICAL SUPPORT PLAN

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C.1 INTRODUCTION

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (PL95-604) gave the responsibility of developing standards for remedial action to the U.S. Environmental Protection Agency (EPA). Section 108 of PL95-604 states that the DOE shall "select and perform remedial actions at the designated processing sites and disposal sites in accordance with the general standards" prescribed by the EPA. The EPA standards state:

> "Section 108 of the Act requires the Secretary of Energy to select and perform remedial actions with the concurrence of the Nuclear Regulatory Commission and the full participation of any State that pays part of the cost, and in consultation, as appropriate, with affected Indian Tribes and the Secretary of the Interior. These parties, in their respective roles under Section 108, are referred to hereafter as 'the implementing agencies.'
>
> The implementing agencies shall establish methods and procedures to provide 'reasonable assurance' that the provisions of Subparts A and B are satisfied. This should be done primarily through use of analytical models, in the case of Subpart A, and for Subpart B through measurements performed within the accuracy of currently available types of field and sampling procedures. These methods and procedures may be varied to suit conditions at specific sites."

Subpart B consists of standards for cleanup of land and buildings. The standards applicable to the project are:

> "Remedial actions shall be conducted so as to provide reasonable assurance that, <u>as a result of residual radioactive materials from any designated processing site</u>:
>
> A. the concentration of Radium-226 in land averaged over an area of 100 square meters shall not exceed the background level by more than --
>
> (1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and
>
> (2) 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.
>
> B. in any occupied or habitable building --
>
> (1) the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and
>
> (2) the level of gamma radiation shall not exceed the background level by more than 20 microR/h."

In addition to the EPA standards for buildings, removable surface alpha contamination shall not exceed 1000 dpm/100 cm^2, and the total nonremovable alpha contamination shall not exceed 5000 dpm/100 cm^2. This limit will ensure that potential airborne radionuclide concentrations will not exceed 10 CFR Part 20 Appendix B standards, and that physical contact with the surfaces by occupants of the structures will not result in a measurable radiation exposure.

As indicated earlier, the standards suggest that the implementing agencies determine what methods and procedures will be used to provide "reasonable assurance" that the standards are met. Reasonable assurance implies that a site-specific analysis is appropriate where the cost of demonstrating compliance with the standards is to be weighed against the health risks or other impacts associated with leaving areas that slightly exceed the standards.

The following sections provide the procedures proposed for use at the Monument Valley and Mexican Hat sites. Consideration was given to the time required to collect samples and perform the analyses.

C.2 BASIS FOR RADIOLOGICAL SURVEY STRATEGY

The Monument Valley and Mexican Hat sites consist of tailings piles, mill and ore storage areas, and areas of windblown contamination. Excavations will range from removal of surficial contamination to several feet in depth. Except for backfill required to provide an appropriate drainage pattern, backfilling of excavated areas will not be needed. For most of the excavated area, residual contamination should not exceed 5 picocuries per gram (pCi/g) each of radium-226 (Ra-226), Ra-228, Th-230, and Th-232 above the naturally present concentration. Based on the EPA standards cited above, an area average concentration from 100 square meters will be used.

In areas where backfilling to grade is required, uncontaminated fill will be used and will minimize the potential health effects due to slight residual contamination. In these areas, EPA standards allow 15 pCi/g of residual Ra-226 if the backfill is at least six inches thick.

All structures at the Monument Valley site have been demolished and removed from the site. All structures at the Mexican Hat site except the sheet metal shop and former clinic building have been demolished. The sheet metal shop is the only building that will require decontamination and verification measurements.

C.3 REMEDIAL ACTION RADIOLOGICAL SURVEY PLAN

Radiological surveys are performed for three purposes: site characterization, excavation control, and final radiological verification. Site characterization surveys, or pre-remedial action surveys, are performed to identify volumes of material that exceed the standard. The results are used for planning and engineering design. Excavation control monitoring is performed as the work is being done to guide and control the amount of contaminated material removed. Finally, when excavation control monitoring results indicate that the area meets the standards, a final radiological survey is carefully performed and the results documented.

C.3.1 SITE CHARACTERIZATION SURVEYS

Field sampling programs at the Mexican Hat site conducted by Mountain States Research and Development (MSRD) and by Bendix Field Engineering Corporation (BFEC) have been used to identify the subsurface boundary of the tailings pile, as well as the depth and area of the mill yard, ore storage, and windblown contaminated areas. Subsurface evaluations were performed using gamma well logging techniques and by analyzing cores from boreholes. In general, boreholes and surface measurements and samples were made on grids ranging from 100 by 100 feet to 200 by 300 feet. Additional measurements were performed in areas of radiological interest. The grid points have been identified by a land survey tied to a state plane survey point. All recordable data were located by these coordinates.

Field sampling programs at the Monument Valley site were conducted by BFEC. The results have been used to identify the subsurface boundary of the tailings pile, as well as the depth and area of contamination of the former mill yard, ore storage, evaporation pond, and windblown contaminated areas. Subsurface evaluations were performed using gamma well logging techniques and by analyzing cores from boreholes. In general, boreholes and surface measurements and samples were made on grids ranging from 100 by 100 feet to 200 by 300 feet. Additional measurements were performed in areas of radiological interest. The grid points have been identified by a land survey tied to a state plane coordinate system. All recordable data were located by these coordinates.

C.3.2 EXCAVATION CONTROL MONITORING

The purpose of excavation control monitoring is to guide excavation through the use of real-time radiological measurements. It is designed to ensure that the 5 pCi/g (surface) and 15 pCi/g (subsurface) Ra-226 standards are met. In addition, it minimizes the possibility that material meeting the standards is also excavated. Properly performed excavation control monitoring simultaneously ensures that neither under-excavation nor over-excavation occurs.

Excavation will be monitored by qualified technicians relying principally on gamma field measurements employing hand-held instruments such as gamma-scintillation detectors. This technique will be used only where measurements are not seriously impaired by interference from nearby tailings deposits. In areas where significant interference exists, alternate monitoring techniques will be used. These techniques may include use of a shielded probe gamma-scintillation instrument (operated in a gross count mode or in a delta mode) or the immediate counting of soil samples. In all cases, these techniques will be routinely calibrated by comparing the field measurements to soil samples analyzed in the laboratory, and reported on a fully equilibrated dry-weight basis. Because the standards are based on average areas of 100 square meters (m^2), the excavation control monitoring will be performed on areas of this characteristic size as well.

Elevated gamma-ray radiation fields will preclude exclusive use of in-situ monitoring devices to estimate the surface radionuclide concentrations in soil on or immediately adjacent to the tailings pile. When in-situ measurements cannot be performed, the suggested method for analysis is to take individual or composite samples of soil, seal by canning, and immediately count the sample by gamma-ray spectrometry. Errors associated with this approach will be reduced by taking several samples 30 days prior to starting work to determine calibration factors. They will be counted later after the Ra-226 daughters reach equilibrium. Analyses of these prepared samples can then be compared to standards. Several samples will be collected weekly during the remedial action and analyzed to provide a measure of the variation of the calibration factor.

Additional excavation control procedures may be necessary for monitoring of thorium-230 (Th-230).

C.3.3 BUILDING DECONTAMINATION CONTROL MONITORING

Only the sheet metal shop will require radiological measurements. All of the buildings except the former health clinic and the sheet metal shop have been demolished.

C.3.4 FINAL RADIOLOGICAL VERIFICATION SURVEY FOR LAND

The final radiological survey will be based on 100-m^2 areas, with a composite sample used to obtain a measure of the average Ra-226 concentration in an area. The radium measurement will be reported on a dry-weight basis. For measurements based on gamma spectrometry of radium daughters, full equilibrium will be assured. It is expected that at least preliminary measurement results will be obtained prior to back-filling.

The average Ra-226 concentration on each 100-m^2 area surveyed will be determined by a composite sample composed of nine 15-cm-deep samples of approximately equal mass taken on a uniform spacing over the survey area. Other sampling protocols may be used, if they are shown to

characterize the mean concentration adequately and approved in advance by the UMTRA Project Office.

After the radon barrier has been put on the tailings pile, measurements will be made to ensure that the radon emission rate is less than 20 pCi/m^2s.

C.3.5 FINAL RADIOLOGICAL VERIFICATION SURVEY FOR BUILDINGS

The former health clinic has been surveyed and found to be free of contamination. The sheet metal shop will require radiological verification, including radon monitoring, following decontamination.

C.4 DATA AND SAMPLE MANAGEMENT

During the cleanup operations, the Remedial Action Contractor (RAC) will collect data to support excavation control. Data used in declaring an area adequately decontaminated will be documented in a format approved by the UMTRA Project Office.

Site characterization survey data, excavation control data, and the final radiological survey data will be collected using procedures and analytical methods meeting the requirements of the UMTRA Project Quality Assurance Program Plan (DOE, 1990). All data used in describing the final radiological condition of the site, as well as other data as specified by the UMTRA Project Office, will be provided in a convenient format. Data generated in the remedial action will be presented in a report documenting the final radiological condition of the property.

C.5 CERTIFICATION

Certification is a professional judgment by an independent party that the remedial action has been completed according to the site-specific Remedial Action Plan and meets the applicable standards.

During the remedial action operations, the RAC will make data related to the cleanup available to appropriate state agencies, Federal agencies, or UMTRA Project-designated contractors. In addition, samples collected during the cleanup operations may be split for analyses by these agencies to allow comparison of analytical results. These data, along with any additional data collected at the discretion of the certifying agent, will be used in the final certification report.

REFERENCES

DOE (U.S. Department of Energy), 1990. UMTRA Project Quality Assurance Plan, UMTRA-DOE/AL-400324.0195, DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

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APPENDIX D

SITE CHARACTERIZATION

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D.1 INTRODUCTION

This appendix assesses the present conditions relative to the inactive uranium mill site near Mexican Hat, Utah. It consolidates available engineering, radiological, geotechnical, hydrological, meteorological, and other information pertinent to the design of the remedial action plan (RAP). The objective of the data is to characterize the conditions at the mill and tailings site so that the Remedial Action Contractor (RAC) may complete final designs of the remedial action.

For ease in reading, figures and tables are grouped (figures first) at the end of each section of this appendix.

The information contained in this section is based on data collected by the Technical Assistance Contractor (TAC). For final design, additional data were collected and are presented in Information for Bidders, and Calculations, Appendices A and B.

D.1.1 SITE DESCRIPTION

D.1.1.1 Location

The Mexican Hat site is in southeastern Utah at Halchita, 1.5 miles southwest of Mexican Hat, Utah. The site lies within the Navajo Reservation, approximately 50 miles west of Four Corners and approximately nine miles north of the Utah-Arizona border (Figure D.1.1). The site is located at 37° 07'54" north latitude, and 109° 52'30" west longitude.

D.1.1.2 Physical description

The designated mill tailings site (Figure D.1.2) consists of 235 acres and is 0.5 mile southeast of U.S. Highway 163. The site is situated in an arid desert-like environment consisting of low rolling hills and steep washes formed by drainage tributaries of the San Juan River. The San Juan River, approximately one mile from the site, is a perennial stream that drains into the Colorado River.

Prior to Phase I and Phase II remedial activities, the site consisted of two tailings piles, several of the original buildings and structures, and the concrete pad of the former mill building.

The mill yard located on the western portion of the site and the ore storage area covered approximately 19 acres. The mill, several of the associated buildings, and much of the processing equipment have been removed from the site. The former mill office building was used as a health clinic by the Utah Navajo Development Council (UNDC) until it closed in October 1985 (Clah, 1985). The UNDC is a private non-profit organization with offices in Blanding, Utah.

Some dikes were constructed around the piles, but have eroded in several locations. Most of the windblown and water-eroded material is north and east of the lower pile.

D.1.1.3 History

Operations

In 1957, the Texas-Zinc Minerals Corporation built the mill and operated it until 1963. It was then sold to Atlas Corporation, which operated it until it closed in 1965. Approximately 2.2 million tons of ore were processed with an average grade of 0.28 percent uranium oxide (U_3O_8) to produce 5700 tons of U_3O_8 concentrate, which was sold to the U.S. Atomic Energy Commission (AEC). In addition to the uranium operation, a sulfuric acid plant was operated at the site until 1970, after the main plant shut down in 1965.

Process

Much of the ore processed contained large quantities of copper sulfide and other sulfide minerals. Thus, the milling process included grinding the ore and treating it by froth flotation to recover the copper. The flotation concentrates and the tailings were acid-leached separately, with subsequent filtration of the flotation concentrates to recover a final copper product. The filtrate was then combined with the main circuit-leached slurry obtained from the flotation tailings. A five-stage counter-current thickener was used to separate leached solids from the pregnant liquor, which then went through solvent extraction. The organic solvent was stripped with an ammonium nitrate solution. It was then neutralized with magnesium hydroxide to precipitate the final uranium concentrate (FBDU, 1981).

The tailings were piped to the piles after separation in a cyclone separator. Coarse sand that settled near the outside of the pile was used to build the dikes higher, while fines and slimes flowed toward the center of the pile (ORNL, 1982).

Ownership and leaseholders

The mill site leased from the Navajo Nation consisted of a 555-acre tract. When the lease expired in 1970, control of the site and all structures and materials on the site reverted to the Navajo Nation.

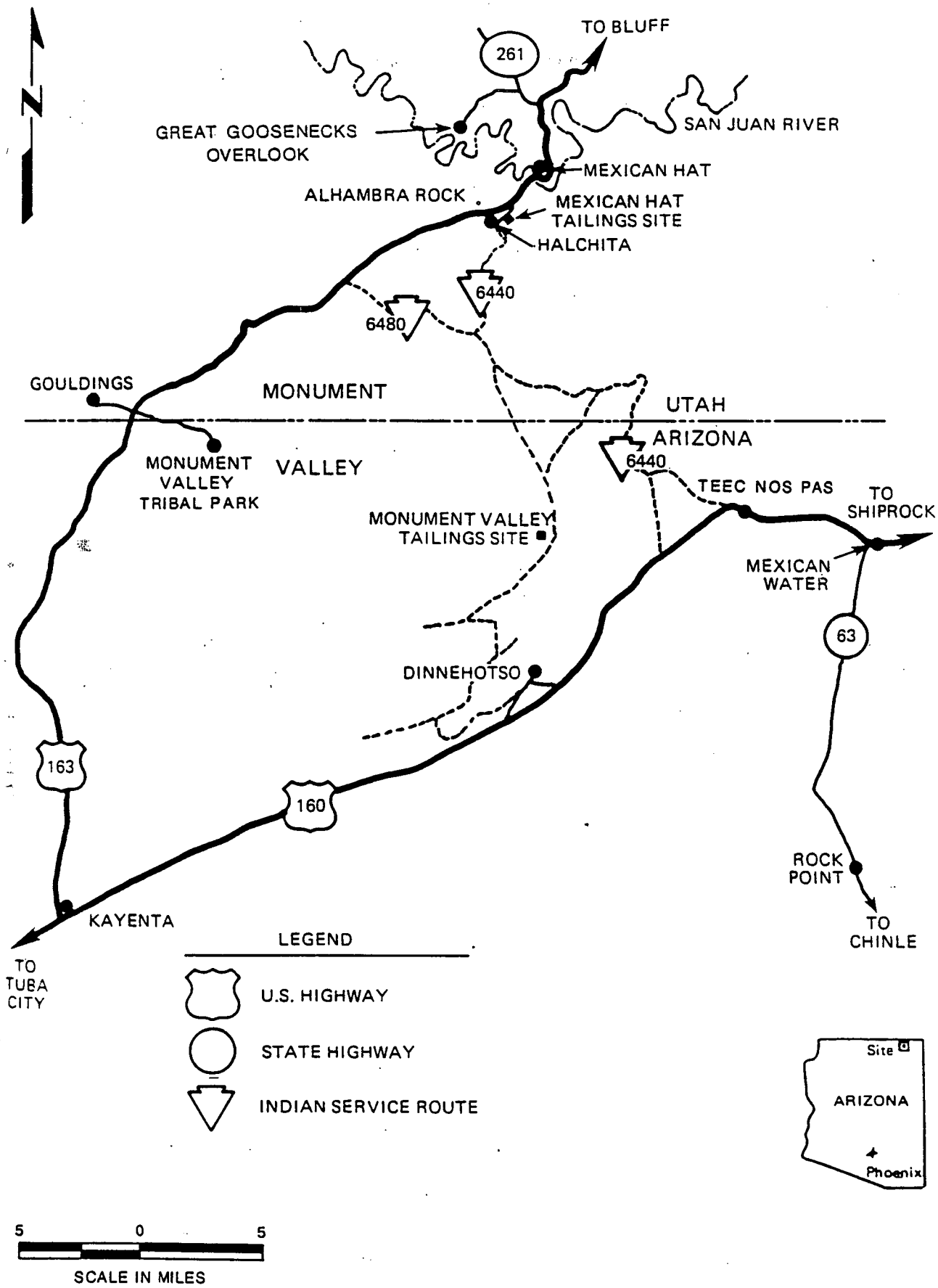
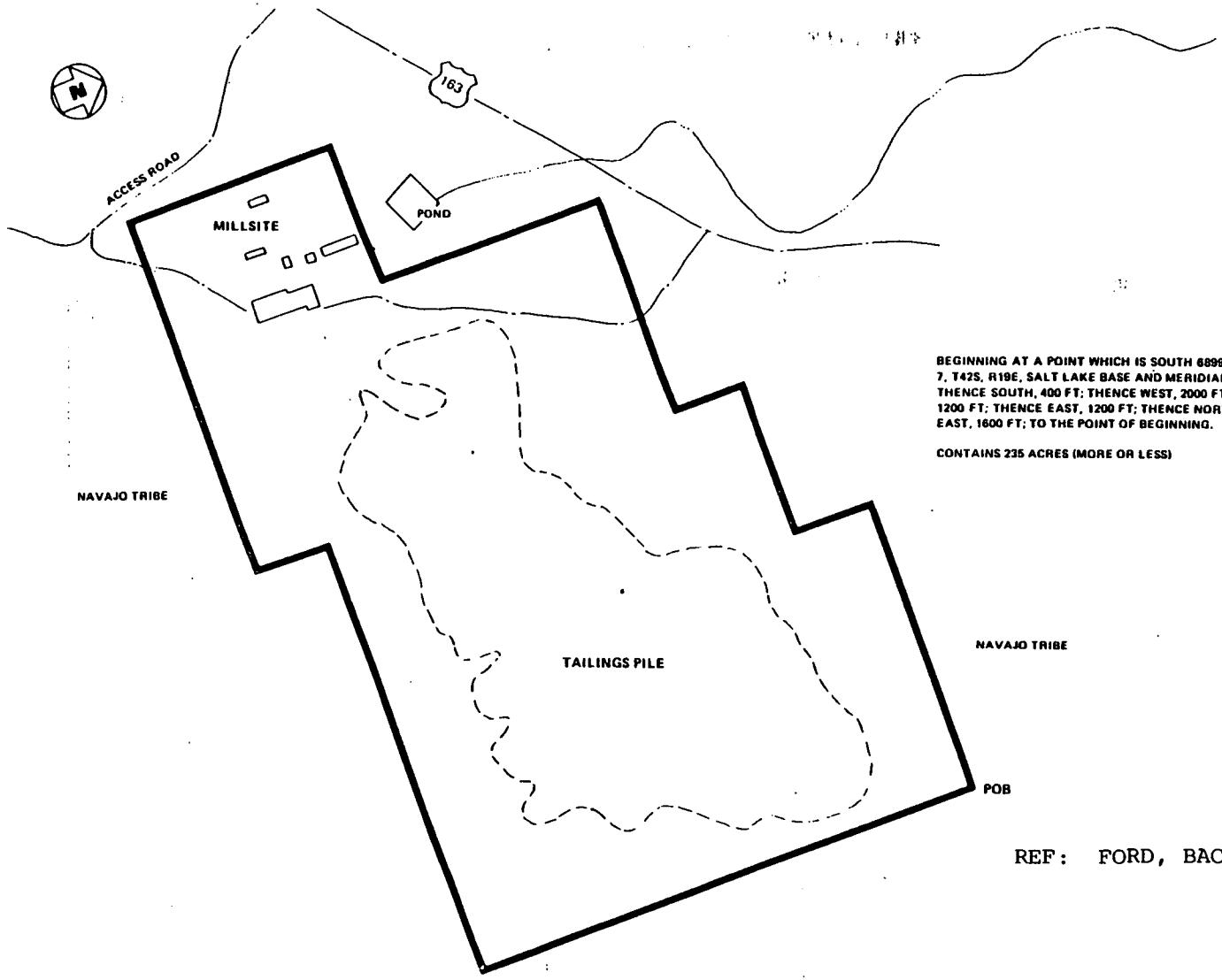


FIGURE D.1.1
MEXICAN HAT SITE



MEXICAN HAT SITE

BEGINNING AT A POINT WHICH IS SOUTH 6899.96 FT AND EAST 6746.01 FT FROM THE N.E. CORNER OF SECTION 7, T42S, R19E, SALT LAKE BASE AND MERIDIAN, AND RUNNING THENCE SOUTH, 2800 FT; THENCE WEST, 2400 FT; THENCE SOUTH, 400 FT; THENCE WEST, 2000 FT; THENCE NORTH 1200 FT; THENCE EAST, 800 FT; THENCE NORTH, 1200 FT; THENCE EAST, 1200 FT; THENCE NORTH, 400 FT; THENCE EAST 800 FT; THENCE NORTH, 400 FT; THENCE EAST, 1600 FT; TO THE POINT OF BEGINNING.

CONTAINS 235 ACRES (MORE OR LESS)

REF: FORD, BACON & DAVIS UTAH INC., 1981

FIGURE D.1.2
MEXICAN HAT SITE DESIGNATION

D.2 RADIATION DATA

This section describes the magnitude and characteristics of the radiation emitted from the Mexican Hat uranium mill tailings site. Radiological data from the vicinity of the Mexican Hat site have been collected by numerous investigators since 1961. All have contributed to an understanding of the radiological picture of the site; however, each investigator has concentrated on a certain aspect of the site contamination, and the results have not been combined to give an overall description of the extent of contamination until now.

The earliest radiological data collection entailed water sampling from the nearby San Juan River, when the U.S. Environmental Protection Agency (EPA) conducted a 10-year period of sampling (from 1961 to 1972) from the river upstream and downstream of the site (EPA, 1973). In May 1968, the EPA conducted a sampling effort to measure radiation levels in air, water, and soil in the immediate vicinity of the site (Snelling, 1971). This survey was performed about three years after operations at the site were discontinued. The external gamma exposure rates around the site were further characterized by the EPA in 1974 (EPA, 1975). Also in 1974, the AEC funded a project to report on the conditions at the site (Brown, 1975).

The first attempt to map the boundaries of the contaminated regions was performed by Oak Ridge National Laboratory (ORNL, 1980) and Ford, Bacon & Davis Utah Inc. (FBDU, 1981) in March 1976. A broad mapping of the gamma exposure rates using aerial radiological survey methods over an area of about eight square miles, including the site, was performed by EG&G in 1980 (EG&G, 1982). A program to specifically sample the tailings piles was conducted by Mountain States Research and Development in 1981 (MSRD, 1982). The data collected from that program provide the basis for estimates of the subpile contamination. The data collected from that program provide the basis for estimates of the subpile contamination. Finally, an extensive survey of the limits of contamination off the pile was performed in 1984 by Bendix Field Engineering Corporation (BFEC, 1985). Due to the comprehensive nature of this most recent work, the BFEC radiological characterization report is in Appendix B, Information for Bidders, Volume I. The BFEC data form the primary basis for the current understanding of contamination distribution across the site.

Data from all major sources listed above are presented in this section, as well as other data, in an interpretation of the contamination distribution around and beneath the Mexican Hat site. This section does not assess the health risks from this contamination or recommend a course of remedial action. The purpose is to present the current understanding of radiological conditions associated with the inactive uranium mill tailings site.

D.2.1 BACKGROUND RADIATION DATA

The purposes of measuring background radiation near the site are to provide a reference point to which levels of contamination on the site can be compared and to assess construction impacts on the surrounding population and the environment. Measurements of background radiation near the Mexican Hat site have resulted in the following determinations.

D.2.1.1 Background gamma exposure rates

The average background external gamma exposure rate at a height of one meter above the surface is approximately 11 microroentgens per hour (microR/hr). Measurements made in 1968 resulted in an average background of 30 microR/hr; however, these values were collected using Geiger tubes at the very lower limit of their detection range, and should not be considered accurate. Measurements made in 1976 (ORNL, 1980) at the locations shown in Figure D.2.1 resulted in an average background gamma exposure rate of 9 microR/hr. Table D.2.1 presents the individual measurement values at these locations.

The aerial gamma exposure survey (EG&G, 1982) indicates that the gamma exposure rate drops monotonically from the piles down to background levels in the range of 11 to 15 microR/hr. More recent measurements (BFEC, 1985) made at four locations at distances from 0.5 to six miles from the site ranged from 10.8 to 12.5 microR/hr, with a mean value of 11.6 microR/hr. These measurements were made with a pressurized ionization chamber (PIC) and are considered the most representative background exposure values collected to date. This is confirmed by noting the background values in Table D.2.1 for the three sites nearest the Mexican Hat site (AZ1, AZ6, and UT19), which average 9.7 microR/hr.

D.2.1.2 Background radionuclide concentrations in soil

Background radionuclide concentrations in soil samples collected at the same eight locations shown in Figure D.2.1 are presented in Table D.2.1. There is little, if any, correlation between the total activity and the gamma exposure rate. This is likely because 1) the spatial distribution of the radionuclides is highly variable, and 2) the gamma exposure rate is a combination of the spatial average radionuclide activity and the cosmic ray flux (which varies with altitude). The average of the Ra-226 values is 0.9 picocuries per gram (pCi/g).

Samples of surface material (zero to six inches) during the most recent survey (BFEC, 1985) at four locations near the site averaged 1.1 pCi/g Ra-226. The data can be found in Table G-1 of Addendum D1. Considering the different locations from which the data were collected, the two sets of background Ra-226 measurements are considered to be in reasonable agreement with each other. For purposes of determining compliance, the soil will be remediated to an average background soil concentration of 1.1 pCi/g radium-226.

D.2.1.3 Background radon concentrations in air

A quarterly radon monitoring program was conducted from August 27, 1985, through September 22, 1986, at the Mexican Hat site. This program used film-type radon detectors to measure both background and on-pile radon concentrations. The results of this monitoring program are presented in Appendix B, Information for Bidders, Volume II.

D.2.2 ON-PILE CONTAMINATION

The description of the on-pile contaminated materials and the calculation of the volume for these materials are given in Appendix A Calculation No. 9-226-03-00, Upper Pile Tailings Excavation—Excavation Limits and Quantity Estimate, and Calculation No. 9-239-05-03 (Appendix B), Radon Barrier Design—Material properties for Radon Barrier Design of the Final Engineering Design.

D.2.3 OFF-PILE CONTAMINATION

The description of the off-pile contaminated materials and the calculation of the volume for these materials are given in Appendix A Calculation No. 9-226-02-01, Contaminated Material Excavation—Windblown and Waterborne Excavation Quantities of the Final Engineering Design.

D.2.4 OTHER RADIOLOGICAL PARAMETERS

D.2.4.1 Radionuclide concentrations in air samples

Air particulate measurements were first made in 1968 (Snelling, 1971) at nine locations in and around the Mexican Hat site. Continuous 24-hour samples were collected at each location on 11 consecutive days at a rate of 140 liters per minute. Although an 11-day average is significantly shorter than an annual average, many short-term fluctuations are smoothed out. The filters were analyzed for gross alpha content and for Ra-226, thorium-230 (Th-230), and natural uranium. Only those locations in the ore storage area and on the tailings piles showed levels above background. The most restrictive maximum permissible concentration (MPC) is for Th-230 at 8.0×10^{-5} picocuries per liter (pCi/l). The highest 11-day average Th-230 value measured was 1.4×10^{-5} pCi/l, or 17 percent of the MPC. This value was obtained at a location immediately downwind of the lower tailings pile.

More recent measurements (FBDU, 1981) made in 1974 confirmed the earlier data. All radionuclides except Th-230 were orders of magnitude below the 10 CFR Part 20 MPC values. The concentration of Th-230 in air particulates at a location

at the center of the mill yard was measured to be 1.2 X 10^{-5} pCi/l (15 percent of the MPC).

It can be concluded that the Th-230 levels during remedial action construction may approach and even exceed the MPC limits.

D.2.4.2 Gamma radiation

The uncovered tailings piles at Mexican Hat produce gamma exposure rates in excess of 1500 microR/hr at some points (FBDU, 1981). The average gamma exposure rate is 380 microR/hr over the upper pile and 850 microR/hr over the lower pile. The highest gamma exposure rates are associated with the lowest portions of both piles where slimes are visible at the surface. The average exposure rate measured in the ore storage and mill yard area is 180 microR/hr.

The aerial radiological survey (EG&G, 1982) provides the most complete overall picture of the gamma fields produced by the tailings. Isopleths of gamma exposure rate from the aerial survey are presented in Figure D.2.2. This distribution is confirmed by the individual point measurements made by FBDU. Note the contribution to the fields along the large arroyo extending to the northeast of the lower tailings pile and the drainage along the trench from just north of the mill yard to the highway.

D.2.4.3 Emanating fractions

The current estimates of the emanating fractions for the contaminated materials at Mexican Hat are given in Appendix B, Calculation Volume II, No. 9-239-05-03, Radon Barrier Design—Material Properties for Radon Barrier Design of the Final Engineering Design.

D.2.4.4 Diffusion coefficients

Calculation No. 9-239-05-02, (Appendix B), Radon Barrier Design—Material Properties for Radon Barrier Design of the Final Engineering Design, presents the diffusion coefficients for all of the contaminated materials at the Mexican Hat site.

D.2.4.5 Ambient radon concentrations

The ambient radon concentrations at the Mexican Hat site are discussed in Appendix D, Addendum D7, Additional Radiological Data.

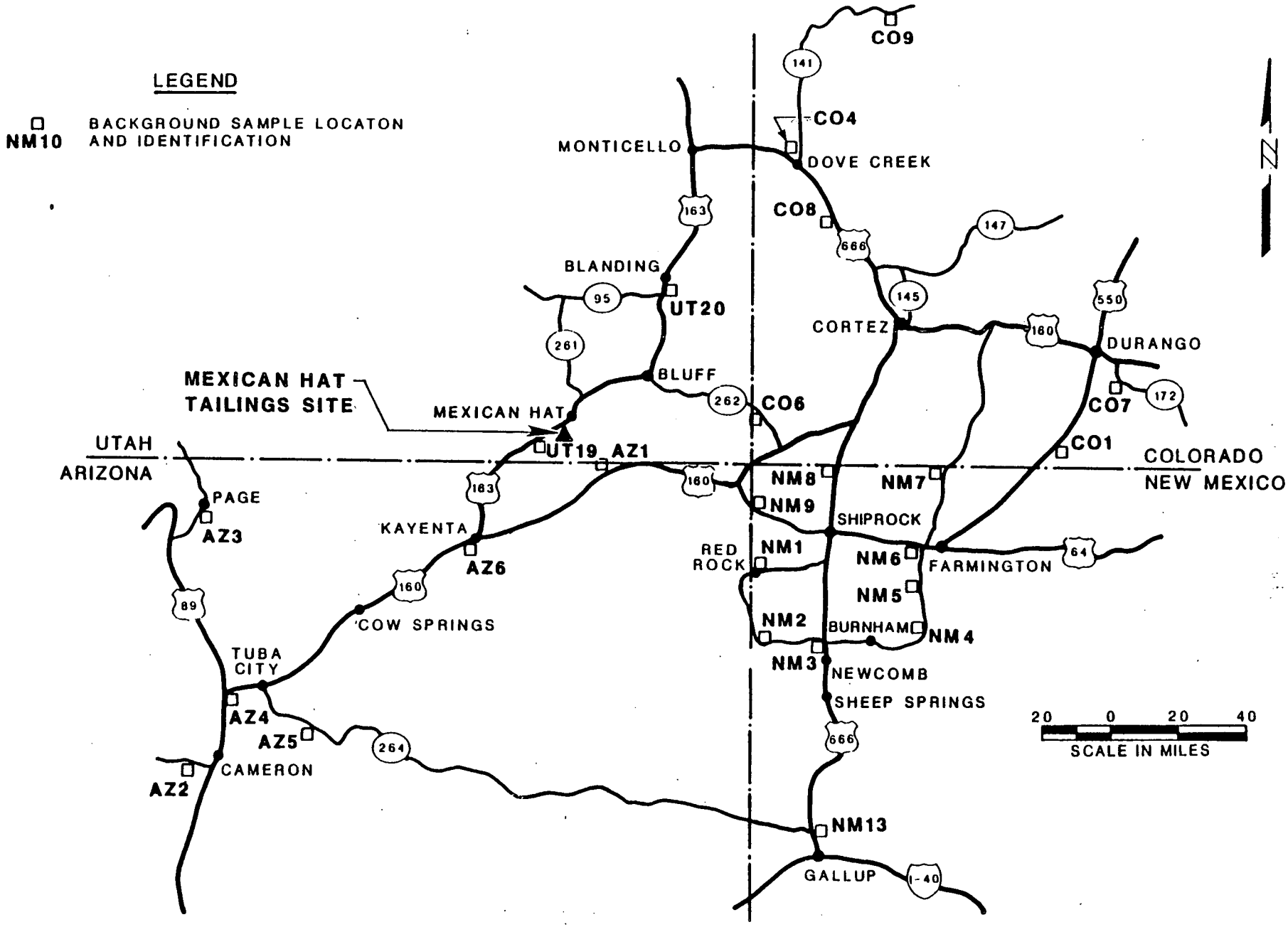
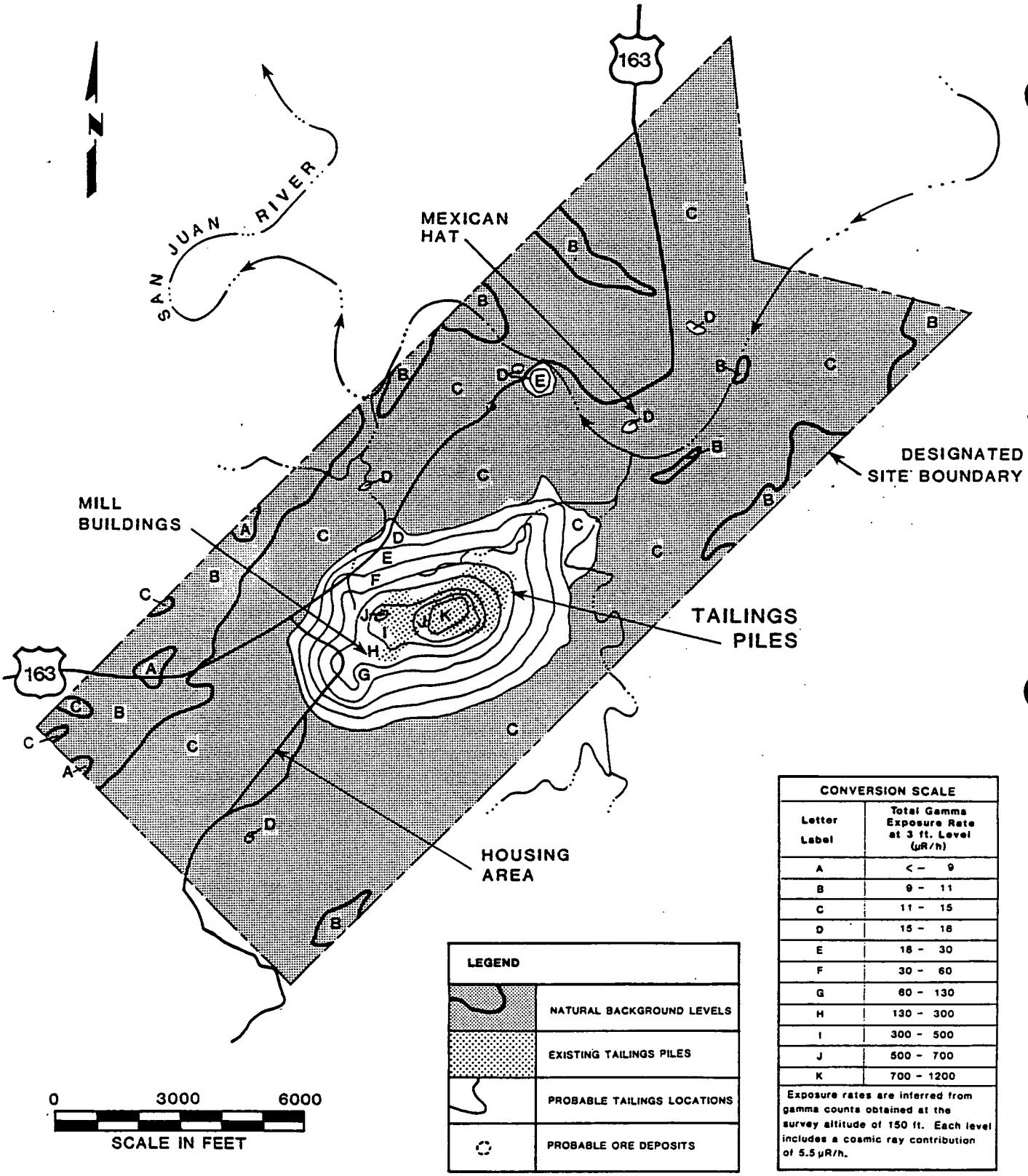


FIGURE D.2.1
LOCATIONS OF BACKGROUND EXTERNAL GAMMA MEASUREMENTS AND BACKGROUND SOIL SAMPLES



CONVERSION SCALE	
Letter Label	Total Gamma Exposure Rate at 3 ft. Level (μR/h)
A	< – 9
B	9 – 11
C	11 – 15
D	15 – 18
E	18 – 30
F	30 – 60
G	60 – 130
H	130 – 300
I	300 – 500
J	500 – 700
K	700 – 1200

Exposure rates are inferred from gamma counts obtained at the survey altitude of 150 ft. Each level includes a cosmic ray contribution of 5.5 μR/h.

FIGURE D.2.2
EXPOSURE RATE CONTOURS DERIVED FROM AERIAL SURVEY DATA TAKEN OVER MEXICAN HAT, UTAH, AND SURROUNDING AREAS (FROM EG & G, 1982)

Table D.2.1 Background radiation levels and background concentrations of radionuclides in surface soil near Mexican Hat, Utah

Sample point	Description of sample location	External exposure rate[a] (microR/hr)[b]	Nuclide concentration (pCi/g)[c]		
			Ra-226	Th-232	U-238
AZ1	In valley 9.7 km[d] south of tailings	9	1.7	0.5	0.5
AZ2	South side of Hwy 64, approx. 0.6 km west of intersection of Hwys 89 and 64	10	0.9	1.3	0.5
AZ3	North side of Hwy 89, 2.4 km east of Glen Canyon Dam (mileage marker 548)	5	0.2	0.2	0.1
AZ4	South side of Hwy 160, approx. 0.4 km east of intersection of Hwys 160 and 89	11	2.0	1.0	0.9
AZ5	Near rest stop on Hwy 264, 11.4 km east of Tuba City, Arizona	6	0.4	0.4	0.2
AZ6	South side of Hwy 160, 3.2 km west of Kayenta, Arizona	12	0.4	0.4	0.2
UT19	12.9 km south of Mexican Hat, northeast corner of intersection of Hwy 163 and road to Monument Valley site	8	0.8	[e]	0.3
UT20	East side of Hwy 163, 4.8 km south of Blanding, Utah	10	1.1	[e]	0.4
	Average	9	0.9	0.6	0.4

[a]One meter above the ground.
[b]Microroentgens per hour.
[c]Picocuries per gram.
[d]Kilometers.
[e]No analysis for this nuclide was performed.

Ref. ORNL, 1980.

D.3 GEOLOGIC CHARACTERISTICS

D.3.1 INTRODUCTION

Detailed investigations of geologic, geomorphic, and seismic conditions at the Mexican Hat site were conducted to provide a basic site characterization and an identification of potential geologic hazards that could affect long-term site stability. Subsequent engineering studies (e.g., analyses of hydrologic and liquefaction hazards) used the data developed in these studies. The geomorphic analysis was employed in the design of effective erosion protection. Studies of the regional and local seismotectonic setting included a detailed search for possible capable faults within a 65-kilometer (km) radius of the site, and a review of historic earthquake data and major studies by previous investigators. These studies provided the basis for estimation of seismic design parameters.

The scope of work performed included the following:

- Compilation and analysis of previous published and unpublished geologic literature and mapping.
- Review of historical and instrumental seismic data.
- Review of site-specific UMTRA Project geologic data, including logs of exploratory boreholes advanced in the site area.
- Photogeologic interpretation of existing LANDSAT and conventional aerial photography.
- Low-sun-angle (LSA) aerial reconnaissance of the site region.
- Ground reconnaissance and mapping of the site region.

The characterization includes the regional geology as the first phase of the geologic studies. Detailed site geology is then correlated to the regional overview, and various hazards are evaluated from the results to determine site suitability. These various hazards include the following:

1. Geomorphic hazards, including mitigative measures. The individual hazards assessed include the following:
   - Channel erosion, aggradation, degradation, avulsion, and lateral shifting of fluvial systems.
   - Flooding.
   - Gully erosion and headward migration.
   - Mass movement, including landslides, debris flows, soil creep, mud flows, rockfalls, and snow avalanches.

- Expansive, collapsing, and dispersive soils.
- Soil erosion and scarp retreat.
- Change in erosion from climatic change, or tectonic or other change in base level.
- Ground subsidence, including that from mine collapse, dissolution of bedrock layers, and fluid withdrawal.
- Wind erosion.

2. Man-made hazards (i.e., future recovery of economic minerals, aggregates, or petroleum products in the site area).
3. Volcanic hazards.
4. Seismic hazards that provide the following initial design parameters:
   - Design earthquake and resultant acceleration.
   - On-site fault rupture potential.
   - Potential for site damage from earthquake-induced slope failures.
   - Hazard to the site from reservoir-induced seismicity.

This section first presents a regional overview of geologic lithology and structures, and a site review including physiography and local site geology. A discussion of the mineral resources of the site area follows. The seismotectonic setting and geologic hazards analysis are presented in subsequent sections.

This organizational framework allows a presentation of the regional lithology and structure and subsequent relation of this to local site geology, including site-specific surficial and subsurface data generated in previous UMTRA Project studies. Based on these, evaluation is accomplished for geomorphic and seismic hazards incorporating data from specific studies of these subjects.

The National Oceanic and Atmospheric Administration (NOAA) listing of earthquakes within a 200-km (about 125-mi) radius of the site and a tabulation of faults and lineaments in the site region can be found in Appendix B, Information for Bidders, Volume I.

D.3.2 CRITERIA AND DEFINITIONS

This section presents definitions and criteria used to perform site hazard evaluations at UMTRA Project sites. These are presented to standardize usage throughout this section, and are pertinent to the

seismic hazard evaluation because of the wide range of interpretation or usages of certain seismological terms.

Design life. As specified by the EPA-promulgated standards for remedial actions at inactive uranium processing sites (10 CFR Part 192), the controls implemented at the Mexican Hat site are to be effective for up to 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. In the case of assessing seismic hazards, the criteria established and the methodologies applied seek to ensure that the reclaimed wastes will not be damaged by earthquake ground motions or related ground rupture for up to 1000 years.

Design earthquake. The magnitude of the earthquake that produces the largest on-site peak horizontal acceleration is the magnitude of the design earthquake. This controlling earthquake could be the floating earthquake or an earthquake whose magnitude is derived from a relationship between fault rupture and/or fault length and maximum magnitude.

Capable fault. A capable fault is defined as a fault that has exhibited one or more of the following characteristics:

- Movement at or near the ground surface at least once within the past 35,000 years, or movement of a recurring nature within the past 500,000 years.
- Macroseismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
- A structural relationship to a capable fault such that movement on one fault could be reasonably expected to cause movement on the other.

This definition is essentially the one adopted by the NRC for the siting of nuclear power plants (10 CFR Part 100, Appendix A, 1975).

Acceleration. Acceleration is defined as the mean of the peaks of the two horizontal components of an accelerogram record. The exact term used is "peak horizontal acceleration." The design accelerations are determined from the constrained attenuation relationship based on distance and magnitude developed by Campbell (1981). The mean plus one standard deviation (84th percentile) values are adopted. The design value is considered a nonamplified peak horizontal acceleration in the free field.

Magnitude and intensity. Magnitude was originally defined by C. F. Richter as the base-10 logarithm of amplitude of the largest deflection observed on a torsion seismograph located 100 km from the epicenter. This local magnitude value may not be the same as the body-wave and surface-wave magnitudes derived from measurements at teleseismic distances. Unless specified otherwise, Richter magnitude values will be used in the seismic hazard evaluations.

Intensity is the index of the effects of an earthquake on the human population and man-made structures. The most commonly applied scale is the 1931 Modified Mercalli Intensity Scale, one which will be used in the studies.

Because pre-instrumental earthquakes are reported in intensity and more recent instrumental records are in magnitude, there may be a need to relate these values. Several equations have been proposed. Unless otherwise specified, the relationship developed by Gutenberg and Richter (1956) will be applied. This equation is as follows:

$$M = 1 + 2/3\ I_o$$

where M = magnitude in the Richter scale and I_o = Modified Mercalli (MM) Intensity in the epicenter area.

Floating earthquake (FE). An FE is an earthquake within a specified seismotectonic province not associated with a known tectonic structure. Before assigning the maximum FE magnitude, the earthquake history and tectonic character of the province are analyzed.

Geomorphic evaluation. The purpose of the geomorphic evaluation of the Mexican Hat site is to characterize the current geomorphic conditions and to assess the impact of geomorphic processes on the long-term stability of the uranium mill tailings piles. These evaluations are restricted to the assessment of natural geomorphic processes and the geomorphic effects of past land-use activities, and do not address future human activities or potential hazards related to site hydrology.

Schumm and Chorley (1983) have prepared a detailed publication presenting a theoretical discussion of geomorphic processes that may affect a tailings site. Nelson et al. (1983) present a handbook approach to specific methods for site assessment, engineering procedures for mitigation, and confidence levels for hazard predictions over periods of 200, 500, and 1000 years. The methodologies and criteria presented in those publications were used as guides for the geomorphological investigations of the Mexican Hat site.

D.3.3 SCOPE OF WORK

D.3.3.1 Compilation and analysis of previous geologic work

The initial phase of investigation for the site geologic characterization consisted of collection and review of all available pertinent data. The data include the subjects of lithology, stratigraphy, structure, seismicity, geomorphology, mineral resources, tectonics, and soils. The acquired publications are based on geological, geophysical, seismological, and agricultural studies in the site region, and include those generated in earlier UMTRA Project studies for the site.

This compilation is based, in part, on a GEOREF data search yielding an extensive bibliography on various subjects, including those pertinent to this study. The size of this compilation precludes inclusion as an addendum to this appendix. It is available on request from the UMTRA Project Office, Albuquerque, New Mexico.

Published regional and local geologic and topographic maps were used as a base to complete this study in those subject areas.

D.3.3.2 Earthquake data compilation

For an analysis of seismic hazards to the site, an extensive data base of historical seismicity was compiled. This includes generation of an updated NOAA search for a 200-km (125-mi) radius of the site (NGDC/NOAA, 1985). Seismicity from other regional studies of the site region was examined to determine completeness of the NOAA search and to include smaller magnitude events (microseismicity) that may not be included in the NOAA data base. These studies included Kirkham and Rogers (1981) for Colorado; Arabasz et al. (1979) for Utah; DuBois et al. (1982) for Arizona; and Sanford et al. (1981) for New Mexico.

A search was also conducted for unpublished data on earthquake events in northern Arizona. The only regional seismic monitoring network in northern Arizona is run by the Geology Department of Northern Arizona University (NAU) in Flagstaff. A summary of earthquake activity from 1980 to 1985 from the NAU network (Brumbaugh, 1985) updates the published summary of Arizona earthquakes (Dubois et al., 1982, 1981).

Regional and local seismological studies for other areas were also used to determine the FE within the site region and the Maximum Earthquakes (ME) for the seismotectonic provinces adjoining the site region. This determination allowed for an analysis of the effects of earthquakes in the Colorado Plateau and adjoining seismotectonic provinces on site seismic design parameters.

D.3.3.3 Site-specific geologic data

Subsurface geologic data for the Mexican Hat site consist of logs of boreholes drilled on and off the tailings pile in 1980, 1981, 1982, 1984, and 1985 (Appendix D, Addendum D4).

Subsurface site geology and hydrology were investigated and described by Fuhriman and Hintze (1976), FBDU (1977), and Colorado State University (CSU, 1983a,b). Generalized site geology was mapped and described during studies by Sergent,

Hauskins, & Beckwith (SHB, 1985a,b) and Fuhriman and Hintze (1976). Potential borrow source locations and geology have been investigated (SHB, 1984). A geomorphic hazard study for the site area was completed in 1984 (SHB, 1984).

Detailed site geology has not been mapped at a scale larger than 1:125,000. The stratigraphy and lithology of bedrock units in the site area have been compiled from borehole logs and outcrop exposures. All geologic and borehole data were reviewed during the initial site data compilation. The site-specific geologic data were correlated with regional studies of geology and stratigraphy.

D.3.3.4 Ground reconnaissance and mapping

Ground reconnaissance and mapping for the Mexican Hat site were conducted for this study. Local geology and geomorphic hazards were evaluated on the site by the DOE between June 5 and 8, 1984; and January 6 and 7, 1986. Field notes for ground reconnaissance are presented in Addendum D3.

These studies resulted in an evaluation of geomorphic processes and hazards at the site and an evaluation of the capability of faults in the site region that could affect seismic design parameters at the site.

D.3.3.5 Photogeologic interpretation

An evaluation of capable faulting from existing remote sensing imagery was performed for this study. This evaluation included photogeologic interpretation, using the methodology of Glass and Slemmons (1978), of 1:250,000 scale color composite LANDSAT imagery of the site region and conventional black-and-white and/or color aerial photography for a 65-km (40-mi) radius of the site. Scales of this photography varied from 1:18,000 to 1:24,000. Within the 65-km (40-mi) radius of the site, photographic coverage was complete except for one small, nearly five-by-five-square-mile area just southwest of Mexican Hat, Utah, in Townships 42S and 43S of Range 18E. Table D.3.1 is a compilation of photo numbers examined and location of the photography.

The LANDSAT imagery and aerial photography were inspected between August 19 and 29, 1985. A Wilde ST-4 mirror stereoscope using 3X multiplier lenses was used to examine suspect features. Scale and quality of the photography and inspection methods utilized gave resolution limits of sharp geomorphic features of about 0.33 meter (one foot) minimum height and more subtle features of about one meter (3.3 feet) in height.

The photo interpretation study was combined with fault map compilation to enable close examination of mapped faults. In

addition, a search was made for unmapped faults, which were also compiled. Transfer was done by visual inspection.

D.3.3.6 Low-sun-angle aerial reconnaissance

Two LSA aerial reconnaissance missions were flown over the study area. These missions had two primary objectives: 1) analysis of the geomorphic expression of mapped faults and fault systems for detection of Quaternary age (the last 1.8 million years) activity, and 2) inspection of the site region for unmapped faults or fault systems with possible Quaternary age activity.

The missions were flown in a five-passenger Cessna 206 turbocharged single-engine high-wing aircraft. The flights were made on the evening of September 4 and the morning of September 5, 1985, with excellent weather and LSA illumination conditions. Missions were flown at altitudes of 500 to 3000 feet above the terrain for detection of small geomorphic features.

Glass and Slemmons (1978) indicate that the most definitive indication of active faulting is oversteepened land surfaces (fault scarps). They also indicate that the single most effective method of detecting and delineating fault scarps is to conduct aerial reconnaissance and remote sensing using low solar irradiation angles to produce shadows or highlights on scarps. Slemmons (1977) indicates that the use of LSA methods can greatly aid in delineating very subtle geomorphic features associated with active faulting.

The natural degradation of fault scarps in unconsolidated material has been described by Wallace (1977) and Bucknam and Anderson (1978), and occurs as a result of mass wasting and erosional processes. This slowly reduces the slope angle of the scarp over a period of several hundreds of years to a few million years. These scarp degradation studies, performed in the Basin and Range physiographic and structural province, are believed to be applicable to the site region because of similar erosional processes and climate. They indicate that any major surface faulting of Late Quaternary age (the last 500,000 years) should be readily detectable using LSA methods of observation.

LSA methodology has been discussed by Slemmons (1969, 1977), Clark (1971), Cluff and Slemmons (1972), and Glass and Slemmons (1978). They indicate that LSA aerial reconnaissance in areas of low to moderate terrain is best conducted when the sun is between 8° and 25° above the horizon. These sun illumination angles occur in the approximate 2.5-hour time interval beginning 0.5 hour after sunrise or ending about 0.5 hour before sunset. Glass and Slemmons (1978) recommend a "multi" approach (i.e., using multiple observers, multiple times of day (morning and evening), and multiple season missions).

Missions flown for this study included multiple observers and multiple times of day. Multi-season observations are not necessary in the site region, as vegetation differences with respect to seasons are negligible.

During the LSA aerial reconnaissance missions, all known faults within 15 km (9.3 miles) of the site were inspected and an intense low-altitude search for undetected faults within 10 km (6.2 mi) of the site was made. All faults of over a few miles in length within a 65-km (40-mile) radius of the site and any topographic structures that could result from faulting were inspected. All regional structures that could be capable of large or great earthquakes within 200 km of the site were also examined.

D.3.4 REGIONAL CONDITIONS

D.3.4.1 Physiographic setting

The Mexican Hat site is on the northern boundary of the Navajo Uplands section of the Colorado Plateau physiographic province (Hunt, 1967) (Figure D.3.1). The site is about 1.5 km (0.9 mile) south of the San Juan River, the border of the Navajo Uplands section, with the Canyonlands section to the north. This part of the Navajo Uplands section is characterized by 1) extensive areas of gently dipping sedimentary rocks deformed by warping; 2) aridity and shortage of water; 3) large areas of bedrock overlain by thin surficial deposits; and 4) sparse vegetation and population (Figure D.3.2).

Drainages in the tailings site drain to the northeast, to Gypsum Creek, and then northward into the San Juan River. The site elevation is about 1305 m (4280 ft), and topography varies in elevation from about 1250 m (4100 ft) at the San Juan River to over 1705 m (5600 ft) in the Raplee anticline structure to the east.

D.3.4.2 Regional geology

Exposed consolidated strata in the Mexican Hat area range in age from Pennsylvanian to Permian. The oldest formation exposed is the Hermosa Group of Pennsylvanian age, which crops out along the canyon of the San Juan River and, immediately west of the site, crops out along U.S. Highway 163, southwest of the town of Mexican Hat, Utah. Unconformably overlying the Hermosa Group is the Cutler Group of Permian age, which crops out east of U.S. Highway 163, underlies the site, and extends eastward to the westerly dipping beds of Raplee Ridge, east-southeast of the town of Mexican Hat, Utah (Figure D.3.3).

Rock strata older than the Hermosa Group are not exposed in the area of the tailings site. A few wells drilled for oil and gas adjacent to the site area have penetrated the entire Pennsylvanian and into the underlying Paleozoic section. These wells show that below the Hermosa Group is a sequence of rocks from 1450 to 1650 feet thick that includes rocks of Cambrian, Devonian, Mississippian, and Pennsylvanian age. So far as is known, none of the wells have penetrated rocks of the Ordovician or Silurian systems (O'Sullivan, 1965).

The Hermosa Group is subdivided into three formations. The lowest formation is the Pinkerton Trail and does not crop out in the San Juan Canyons. Overlying the Pinkerton Trail is the Paradox Formation, which is exposed in canyons along the San Juan River northeast of Mexican Hat, Utah. The upper formation is the Honaker Trail, which crops out throughout the Mexican Hat area along the canyon walls of the San Juan River.

The Hermosa Group consists dominantly of fine- to very fine-grained crystalline gray limestone. Interbedded with the limestone are minor amounts of gray, greenish-gray, and purple shale and siltstone. The shale and siltstone are in beds as much as two feet thick and commonly form slopes between limestone ledges. A few light-colored, very fine-grained sandstone beds are also in the Hermosa Group (O'Sullivan, 1965).

The lower two formations of the Hermosa Group will not be discussed herein, as their stratigraphic and sedimentological significance to the site are insignificant. The Honaker Trail Formation consists of interbedded siltstones, limestones, shales, and sandstones. The thick siltstone units are prevailingly reddish brown. Locally, thin, less than 1.5-foot lenticular beds or irregular masses of reddish-brown and gray limestone are present. Chert and limestone nodules are found in thin beds in a siltstone matrix or scattered throughout the siltstone units. The siltstone units are commonly evenly bedded, but small-scale crossbedding is locally present (O'Sullivan, 1965). The limestone units are predominantly fine- to very fine-grained, crystalline, fossiliferous, and gray. The sandstone is generally very fine- to fine-grained, exhibiting parallel bedding with some small-scale, low-angle crossbeds present locally. These strata were deposited in a marine environment of a very shallow sea.

Disconformably overlying the Pennsylvanian-age Honaker Trail Formation is the basal formation of the Permian-age Cutler Group. This disconformity has been recognized only recently (Wengerd, 1973). Regionally, past U.S. Geological Survey (USGS) reports recognized the "Rico Formation" as a transitional formation between the marine rocks of Pennsylvanian age below, grading into non-marine redbeds of Permian age above. The existence of regional unconformity indicates that there are no transitional beds between Pennsylvanian and Permian age strata,

and therefore the Rico Formation does not exist in the Mexican Hat area. Wengerd (1973) includes all of the marine strata to the top of the Pennsylvanian sequence as Honaker Trail Formation (Baars, 1973).

The Halgaito Shale or Halgaito Tongue is the basal formation of the Cutler Group. It consists of an interbedded sequence of very fine-grained silty sandstone and siltstone beds that are characteristically reddish brown. At places, the beds are micaceous and mottled very pale green or greenish gray. Calcareous, well-cemented beds alternate with softer beds to form ledges, slopes, and benches. Thin, lenticular, unfossiliferous beds of light-gray limestone are widely dispersed throughout the sequence. Beds of conglomerate occur at different levels within the Halgaito. The conglomerate consists of subrounded pebbles of siltstone and limestone generally in a silty matrix. Locally, beds of very fine- to fine-grained sandstone showing irregular bedding are present (O'Sullivan, 1965). It is probable that the Halgaito is composed mainly of continental lowland deposits that include stream channel and point bar deposits, floodplain deposits, and tidal flat accumulations. The Halgaito Formation is the bedrock unit that directly underlies the tailings site and surrounding area primarily east of U.S. Highway 163 and along Monument and Gypsum Creeks. The contact between the Halgaito Formation and the underlying Hermosa Group-Honaker Trail Formation is the top of the highest fossiliferous limestone bed of the Honaker Trail Formation.

Conformably overlying the Halgaito Formation is the Cedar Mesa Sandstone Member of the Cutler Group. The Cedar Mesa Sandstone Member consists of two totally different facies: a sandstone facies present only in the area near Cedar Mesa, northwest of the site; and a gypsiferous facies present south of the San Juan River and east of Gypsum Creek. (The sandstone facies will not be described herein, as it is present only along Cedar Mesa and in remnants capping erosional features near Mexican Hat, Utah.) The gypsiferous facies consist dominantly of siltstone and shale and subordinate amounts of sandstone, gypsum, and limestone. The member is soft and weathers to a series of mounds and gentle slopes, although locally a resistant ledge may form a minor hogback. The depositional environment of the gypsiferous facies of the Cedar Mesa Sandstone was probably in a near-shore, littoral to sublittoral environment (O'Sullivan, 1965).

Rock units stratigraphically above the Cedar Mesa Sandstone Member crop out farther east of the site along Comb Ridge. These formations include the Organ Rock and DeChelly Sandstone Members of the Cutler Group, Triassic-age Moenkopi and Chinle Formations and Wingate Sandstone, Triassic-Jurassic-age Kayenta Formation and Navajo Sandstone, Jurassic Carmel Formation, Entrada Sandstone, Summerville Formation, Bluff Sandstone, and

Morrison Formation. These strata crop out some distance away from the site. They are of no significance to the geologic setting underlying the site, and therefore are not described herein.

Sparse volcanic rock in the site area consists of Pliocene-age explosive breccias and intrusive dikes with associated small stocks. Surficial deposits consist of eolian sand occurring as unconsolidated dunes in low-lying areas. Minor terrace gravels of the San Juan River occur about 1.9 km (1.2 miles) north of the site, at the town of Mexican Hat, Utah.

D.3.4.3 Regional structure

The Mexican Hat site is in the central portion of the Colorado Plateau, a stable intracontinental subplate characterized by a thick cover of relatively flat-lying sedimentary rock of Phanerozoic age overlying a complex Precambrian igneous and metamorphic core. The central, stable portion of the plateau exhibits characteristics of cratonic areas, while the margins of the subplate exhibit crustal structure similar to more highly active bordering provinces. The plateau is bordered on the east, south, and west by the extensional, block-faulted regime of the Rio Grande Rift and Basin and Range Provinces.

The principal present-day structural elements of the Colorado Plateau are as follows (Hunt, 1967) (see Figure D.3.2):

- Broad west- and northwest-trending basins such as the Uinta, San Juan, and Navajo Basins.
- Clusters of uplifts that lie between these broad basins, including the Monument, San Rafael Swell, Circle Cliffs, Kaibab, Defiance, and Zuni Uplifts.
- Northwest-trending anticlines and faults of east-central Utah and southwestern Colorado, underlain by thick salt deposits.
- Northward-trending fault blocks of the high plateaus in Utah and Arizona. These features represent a zone of transition between the Colorado Plateau and Basin and Range Provinces.
- Domes and other folds related to laccolithic intrusions, most of which are in the central part of the plateau.

The modern day structural elements of the plateau are principally the result of Cenozoic deformation, but follow, at least in part, the trends of older features. Structures in the Precambrian basement have undoubtedly influenced the later tectonic history of the plateau. However, relatively little is known of the Precambrian structure. Precambrian rocks are

exposed only in the Uncompahgre Uplift, Grand Canyon, Zuni Mountains, and Defiance Uplift (Hunt, 1967). These rocks consist of a complex series of metasedimentary and metavolcanic rocks cut by a series of large intrusions. During much of Paleozoic and Mesozoic time, the plateau region was occupied by a stable continental shelf area. From the Late Mississippian to Permian time, the "Ancestral Rockies" disturbance affected parts of the eastern plateau and the Rocky Mountain region farther east. The Uncompahgre Uplift rose during this time, while the Paradox Basin received large volumes of Pennsylvanian and Permian redbeds and evaporite deposits (Cater, 1966, 1970). The Zuni Mountains and Defiance Upwarps probably were also uplifted at this time (Hunt, 1967). The Late Cretaceous-Eocene Laramide orogeny produced a series of monoclines and fault-bounded uplifts and basins within the plateau. From the end of the Eocene until Miocene or Pliocene time, the plateau was undergoing erosion by the ancestral Colorado River. Since Late Tertiary time, the plateau has been experiencing gradual uplift at an average rate of about two millimeters per year (mm/year) (Gable and Hatton, 1980). This uplift is regional in character and produces relatively little internal deformation.

The Mexican Hat site lies on the eastern edge of the Monument Uplift (Monument Upwarp of O'Sullivan and Beikman, 1963) (Figure D.3.4). South and east of the Monument Uplift is the Tyende Saddle (O'Sullivan and Beikman, 1963), separated from the uplift by the Comb Ridge Monocline, a major monocline of the Colorado Plateau (Kelley, 1955), with a length of about 153 km (95 miles). Stratigraphic units are displaced a maximum of 914 meters (m) (3000 ft) at a maximum dip angle of 45° across the Comb Ridge Monocline (Kelley, 1955).

Overprinted on these major subprovinces defined by folded uplifts are smaller amplitude and more gently folded features. Within the Monument Uplift and west of the Mexican Hat site about 13 km (eight miles) is the Halgaito anticline, a north-south trending, doubly plunging structure about 16 km (10 miles) in length and 150 m (500 ft) in amplitude. Another structure of equivalent length but over 300 m (1000 ft) in amplitude, the Raplee anticline, is about 4.8 km (three miles) east of the site.

The major structural feature of the area is the Monument Upwarp, a broad north-south trending uplift about 35 miles wide and 100 miles long that extends from Kayenta, Arizona, to near the junction of the Colorado and Green Rivers in Utah. Smaller anticlines and synclines with north-south to northeast-southwest trends are superimposed on the major structure. The upwarp is asymmetrical, with a steeply dipping east limb and a gently dipping west limb. Comb Ridge, which marks the eastern flank of the uplift, lies about eight miles east of the site.

Faulting is rare in the Mexican Hat area. The few faults that have been mapped have offsets ranging from only a few inches to a few feet. None are mapped as offsetting strata of Quaternary age. The dominant geologic structural features probably formed during the Early Tertiary. Minimal tectonic activity has occurred in the region since at least the end of Eocene time. The ages of the last episodes of volcanic intrusion are not known, but most studies of the area conclude that the latest volcanic activity occurred during the Pliocene (e.g., Williams, 1936, as quoted by O'Sullivan, 1965).

West of the site, highlands are formed by a doubly plunging, gently folded anticlinal structure, the Halgaito anticline. To the east, highlands are formed by the moderately dipping limbs of the Raplee anticline. The Mexican Hat syncline occupies the area between the two anticlines.

D.3.4.4 Regional geomorphology

Hunt (1967) subdivided the Colorado Plateau physiographic province into physiographic units (see Figure D.3.1). The Mexican Hat site lies on the northern border of the Navajo Uplands section adjacent to the Canyonlands section, north of the San Juan River. Essentially, the Navajo Uplands section is a large depression enclosing Black Mesa and the San Juan Basin. The so-called "valley" of Monument Valley is the eroded broad summit area of the Monument Upwarp, a major feature that continues northward into Utah and the Canyonlands physiographic section. Erosion has cut below the Mesozoic rocks of the Monument Upwarp into the continental Permian redbeds and sandstones. In the site region, on the east edge of the Monument Upwarp, erosion has generally reached the lower members of the Cutler Group or the underlying Hermosa Limestone.

The site lies in northeast-trending channel tributaries to Gypsum Creek, an ephemeral stream that drains northward into the San Juan River. Gypsum Creek has eroded to the Halgaito Tongue of the Cutler Group or the underlying limestone of the Hermosa Group, but the channels at the site and the site itself lie in the Halgaito Tongue of the Cutler Group. Erosion of the Halgaito Tongue forms a dendritic drainage pattern with very minor surface cover, except eolian sand dunes in low-lying areas.

Arroyos are formed generally in bedrock from infrequent periods of runoff, and channel incision is a very slow process in the site region. Gullying and headward erosion proceed slowly in channels cut into sandstone bedrock. Well developed gullies and more rapid erosion occur in channels incised into weakly cemented silty sandstone and deposits of alluvial and eolian materials. Alluvial-colluvial cover is generally thin and soils are poorly developed.

The geomorphic features of the Colorado Plateau region of southeast Utah reflect mainly the processes of erosional denudation throughout the Cenozoic. The general geomorphic processes described herein are those characteristic to the physiographic subdivision of the plateau closest to the Mexican Hat tailings site--the eastern Navajo Uplands, and the eastern Monument Valley. Although the development of the ancestral and present Colorado River systems has been the subject of regional and local studies since the late 1800s, little has been published on the regional geomorphic development of the Colorado Plateau region of northern Arizona and southeastern Utah. Landform development during the Cenozoic Era has been influenced by the bedrock lithology, volcanic and tectonic processes, fluvial drainage system changes, and eolian erosion. Poorly developed soils and sparse vegetation have been attributed to the rates of differential erosion of the weakly- to moderately-resistant sedimentary formations (Stokes, 1973). Likewise, the tectonic history is known only in a general sense. Uplift of over one mile above mean sea level has occurred since the Cretaceous, but the rate and timing of uplift is not fully known. The history of climatic changes in the Colorado Plateau and Grand Canyon regions is now understood in some detail, but the effects of different climates on geomorphic processes are not well known.

The eastern part of the Navajo Uplands section curves to the east of the Mexican Hat site and lies between the Monument Valley section to the north and the Black Mesa section to the south. The southern inner border is the base of the slope leading to Black Mesa. Bedrock of the Navajo Uplands east of Mexican Hat consists of sandstones and mudstones of the Glen Canyon Group, the San Rafael Group, and the Morrison Formation, in ascending order. The Navajo Sandstone of the Glen Canyon Group is the most widespread and conspicuous component (Stokes, 1973). Much of the area is mantled by thin deposits of sand or sandy soils. Elevations range from about 1525 to 1780 m (5000 to 5835 ft). Weathering and erosion have produced a combination of mesas and "slickrock" surfaces cut by deep gorges eroded below the general level of the terraced surfaces. Drainage is mainly to the north to the San Juan River, but the sandy regolith results in many areas of no surface runoff.

West of the Mexican Hat site lies the Monument Valley subdivision of the Navajo country. The landforms of Monument Valley are developed on the Cedar Mesa Sandstone of the Cutler Group. The region is a nearly featureless, stripped surface with mesas, buttes, and spires rising abruptly from the flat plain (Barnes, 1984). Lower slopes of the buttes are formed on the Organ Rock Shale, the vertical cliffs consist of the DeChelly Sandstone, and the resistant caprocks are tan sandstones of the Shinarump Member of the Chinle Formation. The "valley" of Monument Valley is actually formed in the broad summit area of the Monument Upwarp, a major feature that continues northward into east-central Utah. Stream incision

into the broadly-folded, low arch eroded the soft Organ Rock Shale, leaving the mesas protected by thick caprocks of fluvial sandstones and gravels of the Shinarump Member (Barnes, 1984). Some mesas stand more than 260 m (853 ft) above the valley floors of about 1435 m (4700 ft). Surface drainage is mainly to the north in deeply incised tributaries to the San Juan River.

Northeast of Mexican Hat, Cedar Mesa and the Grand Gulch Plateau are developed on Pennsylvanian and Permian age limestones, sandstones, and siltstones of the Hermosa and Cutler Groups. This region consists of extensive, flat, stripped surfaces cut by narrow, deep gorges trending eastward toward Comb Wash and southward toward the San Juan River. Thin surficial deposits of eolian sand and alluvial sand and gravel occur sporadically on the plateau surface. The plateau terminates to the east at the Comb Ridge Monocline (Haynes et al., 1972). Elevations range from about 1515 m (5000 ft) near the San Juan River to about 1983 m (6500 ft) on upper plateaus.

Erosional processes throughout the interior Colorado Plateau are related to the development of the Colorado River, Little Colorado River, and San Juan River systems since Miocene times (Lucchitta, 1984). Prior to Arizona Basin and Range faulting, the Little Colorado River and streams in central Arizona drained to the north toward Utah. Basin and Range faulting and opening of the Gulf of California Rift about five million years ago resulted in stream capture of the ancestral Colorado River system in Colorado and Arizona, downcutting into the sedimentary rocks of the Colorado Plateau, and development of the present drainage system. The major period of the Grand Canyon development appears to have occurred between one and six million years ago. Development of canyons and river downcutting have continued throughout the period of plateau uplift, and will slowly reduce the plateau region to a smooth, subdued landscape. Processes of canyon head erosion and cliff retreat in rock units of varying erosional resistance will continue to produce the mesa and butte topography currently observable in the Monument Valley area.

Wind activity has been a major factor in the development of the landscape of northeastern Arizona and southeastern Utah. Eolian deposits of Pliocene age indicate wind directions similar to those at present. Longitudinal dunes of Pleistocene and Holocene age also indicate a prevailing southwest wind direction. Vast areas of the Colorado Plateau are covered with dunes and thin sand sheets. Eolian erosion continues to be an important factor in the denudation of the flat plateau surfaces.

An increase in the magnitude and rate of stream arroyo development has been observed in the semiarid southwest during the past 100 years. Studies of gully erosion in sediment-filled valleys in New Mexico, Arizona, and Colorado indicate an increased rate of gully development beginning in the mid- to

late-1800s. The cause has been attributed to either livestock overgrazing or short-term climatic change. Gully erosion seems to be less intense on the plateaus and valleys of the Colorado Plateau interior. The shallow valley fills and thin sandy soils appear to have been major factors preventing the rapid development and growth of arroyos.

D.3.4.5 Rates of denudation

In reference to the possible influence of the long-term erosional process upon reclamation design, a discussion of the rates of denudation and neotectonics of the Colorado Plateau is provided below.

The rates of denudation are the rates at which a land surface is being lowered as a result of erosional processes. These rates vary with climate and the amount of precipitation. As reported by Schumm (1963), it is obvious that no surface is lowered in a uniform manner; however, rates have been estimated, generally for a period of 1000 years.

Denudation rates for drainage basins of about 1500 square miles are 0.29 foot per 1000 years from gauging station data, and 0.51 from reservoir data with an effective precipitation (amount required to produce a known amount of runoff) of 10 inches (Langbein and Schumm, 1958). In another publication, Schumm (1963) concludes that an average rate of denudation for a 1500-square-mile area is about 0.25 foot per 1000 years. For a small drainage basin in southwestern Utah, Eardley (1966) determined a rate of 2.75 feet per 1000 years.

In 1948 and 1949, a comprehensive survey was made of the sedimentation in Lake Mead as the result of construction of Hoover Dam. For 1935 and 1948, the average rate of sedimentation was estimated at 140 million tons for the Colorado River (Gould, 1960). The mean specific weight for the sediments was 64.6 pounds per cubic foot. The drainage basin for the Colorado River above Lake Mead is about 168,000 square miles. In addition, it is assumed that the specific weight of the uneroded soils is 90 pounds per cubic foot. Using these figures, the rate of denudation for the Colorado River drainage basin for the period 1935 through 1948 is 0.93 foot per 1000 years.

Thomas (1960) prepared a map showing source areas as inferred from surface geology of the drainage area upstream from Lake Mead. This map indicates that the Mexican Hat site is in an area that produces sandy sediments. The amount of sediments produced from a unit area in these sediments would probably be less than the amount produced from areas of silt and clay.

The rates of denudation that have been determined are from large drainage areas. For smaller drainage areas, the

variability in rates is apparent. In the case of this site, an extremely small area, the importance of a rate of denudation needs to be put in perspective in relation to the site geology.

Wind is the dominant factor acting on the surficial geology. Undoubtedly over a period of 1000 years, sediment would be removed by runoff, but this would not be as important as that removed by wind.

As an example of localized variation, Moenkopi Wash near Tuba City has cut down about 300 feet since the formation of the early Wapatki and Black Point surfaces. Damon et al. (1974) indicate that the rate of denudation in the Little Colorado River since the time of these surfaces is about 3.15 feet per 1000 years. Although the Moenkopi Wash has been dissected, the surfaces remain and are easily identifiable. Thus, Moenkopi Wash indicates a large rate of denudation, whereas the above-mentioned surfaces have not been subjected to such high rates.

D.3.4.6 Climate and vegetation

Details of site meteorology are presented in Section D.9. Rainfall in the site region is generally less than 20.3 centimeters (cm), or eight inches, and maximum daily temperatures in July and August exceed 100°F (USGS, 1970; Hicks, 1969). This climate directly affects vegetation, leading to sparse cover. The vegetation type is controlled by topography, with a grass-shrub zone occurring below 1675 m (5500 ft), pinon-juniper between 1675 m (5500 ft) and 2285 m (5500 ft), and pine forest above 2285 m (7500 ft) in elevation (Hicks, 1969). The Mexican Hat site, at an approximate elevation of 1305 m (4280 ft), is in the grass-shrub zone dominated by isolated stands of grass and sparse growth of shrubs, principally greasewood and sagebrush.

Wind direction determined from modern sand dune morphology is predominantly from the southwest. Paleoclimate studies of the Chuska Sandstone indicate a predominant regional wind direction from the southwest during the Pliocene (Hicks, 1969).

D.3.4.7 Long-term climate variation

Major climatic changes during the next 1000 years in the Mexican Hat area will probably be of lesser magnitude than the climatic shift following the last full glacial period in the southwestern United States. This period ended in Arizona about 10,000 years ago. Paleoclimatic reconstructions for the last full glacial period differ in interpretation of precipitation and temperature in comparison with the present. Most interpretations of this period propose a climate characterized by increased precipitation, cooler summer temperatures, and milder winters for the desert areas (Spaulding et al., 1983). Other

paleoclimatic data suggest a period of precipitation amounts similar to today's, but with much colder summers and winters (Brackenridge, 1978). Studies in Canyon de Chelly, Arizona (Betancourt and Davis, 1984), and in the Chaco Canyon region of New Mexico (Betancourt et al., 1983; Hall, 1977) indicate a late glacial climate for the Colorado Plateau characterized by cooler summers and more abundant rainfall concentrated in the winter months. Paleoecological reconstructions based on evidence from the eastern Grand Canyon and the Mogollon Rim regions also indicate glacial climatic conditions cooler and probably moister than at present. Upper elevation plateaus north of latitude 36°N probably experienced severe winters. Paleohydrologic reconstructions of the Colorado Plateau region suggest an increase of total annual precipitation of 18 to 25 cm (seven to 10 in) (Spaulding et al., 1983). Analysis of periglacial features in the San Francisco Peaks and the White Mountains of Arizona indicate mean annual mountain temperatures 5°C to 6°C (9°F to 11°F) lower than today's (Péwé et al., 1984). Colorado Plateau temperatures were probably lowered by about the same amount.

Although no paleoclimatic studies are available for the local Mexican Hat area, a generalized late glacial climatic reconstruction can be made for the Colorado Plateau interior. Based on an increase in total annual precipitation of 18 cm to 25 cm (seven to 10 in), the full glacial annual precipitation may have been as great as 33.5 cm to 40.5 cm (13 to 16 in). Using an average lowering of 5.5°C (10°F), the average annual temperature about 10,000 years ago was about 7.5°C (45°F). Summer temperatures were probably much lower than today's, while winter temperatures were only slightly lower (Spaulding et al., 1983). Annual evaporation rates for soil moisture may have been 10 to 50 percent less than current rates. The magnitude of climatic change differs throughout the southwest however, depending on geographic location, site elevation, and local topography.

The record of climatic variation during the past 10,000 years (Holocene) in the northwestern New Mexico region of the Colorado Plateau has been inferred from soil and alluvial stratigraphy and paleoecological evidence. In Chaco Canyon, botanical evidence supports increasing annual temperatures and summer monsoon patterns by about 8300 years before the present (BP) (Betancourt et al., 1983). Holocene warming in the White Mountains of Arizona commenced about 10,000 years BP (Péwé et al., 1984). Decreasing effective precipitation and warmer temperatures allowed desert grasslands to replace conifer woodlands by about 8000 years BP (Baker, 1983). A major period of incision of alluvial fills in the Chaco Canyon area from about 8000 to 7000 years BP implies increased water runoff and possible large flood events during summer monsoons (Hall, 1977). Widespread regional erosion suggests a change from cool, moist conditions to warm, moist conditions (Knox, 1983). An increase in aridity in northwestern New Mexico from about 7000 to 2400

years BP correlates with the establishment of the present-day desert vegetation in the southwest. Throughout the southwest, the intensity of alluviation lessened from about 3000 to 2000 years BP, indicating a slight increase in precipitation. Slightly more arid conditions existed from about 2000 to 850 years BP, followed by increased rainfall until about 650 years BP (Lowe, 1980). A period of fairly stable climatic conditions similar to those of today's existed until the onset of the late 19th century channel trenching.

In northeastern Arizona, the end of the Pleistocene was characterized by the disappearance of mountain glaciers and a climatic period similar to today's. This was followed by a short period of warmer, drier conditions during the early Holocene (Péwé et al., 1984). This in turn was followed by a cool, wet time during which small mountain glaciers formed in the White Mountains. A drier and warmer climate followed, continuing to the present time.

An increase in the rate and magnitude of gully erosion began in the mid- to late-19th century throughout the southwest. The initiation of erosion is thought to be a result of either livestock overgrazing or short-term climatic change. Previous work on the causes of increased gullying is summarized by Euler et al. (1979). Along the Rio Puerco, east of Grants, New Mexico, gullying apparently began in the 1840s. In other areas of the southwest, gullying began in the late 1880s. Most investigators agree that a brief period of decreased moisture preceded gully erosion and that overgrazing initiated gully formation. Gullying may have developed later in response to drought without overgrazing.

Climatic variation within the last 1000 years in Arizona has probably been significantly less than the glacial-postglacial change. Interpretations of Colorado Plateau climatic conditions from tree ring studies (Stockton and Jacoby, 1976) and historical records show a high degree of variability in precipitation during the past few hundred years. Average ranges of temperature and precipitation for the past few hundred years and for the future few hundred to a thousand years probably are similar to the range of historical records, although it is recognized that extreme events beyond the range of recorded variability probably occurred in the past and can be expected to occur within the next thousand years. Extreme precipitation events may produce rapid surface-water runoff, localized flooding, and increased channel erosion and deposition.

D.3.5 SITE GEOLOGY

The Mexican Hat site lies in northeast-trending tributaries along the western flank of Gypsum Creek, a north-trending drainage that joins the San Juan River (Figure D.3.5). The bedrock at the site consists of

gently dipping rocks of the Halgaito Shale Formation, lowermost member of the Cutler Group (Figure D.3.3 and D.3.6). The overlying Cedar Mesa Member of the Cutler Group crops out about 1.6 km (one mile) east of the site in Gypsum Creek Wash. Disconformably underlying the Halgaito Shale Formation at the site is the Honaker Trail Formation of the Hermosa Group.

The site lies on the west limb of the Mexican Hat syncline, the structure separating the Halgaito anticline to the west and the Raplee anticline to the east (see Figure D.3.4). The axis of the north-south-trending Mexican Hat syncline lies about 4.8 km (three miles) east of the site. These two anticlines and the intervening Mexican Hat syncline are gently- to moderately-folded, minor structures on the edge of the Monument Upwarp, a regional feature of the Colorado Plateau. The eastern edge of the Monument Upwarp in the site region coincides with the eastern flank of the Raplee anticlinal structure.

Based on the logs of test borings advanced on the site during this investigation, a geologic cross section through the site area was prepared (Figure D.3.7). The site is on east-southeast-tilted Halgaito Shale redbeds. There are only minor eolian sand dune deposits as surficial cover of the bedrock. The Halgaito Shale is 15 to 30 m (50 to 100 ft) thick at the site. The thickness of the Honaker Trail Formation at the site is unknown. The Halgaito thins to the east and the Hermosa thickens to the east. Borehole data for the site are in Addendum D4 of this appendix.

The tailings at Mexican Hat have been reconfigured from two adjoining piles into one pile in the area of the former easternmost pile. The tailings rest within a small drainage that originally flowed northeastward to a confluence with Gypsum Creek. The relatively low topography to the north and west is interrupted by incised arroyos, while an alignment of small hills flanks the lower impoundment to the south. A relatively small watershed is present above the tailings impoundments. Runoff from this area is around the disposal area in a diversion channel that flanks the site to the south. The site is about 240 feet higher than the San Juan River, which is about 1.3 miles to the north.

In addition to the truncation of the main arroyo by the lower tailings dam, three other significant secondary drainage paths extend up to the northern and western toe of the lower embankment. The heads of these arroyos contain little, if any, alluvium, and rocks of the Cutler Group are persistently exposed transverse to the drainage paths.

The site lies on gently sloping eroded bedrock. No indications of subsidence or landslide features are present. The drainage is governed by two northeast-trending ephemeral stream channels through the site (Figure D.3.8). The absence of surficial cover precludes expansive, collapsing, or dispersive soils, but the cold winter temperatures could affect frost heaving, solifluction, and slope creep in the eolian sand or the tailings under proper moisture conditions. Wind has removed some of the tailings to the northeast of the existing piles.

D.3.6 ECONOMIC GEOLOGY

Known mineral and fossil fuel deposits in the area of the tailings site are natural aggregate, crushed stone (manufactured aggregate), and oil and gas.

Natural aggregate deposits in this area are confined to a few scattered occurrences of stream and terrace alluvium. A high-level terrace alluvium occurs at several localities along the San Juan River in the Mexican Hat, Utah, area. The largest deposit of this type is on the north edge of the San Juan River and immediately west of U.S. Highway 163. This deposit caps a series of low-rounded hills and consists of up to 20 feet of gravelly material. Similar deposits of high-level terrace gravels occur elsewhere along the San Juan River (BIA, 1955).

Crushed stone sources consist predominantly of limestone that crops out at several localities in the vicinity of Mexican Hat, Utah. Several of these sites are within the San Juan River Canyon and would require the removal of thick rock overburden or underground quarrying to produce a large tonnage. The most accessible and ideal deposit of limestone occurs southwest of Mexican Hat along U.S. Highway 163. At this site, a limestone bed three to four feet thick crops out on the eroded dip-slope of the Halgaito anticline. The limestone at this site is essentially bare or covered by a thin silt and "blow" sand overburden (BIA, 1955).

Oil and gas are present in the Pennsylvanian age sedimentary bedrock of the Mexican Hat Oil Field. This oil field lies directly north of the San Juan River and extends from the town of Mexican Hat northward for a distance of about three miles (Wengerd, 1955). Production from this oil field is ongoing, and to December 1984, the Mexican Hat Oil Field had produced 10,951 barrels of oil, 1584 million cubic feet of gas, and 673 barrels of water (Carney, 1985). Drill holes west of the tailings piles encountered oil and gas traces within the Honaker Trail Formation at depths of 175 to 190 feet.

D.3.7 SEISMOTECTONIC SETTING

D.3.7.1 Regional setting

Seismic hazard studies in much of the southwestern United States are hampered by the lack of a reliable long-term historical record. Movements on major fault systems in the region may have recurrence intervals on the order of tens to hundreds of thousands of years, while the historical record dates back only to the middle or late 19th century. The historical record for Arizona dates back to 1776 (DuBois et al., 1982); for Utah to 1850 (Arabasz et al., 1979); for Colorado to 1870 (Kirkham and Rogers, 1981); and for New Mexico to 1849 (Sanford et al., 1981). Reliable and reasonably complete instrumental records generally date back only to the early 1960s. As a general rule, the historical record is probably reliable for moderate to large earthquakes since about 1900 to 1910, while the instrumental

record is probably reliable for earthquakes of magnitude 4.5 or greater since the early 1960s (Von Hake, 1984).

In the absence of a reliable long-term historical record, probabilistic analyses of seismic risk are of limited use. Therefore, seismic risk analyses are largely based on studies of the geologic and seismotectonic setting, Cenozoic geologic history, and geomorphic evidence of Late Tertiary and Quaternary fault movements. Fortunately, erosion rates are slow and vegetation is generally sparse in the arid to semiarid climates that prevail in most of the region. Long faults, which are necessary for large earthquakes, will not remain undetected if careful geologic investigations are made (Krinitzsky and Chang, 1975).

The site is near the geographic center of the Colorado Plateau physiographic and seismotectonic province. The boundaries of seismotectonic provinces in the site region, as defined for this study, are shown on Figure D.3.9. They are determined on the basis of published studies of Neogene faulting, regional seismicity trends, areas of Cenozoic igneous activity, geophysical data, and the distribution of major physiographic provinces. Shown on Figure D.3.10 is a plot of historical and instrumentally located earthquake epicenters (for events of magnitude ≥ 4 and intensity (I_{MM}) $\geq$ V) for the Colorado Plateau region. These data were provided by the National Oceanic and Atmospheric Administration (NOAA), National Geophysical Data Center (NGDC). A listing of the epicentral data used in compilation of this figure is available from the UMTRA Project Office, Albuquerque, New Mexico.

The Colorado Plateau, Basin and Range, Rio Grande Rift, and Sierra Nevada Provinces appear to be part of an interrelated system that has experienced major uplift and extension during the last 20 million years (Thompson and Zoback, 1979). Within the Basin and Range and Rio Grande Rift bounding the Plateau is found geologic and geomorphic evidence of repeated surface faulting events associated with large earthquakes during Quaternary time. They have experienced some of the largest historical earthquakes in the entire United States. These regions are characterized by large volumes of Cenozoic intrusive rock, thinner crust, higher heat flow, and stress fields oriented differently than the modern stress field in the interior of the Plateau (Thompson and Zoback, 1979). The boundary of the Colorado Plateau and the Basin and Range Province on the west is marked by the Wasatch Frontal fault system in Utah, which forms a major segment of the Intermountain Seismic Belt (Smith and Sbar, 1974). The transition zone in northern and central Arizona is referred to in this study as the Arizona Border Zone. Some of the largest historical earthquakes of the Colorado Plateau have occurred in this region. The Rio Grande Rift and the eastern Colorado Plateau border zone in New Mexico and southwestern Colorado, and the border zone of the Colorado Plateau and Western Mountain Provinces in western Colorado, have

also been the locus of elevated seismicity in historical times. To the north, the Plateau is bordered by the Wyoming Basin, a series of broad basins and uplifts that are structurally and tectonically similar to the Plateau. This transition zone is not marked by elevated seismicity.

The Mexican Hat site is within the stable interior portion of the Colorado Plateau, at distances of 100 to 200 km from the major seismic zones. The occurrences of MEs at the closest approaches to the site of the Intermountain Seismic Belt, Rio Grande Rift, and Basin and Range Provinces would not produce significant accelerations in the site area. The major features of interest to a seismic hazard study of the Mexican Hat site are 1) possible FEs (not associated with known structures) in the immediate site area; 2) mapped faults, fault groups, and lineaments within a 65-km radius of the site; and 3) faults of the San Francisco volcanic field fault domain in north-central Arizona (Menges and Pearthree, 1983). These features all lie within the Colorado Plateau Interior, except for the San Francisco volcanic field fault domain, which overlaps the boundary of the Interior and the Arizona Border Zone.

D.3.7.2 Colorado Plateau seismotectonic province

The modern Colorado Plateau is composed of a stable interior portion bounded on the west, south, and east by more highly active border zones. For this study, the interior and border zones are defined as separate subprovinces, and the boundary is drawn at the 40-km crustal thickness contour. The border zones lie within the physiographic boundary of the Colorado Plateau, but are characterized by elevated seismicity, thinner crust, higher heat flow, common normal faulting, and elevated levels of Tertiary and Quaternary volcanism relative to the interior. Nearly all of the larger historical earthquakes of the Plateau have occurred within the border zones.

Neogene faulting is generally rare within the interior portion of the Colorado Plateau, except for faulting associated with the Uncompahgre Uplift and the collapsed salt anticlines of the Paradox Valley. Earthquakes are rare. The historical seismicity of the interior portion has been classified by Wong et al. (1982) as very low level, having events of small to moderate magnitude with diffusely distributed epicenters. The largest instrumentally recorded earthquakes within the interior portion have fallen in the magnitude range 4.5 to 5.0.

The largest historical earthquakes recorded within the Colorado Plateau have occurred in the border zones. These include:

- Events of estimated magnitudes 5.5 to 5.75 (M_L) at Lockett Tanks, Arizona, in 1912 and Fredonia, Arizona,

in 1959 (DuBois et al., 1982). These events occurred within the Arizona Border Zone separating the Colorado Plateau from the Basin and Range Province to the south.

- The Dulce, New Mexico, earthquake of January 23, 1966, of magnitude (M_b) 5.5 (NGDC/NOAA, 1985). This event occurred in the zone of transition between the Colorado Plateau and Rio Grande Rift (Herrmann et al., 1980).

- The earthquake of October 11, 1960, of magnitude 5.5, northeast of Ridgway, Colorado, which was strongly felt in the Ridgway-Montrose area. This event may be associated with the Ridgway fault that terminates the southeastern end of the Uncompahgre Uplift, marks the northwestern boundary of the San Juan volcanic field, and may be the boundary between the Colorado Plateau and Western Mountain provinces (Kirkham and Rogers, 1981; Sullivan et al., 1980).

Recurrence intervals have not been established for large earthquakes within the Colorado Plateau. They may be on the order of tens or hundreds of thousands of years.

D.3.7.3 Intermountain seismic belt

The following discussion is largely excerpted from Smith and Sbar (1974). The Intermountain Seismic Belt shown on Figure D.3.9 is a zone of pronounced earthquake activity extending north from Arizona through Utah, eastern Idaho, and western Wyoming, and terminating in northwestern Montana (see Figure D.3.9). It coincides with the boundary between the Basin and Range Province and the Colorado Plateau-Middle Rocky Mountains in central Utah, and lies roughly 200 km to the northwest of the Monument Valley site. The largest historical event of the Intermountain Region was the 1959 earthquake of magnitude 7.1 at Hebgen Lake, Montana. More than 15 events with magnitudes greater than 6.0 have been reported since the mid-1800s.

The Intermountain Seismic Belt includes the Wasatch Frontal Fault System and other major potentially active faults of northern and central Utah. This zone is highly seismic and capable of large earthquakes (up to M = 7.6) at recurrence intervals at short as 250 years and averaging about 500 years (Swan, 1983).

D.3.7.4 Basin and Range Province in Arizona

To the south, the Colorado Plateau is bounded by the Basin and Range Province of Arizona and New Mexico. This province has moderate seismicity with no large historical events, although it is believed capable of large magnitude earthquakes (Menges and

Pearthree, 1983; Pearthree et al., 1983). Recurrence intervals for this province have not been established, but are probably on the order of hundreds to thousands of years.

D.3.7.5 Rio Grande Rift

The Rio Grande Rift is a north-south-trending extensional graben feature of great length and tectonic significance. It extends from Chihuahua, Mexico, through west Texas, New Mexico, and most of central Colorado, almost to the Wyoming state line. The rift was initiated in Neogene time and has experienced continued activity through the Quaternary. It is characterized by fault scarps in young alluvium; abrupt mountain fronts that exhibit faceted spurs; deep, narrow linear valleys; Neogene basin-fill sedimentary rocks; and a bimodal suite of mafic and silicic igneous rocks.

A high percentage of all the potentially active faults in Colorado and New Mexico lies within this province. The rift has been subdivided into northern and southern subprovinces in Colorado by Kirkham and Rogers (1981) on the basis of young faulting. Well-defined evidence of repeated Late Quaternary movement is abundant on several faults in the southern subprovince, whereas such evidence is obscure in the northern subprovince.

D.3.8 GEOLOGIC HAZARDS ANALYSIS

D.3.8.1 Site geomorphology and geomorphic hazards

The Mexican Hat site is in the lower reach of the drainage basin of Gypsum Creek, an ephemeral stream that trends northward near the axial trend of the Mexican Hat syncline just east of the site (see Figure D.3.5). The drainage heads approximately 25 miles south of the site and meets the San Juan River 1/4 mile below the mouth of the site tributary. This basin surface is formed on the eroded Halgaito Shale member of the Cutler Group.

The two tributary basins in which the tailings were placed lie on the west flank of the syncline structure. The upper tailings pile was spread across the head of two tributaries, Arroyo 1 and 2 (Figure D.3.8). The lower tailings pile is located entirely in Arroyo 2, with the edges of the cell located on the drainage divide of this tributary basin (Figure D.3.8). The drainages are controlled by the easterly dip of the syncline structure and by the prominent joint sets that trend north-northwest and east-northeast.

Figure D.3.8 was taken from stereo-pair aerial photos dated August 16, 1946. The acreage shown for drainage basins on the figure is for relative comparisons only. Other stereo-pair

photographs examined for assessment of geomorphic features were dated October 1, 1952 (22-82, GS-W1), August 11, 1982 (2059 MEX. HAT 1-01 & 1-02), and October 19, 1985 (LM 8567 12-1 TO 12-3).

The following features of the disposal cell design were built prior to suspension of Phase II construction (see HAT-Final Site Grading Plan, Drawing No. H/M-DS-10-0214, Appendix B):

- The perimeter toe ditch for keying erosion protection has been constructed.
- West Ditch, which intercepts drainage above the cell, has been constructed.
- North Ditch, which collects runoff from the west end of the cell, has been widened. Gully 1, tributary to Arroyo 1, has also been enlarged to receive flow from the central two-thirds of the cell.
- The side walls and bottoms of the arroyos have been straightened and cleaned.
- Key trenches for placement of rock armoring within Arroyos (Gullies) 2 and 3 downslope of the toe ditch have been excavated.

Arroyo 1 is on the north side of the site, and Arroyo 2 forms the foundation for the disposal cell. There are two other arroyos whose heads are near the toe of the cell and which have contained spurious windblown and alluvial contaminated materials deposits. These are designated as Arroyos 2A and 3. A fifth arroyo south of the site area is designated as the South Side Arroyo. The plans now designate Arroyos 2 and 3 as "gullies," with Gully 1 being a side wall gully to Arroyo 1.

The term "gully" is used to mean active local incision within or on the side walls of established drainages. The term "arroyo" is used for established ephemeral drainages with substantial basins that are tributary to Gypsum Creek. These features and the potential hazards they represent are described below.

Arroyo 1

This channel drains the north side of the site and originally contained the upper tailings pile near its head. The potential hazards presented by Arroyo 1 would be the potential for lateral migration and canyon widening by a process of minor lateral gullies and by undercutting the embankment. Arroyo 1 will receive all the drainage of its original basin plus approximately 82 percent of the tailings area of Arroyo 2. This arroyo and Arroyos 2 and 3 have their bottoms on a lower resistant layer of cemented silty sandstone. This layer, or

zone, is about 15 to 20 feet (4.5 to 6.1 m) below a similar upper resistant layer that forms the north and south drainage divides for Arroyo 2 basin. The north and south sideslope toes of the cell are founded on the upper resistant layer.

Arroyo 1 is bedded on the dip slope of this lower resistant strata for its full length to its confluence with Gypsum Creek. The thalweg (stream bed slope) profile of this drainage is shown on Figure D.3.11. The interval between the upper resistive layer, actually a zone composed of four distinct interbedded strata, and the top of the lower resistive layer consists primarily of a shale/clay stratum that erodes relatively easily.

Figure D.3.11 also shows a composite trench log of the upper resistant layer, the underlying clayey uncemented interval, and the top of the lower resistive layer. The cemented rock of the upper resistant layer resisted ripping by a D-9 bulldozer and required the use of explosives to excavate the diversion channels.

The moderate dip slope of Arroyo 1, shown as ranging from 0.033 foot/foot in the uppermost reach to as low as 0.014 and 0.011 foot/foot in the middle reach of the drainage opposite the cell, has a low potential for gullying (Figure D.3.12). It also has an observable high resistance to erosion. The side slopes of the arroyos adjacent to the disposal cell have been cut back to stable slopes, and the bottom has been cleaned of alluvium for its full width of approximately 50 feet (15 m) extending downslope to the site boundary. Because of the slight meanders in the arroyo, the stream slope is less than the actual bedrock dip (Figure D.3.11).

A demonstration of the resistance to erosion of this resistant layer is that there are no incised gullies or nick points in the flat-bottomed stream bed for its full length of nearly 7000 feet (2100 m) to the Gypsum Creek confluence. At this junction, Arroyo 1 has been undercut by the creek bed, forming a vertical outfall of 15 feet (4.5 m) or more. By comparison, Gypsum Creek is at least 25 miles (40 km) long and has a basin area exceeding 150 square miles (390 km^2). The full thickness of this lower resistant zone of interbedded cemented fine sandstone beds is exposed at this location and is at least 10 feet (three m) thick.

The drainage meanders slightly with control by north-trending bedrock joints systems. The joints become very noticeable as a consequence of slight differential weathering in the lower reach of the stream bed, where perennial seepage flow keeps the surface wet. Where erosion of this layer is observed in Gypsum Creek and Arroyo 2, the resistant layer is not eroded by the typical narrow incised gullies but proceeds by stripping the upper discrete bed to the next parting plane and advances as nick points that are the thickness of this discrete bed. In

this way, the channel maintains a fairly flat bed without constricting the flow. Because the site arroyos are aligned near true dip, there is little tendency to migrate laterally. Also, because of the lack of gullying and the tendency to spread in sheet flow across the resistant cemented layer in the arroyo bottom, the arroyos have widened to accommodate the short-term maximum flows.

The increased flow volume in Arroyo 1 at its confluence with Arroyo 2, as a consequence of the diversion of 82 percent of runoff of Arroyo 2 basin, will be approximately 72 percent. As a way of quantifying the potential for stream bed widening, the channel widths within this same clay/shale stratum in Gypsum Creek, which has a runoff potential of up to 150 square miles (390 km^2), is observed to measure only 300 to 350 feet (90 to 105 m) wide. This is approximately 175 feet (53 m) from the center of the channel in straight or slightly curved reaches. The inner canyon at sharp meanders in Gypsum Creek are as much as 500 feet (150 m) total width. By comparison, the setback of the north toe of the cell is measured at 320 feet (98 m) from the center of the channel in Arroyo 1. The narrowness of the canyon is attributed to the resistance of the upper cemented layer against lateral gullying. It is concluded that there is little potential for Arroyo 1 to pose a hazard to the cell.

Arroyo 2

As shown on Figure D.3.8, Arroyo 2, which originally had a basin area of about 90 acres that includes the disposal cell, has had all the drainage above the cell intercepted by the West Ditch. All runoff from the cell except approximately eight acres of the downslope toe is diverted through North Ditch and Gully 1 into Arroyo 1. The loss of 82 percent of potential runoff will greatly diminish the potential for headcutting to disturb the cell. Any potential headcutting would originate at its confluence with Arroyo 1, where the channel bottom would seek to match the level of that larger channel.

There are currently three nick points between this confluence and the toe of the cell. Each nick point averages approximately 24 inches (61 cm) deep or more. Upslope advancement is in a broad vee that widens to the full width of the channel, exposing the underlying flat bedding plane. The nick point advances by downdip displacement of block-sized fragments that separate along closely- to moderately-spaced joints. The nearest of these nick points to the cell toe coincides with intersection by a north-south trending minor fracture system that can be observed on aerial photographs (see Figure D.3.8). This appears to be the most prominent of the joint sets nearest the cell.

Besides the fracture intercept, another possible cause for the nick point may be the result of undercutting by erosion of

the one-foot (30-cm)-thick clay/shale bed between the cemented beds. Although the resistive layer would appear to be sufficiently stable with the very limited runoff potential, the presence of the nick points with a cumulative height of up to six feet (1.8 m) and within 600 to 800 feet (180 to 240 m) of the cell indicates it is prudent to protect against this potential headcutting.

The keyed erosion protection buffer zone that has been constructed in the channel bottom, located 150 feet (45 m) from the toe of the cell, and the erosion protection rock that will be placed in the keyed ditch will dissipate energy and adequately prevent headcutting by the nick point.

Arroyo 3

This is the larger of two small arroyos that converge a short distance downslope (see Figure D.3.8). This drainage system had approximately 250 feet (75 m) of its head intercepted by the tailings pile. The channel and banks of Arroyo 3 have been cleaned from the toe of the cell to the boundary fence during the initial site preparation, as have Arroyos 1 and 2. The lower resistive layer, which forms the channel bottom in Arroyos 1 and 2, underlies this arroyo but is poorly exposed and has been covered by regrading in the upper reach. Arroyo 3 converges with the tributary arroyo, flows southerly into the South Side Arroyo, and has a basin area of approximately 23 acres.

Arroyo 2A

Arroyo 2A flows northeasterly directly into Gypsum Creek. The basin size is the same as for Arroyo 3 (see Figure D.3.8). The drainage is poorly developed, and in most cases has not exposed the lower resistive layer. Both Arroyos 2A and 3 will not present a threat to the cell because of limited drainage areas and the integrity of the lower resistant rock layer.

Summary of potential hazards

Three potential geomorphic hazards are considered in this setting: 1) upland surface runoff; 2) wind erosion; and 3) headcutting and encroachment from existing drainages or constructed diversion drainages. These are discussed in the following paragraphs.

Upland surface runoff hazard. Diversion of surface water runoff from the watershed upslope of the site is a major concern. Arroyo 1 basin has a substantial area above the disposal cell area. The position of the constructed West Ditch, shown on Figure D.3.8, will intercept this upland drainage and divert it

into Arroyo 1 (the north side drainage). The on-site drainage will be diverted either through North Ditch or Gully 1 ditch to Arroyo 1.

Wind erosion hazard. The topographic setting of the site provides some protection from the erosive force of the wind. Due to the prevailing wind being from the west, the higher topography afforded by the drainage divide west of the site, at an elevation of 4350 feet (1325 m), provides substantial protection for the top of the cell at 4340 feet (1328 m). Additional adequate protection is provided by the erosion protection rock on the sideslopes of the cell.

Headcutting or encroachment of drainages. A potential hazard for headcutting that could affect the cell is represented by the cutoff head of Arroyo 2. The head of this drainage has been armored for 200 feet (60 m) from the toe ditch divide to protect against headcutting.

The potential hazard for encroachment by channel widening is represented by the diversion ditch at the toe of the cell, the West Ditch intercept at the upslope side of the cell, and the channel of Arroyo 1 that is parallel to the north side of the cell. For the reasons presented in the above discussion of Arroyo 1, engineered protection against encroachment by widening is unnecessary.

The West, North, and Gully 1 diversion ditches have been armored in the bottoms at critical points to protect against flow concentration causing local gullying incision. Because of the 15- to 20-foot (4.5- to 6.1-m) drop in elevation, the outfall of Gully 1 Ditch has been sloped to prevent cascading into the bottom of Arroyo 1. See Drawing Nos. H/M-DS-10-0217 through -0220, Appendix B, Subcontract Documents, for design details.

The south side drainage is separated from the tailings by an elevated and sharply defined drainage divide that is founded on the upper resistant layer. This is not considered a potential hazard to the disposal cell because of this substantial relief.

Principal factors that provide assurance of geomorphic stability are as follows:

- The bottom of the north side arroyo has not been gullied, and its flat bottom promotes sheet flow conditions.
- Gypsum Creek canyon demonstrates the stability of the canyon walls and the resistance of the upper resistant layer as a constraint to canyon widening.

- The continuity of the lower resistant layer is demonstrated by the exposure in Arroyo 1 and 2. The persistence of the upper resistant layer is confirmed by the exposure and the effort required in excavations for the ditches and for the key trench in Gully 1 and the toe trench.

- The runoff from the cell will be dispersed between the West Ditch, North Ditch, Gully 1, and Arroyo 2, so that the potential for headcutting is minimized.

- The use of erosion protection armoring in the drainages, in addition to the protection afforded by the resistant strata, is a conservative approach against the potential for geomorphic hazards.

No site hazard is present from mass movement processes of landslides, debris flows, soil creep, mudflows, or rock falls. No quantitative data exist on site-specific rates of slope erosion or scarp retreat. No hazardous soil conditions have been identified.

Subsidence caused by mine collapse or solutioning of underlying bedrock is not a hazard at the site. No evaporites are present in the local stratigraphy, nor are there mines under or near the tailings. Traces of oil and gas have been found at depths of about 175 feet beneath the western edge of the site. Development of any large reservoirs of oil or gas could result in differential settling of ground surface near the site, although the possibility of subsidence is remote.

Gypsum Creek is in a relatively tectonically stable area. The effects of tectonic activity are discussed in Section D.3.8.3. The slow uplift of the Colorado Plateau region would not affect specific site design. Changes in the base level of streams or the local water level may produce changes in the process of degradation and alluviation in the site area. No quantitative data are available on the possible effects of base level or water table level changes in the Mexican Hat area.

Climatic changes would probably be of a lesser magnitude than those that occurred at the end of the Pleistocene, about 10,000 years ago. Predicted changes in the amount of precipitation, seasonality of precipitation, or temperature are not expected to produce site changes that would affect the stability of the final tailings pile design within the next 1000 years.

No hazards from volcanic activity are present in the tailings site area. No volcanic flows, cinders, or ash deposits have been recognized in the immediate vicinity of the Mexican Hat site. Small outcrops of Tertiary age explosive breccias occur about eight km (five miles) east of the site. No evidence occurs of volcanic intrusive activity younger than Pliocene in age.

D.3.8.2 Impact of natural resource development

In the site area only three economic natural resources may occur: petroleum and natural gas; uranium; and sand and gravel.

The economic uranium occurrences in the Mexican Hat region occur in the Recapture Member of the Morrison Formation. The nearest known economic deposit is about 37 km (24 miles) northeast of the site. No known uranium deposits occur close enough to the site area to affect future mining activity and site stability.

Although traces of oil and gas may have been found in the Paleozoic strata underlying the site, there appears to be little hazard to site stability, except for drilling directly on the stabilized tailings. A remote possibility of subsidence from fluid withdrawal exists if petroleum resources were developed.

Sand and gravel exploitation possibilities are low. The quality and quantity of sand and gravel deposits and eolian sand deposits are very poor.

No hazards exist from coal mining. All known coal resources in the region occur in strata younger than that at the site.

D.3.8.3 Seismic hazards

Technical approach

The objectives of the seismic hazard analysis performed for this study are as follows:

- Selection of the design earthquake and estimation of the on-site peak horizontal acceleration for use in subsequent engineering analyses.
- Recognition of any potential for on-site fault rupture.
- Recognition of any potential for earthquake-induced landsliding or subsidence due to tectonic causes.

The technical analysis performed for this study involves a critical review of all the information developed during the investigation and a step-by-step approach to estimating seismic risk.

The first step is to determine the largest possible magnitude of FEs in the seismotectonic province within which the site is located. The maximum FE is then assumed to occur at a radial distance of 15 km from the site, and the resulting on-site acceleration is calculated using the constrained acceleration/attenuation relationship of Campbell (1981). In this and subsequent steps of the analysis, the mean-plus-one standard

deviation (84th percentile) value will be adopted. The design value is considered a nonamplified, free-field, peak horizontal acceleration.

Following this, the maximum possible on-site acceleration resulting from earthquakes occurring in each of the remote seismotectonic provinces within the region of interest is determined. A detailed analysis of individual faults within remote provinces is not performed unless they lie within a 65-km radius of the site. A conservative approach is taken, wherein the closest distance of the remote province from the site is first measured. The measurement is made using published maps and literature to delineate province boundaries. The ME values for the remote provinces are estimated based on published studies and personal communications from researchers active in the areas. The ME is then assumed to occur at the closest distance of each remote province from the site, and the resulting on-site acceleration is calculated.

After completion of the first two steps in the analysis, the on-site accelerations resulting from the FE within the province containing the site and from the MEs at the closest approach of each of the remote provinces are compared. The largest value is taken as the critical acceleration during the subsequent capable fault analysis.

Based on the review of published and unpublished geologic data and the air-photo analysis, a compilation of all mapped faults and air-photo lineaments within a radial distance of 65 km of the site is prepared. The fault length/magnitude relationships of Bonilla et al. (1984) are used to determine the maximum magnitude earthquake that each structure could be capable of producing if it were determined to be a capable fault. An on-site acceleration resulting from each fault is then calculated using the acceleration/attenuation relationship of Campbell (1981). These values are then compared to the critical acceleration determined during the previous analysis. Any features potentially capable of producing a larger on-site acceleration than the critical value are subjected to a detailed field investigation to determine if they are capable faults.

The field investigation consists of analysis of the seismic record for evidence of micro- or macroseismicity associated with the fault, close inspection of the mapped fault trace on aerial photography, detailed ground reconnaissance for evidence of Late Quaternary or Holocene movements, and careful investigation of the indicated fault during the LSA aerial reconnaissance.

If any evidence is found to indicate the fault (or faults) to be capable, the calculated on-site acceleration is then recommended as the design acceleration value. The fault is designated as the controlling fault, and the ME on that fault is specified as the design earthquake.

Previous seismic zoning studies

Several probabilistic earthquake maps, which plot contours of maximum horizontal accelerations, velocities, and intensities for various return periods, have been prepared for the contiguous United States. Examples of such studies are those by Liu and DeCapua (1975), Algermissen and Perkins (1976), the Applied Technology Council (1978), and Algermissen et al. (1982). These studies were utilized to estimate the maximum value of each parameter for the site area. The resulting values are listed in Table D.3.2.

Liu and DeCapua (1975) developed 100-year contour maps of intensity and acceleration for the Rocky Mountain states. On their 100-year contour map of maximum predicted intensity, the site area lies in a north-south-trending region characterized by Modified Mercalli Intensity IV to V, which lies between the Intermountain Seismic Belt and the Rio Grande Rift. The Colorado Plateau is not clearly distinguished as a seismotectonic province. This indicates that a Modified Mercalli Intensity IV-V event will be experienced in the site area once every 100 years. Based on their 100-year contour map of peak accelerations for the Rocky Mountain states, an acceleration of 0.02 g to 0.03 g is predicted once every 100 years.

Contours of horizontal acceleration in rock having a 90 percent probability of not being exceeded in 50 years were presented for the contiguous United States by Algermissen and Perkins (1976). On their map, the stable interior portion of the Colorado Plateau is defined as a zone of maximum predicted horizontal acceleration in rock of less than 0.04 g.

The preliminary study of Algermissen and Perkins (1976) was updated by Algermissen et al. (1982), who presented probabilistic estimates of maximum acceleration and velocity in rock for periods of 10, 50, and 250 years. In comparison with the 1976 study, the 1982 study resulted in only minor modification of their estimates of peak accelerations for the Mexican Hat site region. They estimate that the maximum acceleration that will be experienced in the site region during a period of 250 years falls in the range 0.07 g to 0.10 g.

A study performed by the Applied Technology Council (1978) presented a map showing effective peak accelerations for the contiguous United States in which the geographic contours of seismic source zones and horizontal accelerations in the site area are the same as those presented by Algermissen and Perkins (1976) and Algermissen et al. (1982).

The accelerations calculated in these previous studies are uniformly lower than the maximum values calculated in this study. The discrepancy in the values results from the difference in approach taken for the studies. The previous studies are probabilistic analyses based on the rather brief

historical record, which predict parameters for limited time periods. The approach taken in the present study is a very conservative analysis, which assumes the potential occurrence of the most extreme possible events. A great deal of attention is paid to the details of the regional and local structure in this study. The maximum capabilities of all faults in the study area are taken into account. In addition, the design life of 1000 years is the basis of the present analysis, as compared to the time periods of 10, 50, 100, and 250 years assumed in the previous studies. Extrapolation of the results of the previous studies to the 1000-year design life would result in values more consistent with the conclusions of this study.

Review of epicentral data for the Colorado Plateau

An epicentral compilation for use in derivation of seismic parameters for the Colorado Plateau was obtained for this study from the NOAA/NGDC earthquake data file (see Figure D.3.10). The complete listing is available on request from the UMTRA Project Office, Albuquerque, New Mexico.

To facilitate the computer search, and to restrict the search area as closely as possible to the actual limits of the Colorado Plateau, two search areas were specified: a circle of radius 320 km and center at 36.0°N, 110.0°W, and a rectangular block covering the area 38.2°N-40.3°N, 107.3°-112.0°W. The choice of search areas resulted in some overlap beyond the borders of the Colorado Plateau, especially in central Arizona. These data were considered to be representative of seismicity of the border zones, and were included in the analysis.

Table D.3.3 was derived from this list. It represents all instrumentally located earthquakes within the Colorado Plateau (interior and border zones) of magnitude 4.0 since January 1, 1960. The list contains 70 events. Of these, 15 occurred either in the eastern Utah coal mining belt or in the oil and gas fields near Rangely, Colorado. These are considered to be artificially induced events caused by mining or oil and gas withdrawal (Smith and Sbar, 1974). They were not included in the subsequent analysis. Of the remaining 55 events, only two occurred within the stable interior portion of the Plateau as defined for this study. These include magnitude (m_b) events of 4.0 in the Paradox Basin on February 3, 1970, and 4.4 near Grand Junction, Colorado, on January 30, 1975. The data indicate that only four percent of the seismicity of the Colorado Plateau occurs in the stable interior. Those events that do occur are associated with tectonically unique structures such as the Uncompahgre Plateau and Paradox Basin.

The remaining 53 events, representing 96 percent of the data, occurred in the border zones. Twenty-three events occurred in the Rio Grande Rift border zone, and of these, 18

were associated with the swarm of events near Dulce, New Mexico, from January 1966, to January 1967.

Eighteen of the events are associated with the border zone of the Colorado Plateau and the Intermountain Seismic Belt in Utah and northern Arizona. Most of these events occurred along the Wasatch Frontal fault system. Seven events occurred in the border zone between the Colorado Plateau and the Western Mountain Province. These include the event of October 11, 1960, of magnitude 5.5 near Montrose, Colorado.

The remaining five events occurred in the Arizona Border Zone, and include several events of magnitude (m_b) 5.5 to 5.75 in the Flagstaff area.

Graphical determination of ME

The data were plotted on Figure D.3.13 to determine the ME value for the Colorado Plateau. Due to the scarcity of data for the Colorado Plateau interior, the data are representative of the border zones. The data show that there is no basis for any determination of the ME value for the interior from the instrumental seismic record. The historical record is also extremely limited and is probably even less reliable. The scarcity of recorded earthquakes of magnitude 5.0 and greater also limits the reliability of the ME determination for the border zones. The true ME value may lie anywhere within the range from 6.2 to 6.8. The average value of this range, magnitude 6.5, is considered to be a reasonably conservative value. This value is recommended as the ME value for the Colorado Plateau interior and border zones together. This value is also the value adopted by Kirkham and Rogers (1981) as the ME for the Colorado Plateau. The data do not permit any estimate of the recurrence interval for the ME event within the interior province. It may be on the order of tens to hundreds of thousands of years. For the interior and border zones combined, a reasonable estimate can be made on the basis of the historical record. Assuming the record for moderate to large earthquakes to be complete since about 1900, the data base covers a period of 85 years. This value represents an absolute minimum recurrence interval for the border zones. If it is assumed, conservatively, that one magnitude 6.5 earthquake occurs every 85 years within the approximately 425,000-km^2 area of the Colorado Plateau (interior and border zones), the probability of occurrence of a magnitude 6.5 event within any 15-km radius within the region is 0.06×10^{-4}. The recurrence interval of an ME earthquake within any 15-km-radius area is thus 166,666 years.

A graphical determination of the recurrence interval of the ME for the entire Colorado Plateau (interior and border zones) was also done, using the data shown in Table D.3.4, and is represented in Figure D.3.14. The results indicate a recurrence

probability of 0.0019 ME event per year, or a recurrence interval of 526 years.

Determination of FE magnitude

The definition of "floating earthquake" adopted for use in UMTRA Project seismic hazard evaluations is "an earthquake within a specific seismotectonic province which is not associated with a known tectonic structure." It is important to distinguish between the terms Maximum Earthquake (ME) and Floating Earthquake (FE). The ME magnitude should generally be larger than the FE magnitude, because large earthquakes are generally associated with ground breakage on known tectonic structures. The FE magnitude should never be greater than the ME.

It is generally accepted that FEs are of event slow to moderate magnitude. For example, Slemmons et al. (1982) state "The maximum magnitude for this type of earthquake in the eastern and central United States is about M_s = 5.75 to 6."

Krinitzsky and Chang (1975) state that "Uncertainties in the association of earthquakes with faults affect only small, magnitude 4.0 or 5.0 events. Long faults, which are necessary for large earthquakes, would not remain undetected if careful geologic investigations were made." They further state that the formation of new faults capable of causing destructive earthquakes is not a possibility that should be considered in design.

The maximum magnitude of the FE should therefore be equal to the threshold magnitude at which ground breakage will occur. It is generally assumed that all earthquakes of magnitude greater than about 6.0 to 6.2 do produce fault scarps at the ground surface in the western United States. Wallace (1978) indicates that earthquakes of magnitudes greater than about 6.0 are generally associated with ground breakage in the Basin and Range Province. The threshold magnitude is not precisely known for the Colorado Plateau, because there are no recorded seismic events associated with ground breakage. The largest recorded earthquakes in the Colorado Plateau have all fallen in the approximate magnitude range of 5.5 to 5.75. It is conceivable that this range may represent the ME value for the prevailing stress field. Thompson and Zoback (1979) state that the lack of major faulting and/or seismicity within the Plateau interior indicates low differential (shear) stresses. This range is considerably lower than the ME value of 6.5 used for UMTRA Project studies in the Colorado Plateau. The larger value is adopted in part because of the limitations of the historical data base. The magnitude range 5.5 to 5.8 may be a reasonable value for the FE magnitude, but a more conservative value is advisable considering the lack of a long-term data base. Since all earthquakes of magnitude 6.5 should be associated with ground breakage (i.e., be associated with a known tectonic structure) and the largest historical events fall in the range

5.5 to 5.75, the FE magnitude must fall somewhere within the range 5.75 to 6.5.

A more precise estimate can be made by evaluating the threshold magnitude at which ground breakage occurs from the appropriate fault length/magnitude relationship. The relationship of Bonilla et al. (1984) for plate interiors is:

$$M_s = 6.2 + 0.729 \log L$$

where

L = mapped fault rupture length.

The threshold magnitude can be estimated by setting L equal to zero. The resulting magnitude (M_s) is equal to about 6.0. This is in general agreement with the arguments of Krinitzsky and Chang (1975), Slemmons et al. (1982), and Wallace (1978), cited above. Allowing for possible errors and variability in the determinations discussed above, the more conservative value of M_L=6.2 is recommended for the maximum magnitude of the FE in the Colorado Plateau.

In accordance with Technical Approach Document (TAD) guidelines, this event is assumed to occur at a radial distance of 15 km for the site. Using the constrained acceleration/attenuation relationship of Campbell (1981), this results in an on-site peak horizontal acceleration (mean plus one standard deviation value, or 84th percentile) of 0.21 g. In the absence of known capable faults capable of producing higher accelerations at the site area, this event will be designated as the design earthquake, with a design acceleration of 0.21 g.

The recurrence interval for this event cannot be reliably estimated due to the lack of data, especially for the Colorado Plateau interior. It may be on the order of tens or hundreds of thousands of years. A graphical estimate of recurrence values (Figure D.3.14) shows an occurrence rate of 0.004 events of this magnitude per year, or one event of magnitude 6.2 every 250 years within the Colorado Plateau. This may be an extremely conservative estimate, considering the largest actual historical events and the limited data base. If it is assumed that one earthquake of magnitude 6.2 occurs randomly every 250 years within the entire plateau (an area of approximately 425,000 km^2), then the apparent probability of occurrence is approximately 1×10^{-8} events per square km per year. Using this base value, the probability of an event occurring within a specified time period and within any specified radial distance of the site can be simply derived. The probability of occurrence of the FE within the 15-km radius of any site during the 1000-year design life is 2.25×10^{-3}, or less than one percent.

Effects of MEs occurring within remote seismotectonic provinces

Remote seismotectonic provinces, subprovinces, or domains considered for this study include the following (see Figure D.3.9):

- Arizona Border Zone of Colorado Plateau (including San Francisco volcanic field fault domain). The state of Arizona was divided into separate domains of Late Quaternary faulting, based on regional distribution and spacing of faults and estimates of recurrence intervals, by Menges and Pearthree (1983). No Quaternary faults or potentially active features were recognized in northeastern Arizona. Faults associated with the San Francisco volcanic field near Flagstaff and extending north to the Utah border are the closest identified potentially active features to the site (see Table D.3.5). This domain appears to overlap the Interior/Border Zone transition. Rough ME estimates based on the approximate mapped lengths of faults in this domain indicate that magnitudes on the order of 6.5 may be possible. Faults in this domain are apparently the major potential sources of earthquakes that could affect the Mexican Hat site. Closest approaches of these features to the site area range from about 50 to 55 km. The occurrence of a magnitude (m_b) earthquake of 6.5 at a distance of 50 km would produce an on-site peak horizontal acceleration of less than 0.1 g in the site area (Table D.3.5).

- Intermountain Seismic Belt. The following discussion is largely excerpted from Smith and Sbar (1974). The Intermountain Seismic Belt is a zone of pronounced earthquake activity extending north from Arizona through Utah, eastern Idaho, western Wyoming, and terminating in northwestern Montana. It coincides with the boundary between the Basin and Range Province and the Colorado Plateau-Middle Rocky Mountains in central Utah. The largest historical event of the Intermountain Region was the 1959 earthquake of magnitude 7.1 at Hebgen Lake, Montana. More than 15 events with magnitudes greater than 6.0 have been reported since the mid-1800s.

  The Intermountain Seismic Belt includes the Wasatch Frontal fault system and other major potentially active faults of northern and central Utah.

  The ME value for the Intermountain Seismic Belt may be as high as 7.5 (Smith and Sbar, 1974). Though the seismic activity associated with the Intermountain Seismic Belt is irregularly distributed over a broad area, there is no evidence that seismicity associated with it has occurred within the interior of the Colorado Plateau. It therefore appears that the closest approach of potential earthquakes associated with the Intermountain

Seismic Belt to the Mexican Hat site is approximately 200 km. A magnitude 7.5 earthquake occurring at the closest approach of the Intermountain Seismic Belt would produce a peak horizontal acceleration of less than 0.05 g at the site (Table D.3.5).

- Rio Grande Rift. The Rio Grande Rift is a north-south-trending extensional graben feature of great length and tectonic significance. It extends from Chihuahua, Mexico, through west Texas, New Mexico, and most of central Colorado, almost to the Wyoming state line. The rift was initiated in Neogene time and has experienced continued activity through the Quaternary. It is characterized by fault scarps in young alluvium; abrupt mountain fronts that exhibit faceted spurs; deep, narrow linear valleys; Neogene basin-fill sedimentary rocks; and a biomodal suite of mafic and silicic igneous rocks.

  A high percentage of all the potentially active faults in Colorado and New Mexico lies within this province. The rift has been subdivided into northern and southern subprovinces in Colorado by Kirkham and Rogers (1981) on the basis of young faulting. Well-defined evidence of repeated Late Quaternary movement is abundant on several faults in the southern subprovince, whereas such evidence is obscure in the northern subprovince.

  The closest approach of active or potentially active faults associated with the Rio Grande Rift to the Mexican Hat site area is about 275 km.

  The estimated magnitude of an ME associated with the Rio Grande Rift (Kirkham and Rogers, 1981) is 6.5 to 7.5. An event of magnitude 7.5 occurring at a distance of 275 km from the site area would result in a peak horizontal acceleration of less than 0.01 g, as detailed in Table D.3.5.

The Rio Grande Rift Border Zone is anomalous in that it apparently is not associated with pronounced crustal thinning (see Figure D.3.9). However, the 1966 Dulce earthquake swarm occurred near the approximate transition. For this study, the border zone is defined arbitrarily as a 100-km-wide belt extending into the eastern margin of the Plateau from the mapped boundary of the Rio Grande Rift. The closest approach to the site is thus about 175 km. The occurrence of a magnitude (m_b) event of 6.5 at a distance of 175 km would produce an on-site peak horizontal acceleration of less than 0.01 g.

Fault and epicentral compilation: capable fault analysis

A compilation of all mapped faults and earthquake epicenters within 65 km of the site is shown on Figure D.3.15 and

listed in Table D.3.6. In addition to previously mapped faults, all lineaments derived from aerial photographic interpretation were compiled. All faults were observed at least once during the low-sun-angle aerial reconnaissance. Most features within 35 km of the site were field-checked during the ground reconnaissance phase of the study. Other features of regional significance outside the 35-km radius were also field-checked.

It was determined on the basis of the investigations performed that no faults lying within the 65-km radius show any evidence of Quaternary movements. In addition, no historical or instrumentally located earthquake epicenters lie within this radius. Regional features that are potentially capable of producing large earthquakes are too distant to affect design parameters at the site.

Since there are no capable faults within the 65-km radius from the site, design parameters are not affected by the capable fault analysis.

Recommended seismic design parameters

This study recommends that the FE be adopted as the design earthquake for the Mexican Hat site. The FE has a magnitude of $m_b = 6.2$. At 15 km (9.3 miles) from the site, this event would result in 0.21g of peak horizontal acceleration at the site. As this event is not assigned to a specific source or source area, recurrence, focal depth, and fault mechanism cannot be determined.

The acceleration derived in this report for the FE is a free-field acceleration, and site conditions (i.e., amount of alluvial cover, possible focusing, and the like) need to be considered during subsequent engineering efforts.

Potential for on-site fault rupture

As discussed above, there are no indications of any capable faults in the immediate site area. All mapped faults within the 65-km radius from the tailings piles were carefully examined during the investigation and showed no indications of Quaternary movements. Bedrock is fairly well exposed over much of the site area, except in the deeper washes and areas of large dunes. The possibility that large faults have gone undetected is remote.

Therefore, no evidence exists of any potential for on-site fault movements during the design life of the proposed facility.

Potential liquefaction hazard

A review of published earthquake reports by Youd and Hoose (1977) indicates that shallow, saturated, Holocene fluvial,

deltaic, and eolian deposits, and poorly compacted artificial sand fills have the highest susceptibility to liquefaction and subsequent ground failure. Holocene alluvial fan, alluvial plain, beach, terrace, and playa deposits were found to be less susceptible. Pleistocene sand deposits are generally even less susceptible, and glacial till, clay-rich, and pre-Pleistocene deposits are usually immune to liquefaction. The degree of sorting, the degree of compaction during sedimentation or construction, and the grain-size distribution are major factors controlling liquefaction potential. The greater the sorting and the looser the packing, the greater the liquefaction potential. Most episodes of liquefaction have developed at relatively shallow depths (probably less than 30 feet) and in areas where the water table (free or perched) was within a few meters of the ground surface.

The potential for liquefaction also depends on the degree of seismic shaking. The opportunity for ground failure in a given area is a function of the seismicity of the area and the rate of occurrence of earthquake ground motions of sufficient materials. The maximum distance from a seismic source to potentially damaging ground failures as a function of earthquake magnitude was determined by Youd and Perkins (1978). Liquefaction is not likely to be produced by earthquakes of magnitudes less than about 5.0 or at a distance greater than 75 to 150 km (47 to 93 miles) from the hypocenter.

The mapping and exploratory drilling performed for this study do not indicate the presence of natural materials susceptible to liquefaction beneath the tailings piles. The piles are located primarily on bedrock of the Halgaito Tongue of the Cutler Group. Minor amounts of unconsolidated eolian sands may underlie the pile in places, but are not saturated.

The recommended design earthquake is a magnitude 6.2 event occurring at a radial distance of 15 km from the site. Following the determination by Youd and Perkins (1978) cited above, this event should be considered capable of producing liquefaction at the site in susceptible materials.

Reservoir-induced seismicity

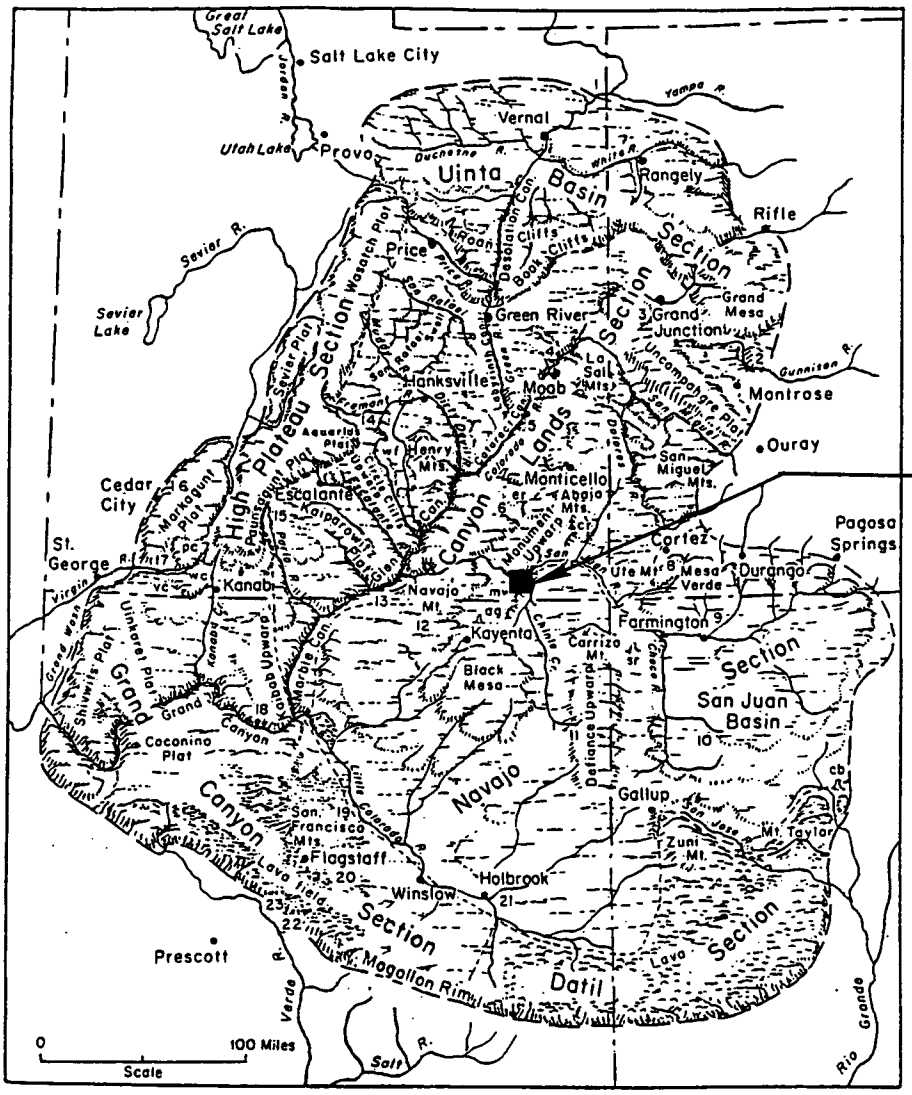
Published studies of reservoir-induced seismicity include reports by Carder (1945, 1970), the National Academy of Sciences (1972), Judd (1974), Milne (1976), Gupta and Rastogi (1976), Stuart-Alexander and Mark (1976), Packer et al. (1979), and Meade (1982).

A review of the previous literature by Meade (1982) indicates that the phenomenon occurs only in association with very deep reservoirs or reservoirs with very large storage capacity. Less than one percent of the world's reservoirs have been associated with macroearthquakes ($M_L \geq 3.0$) (Stuart-Alexander

and Mark, 1976). Table D.3.7 lists representative cases of reservoir-induced seismicity.

There are no large reservoirs near the Mexican Hat site. Due to the lack of abundant surface water in the site region, there is no potential for development of future large reservoirs. Reservoir-induced seismicity therefore does not present a potential hazard to site stability.

The nearest large impounded body of water to the Mexican Hat site is Lake Powell, whose upper reaches are about 70 km to the west. At this distance, even a very large induced earthquake would not produce an acceleration at the site greater than the design acceleration. At 50 km, induced seismicity would have to exceed magnitude 7.8 to produce a greater acceleration than the recommended 0.21 g. Furthermore, there are no known structures in the Lake Powell area which could be activated by crustal loading capable of producing an earthquake of this size.



MEXICAN HAT SITE

National Parks and Monuments

1. Dinosaur Nat. Mon.
2. Black Canyon of the Gunnison Nat. Mon.
3. Colorado Nat. Mon.
4. Arches Nat. Mon.
5. Canyonlands Nat. Park
6. Natural Bridges Nat. Mon.
7. Hovenweep Nat. Mon.
8. Mesaverde Nat. Park
9. Aztec Ruins Nat. Mon.
10. Chaco Canyon Nat. Mon.
11. Canyon de Chelly Nat. Mon.
12. Navajo Nat. Mon. (Betatakin and Kiet Seel)
13. Rainbow Bridge Nat. Mon.
14. Capitol Reef Nat. Mon.
15. Bryce Canyon Nat. Park
16. Cedar Breaks Nat. Mon.
17. Zion Nat. Park
18. Grand Canyon Nat. Park
19. Wupatki and Sunset Crater Nat. Mons.
20. Walnut Canyon Nat. Mon.
21. Petrified Forest and Painted Desert Nat. Mon.
22. Montezuma Castle Nat. Mon.
23. Tuzigoot Nat. Mon.

Escarpments at South End of High Plateaus

pc Pink Cliffs
wc White Cliffs
vc Vermilion Cliffs

Other Prominent Features

wf Waterpocket Fold
er Elk Ridge
cr Comb Ridge
mv Monument Valley
ag Agathla Peak
sr Shiprock
cb Cabezon Peak

REF: HUNT, 1967.

FIGURE D.3.1
PHYSIOGRAPHIC MAP OF THE COLORADO PLATEAU SHOWING LOCATION OF MEXICAN HAT SITE

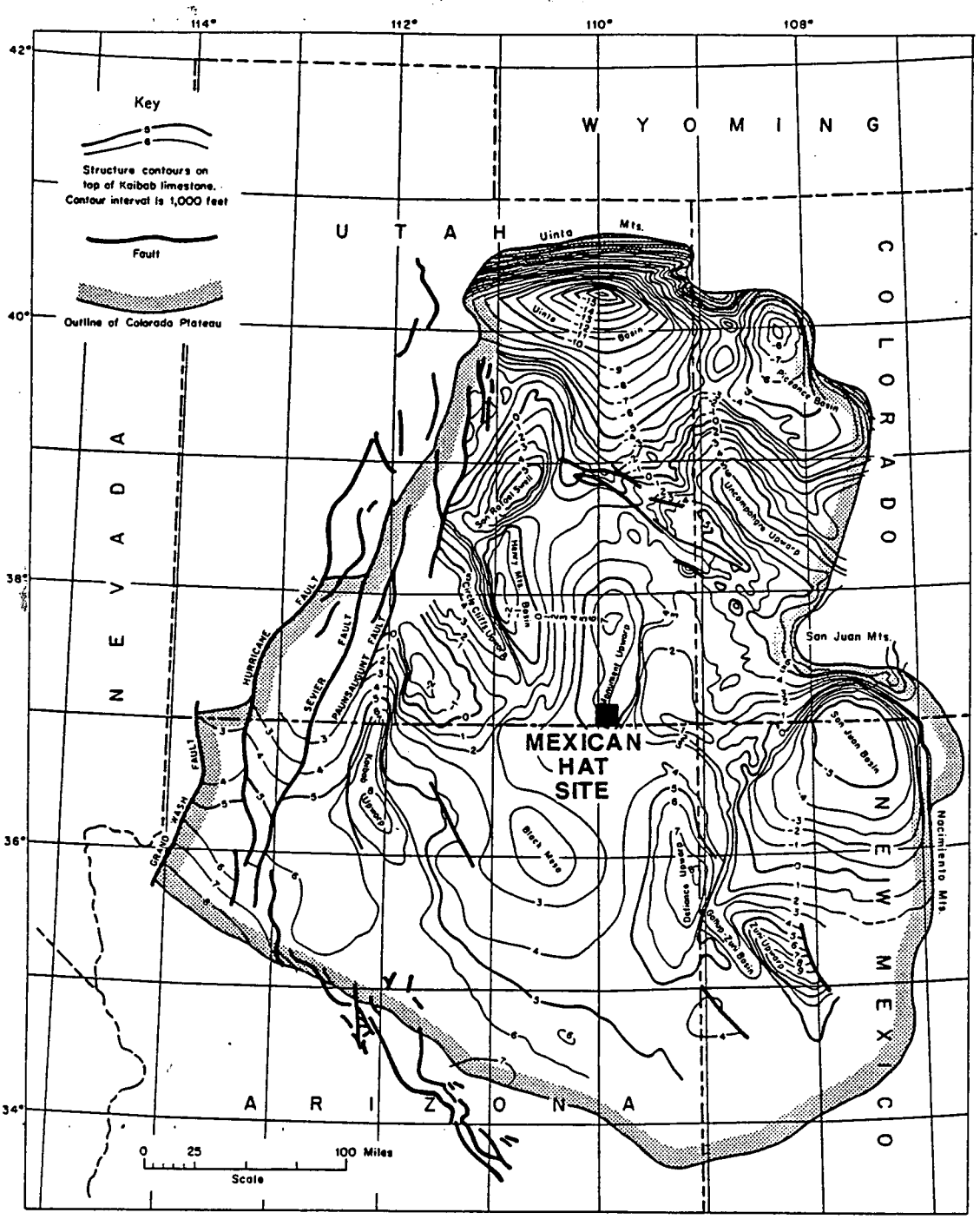
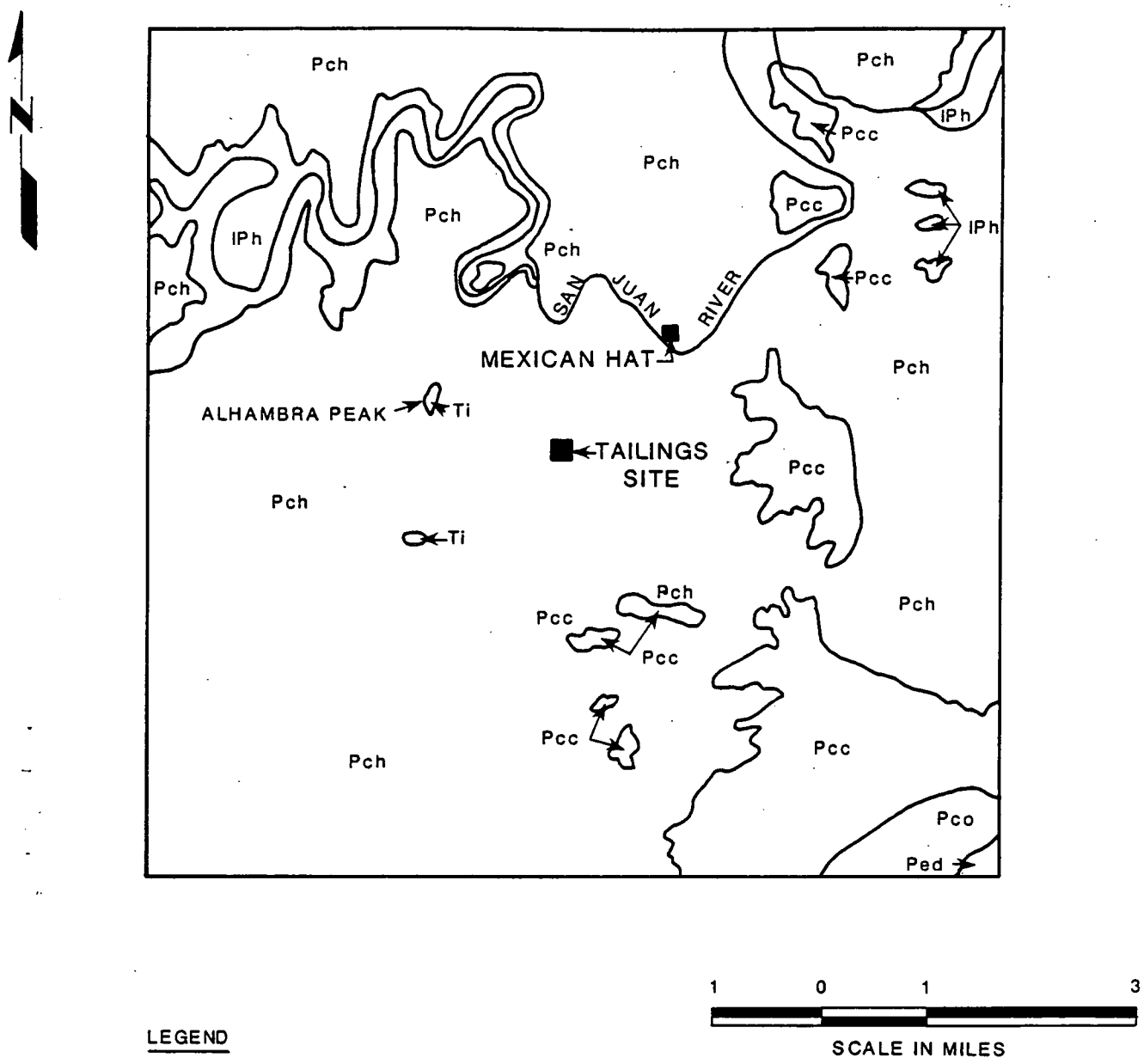


FIGURE D.3.2
STRUCTURAL CONTOUR MAP, MEXICAN HAT REGION

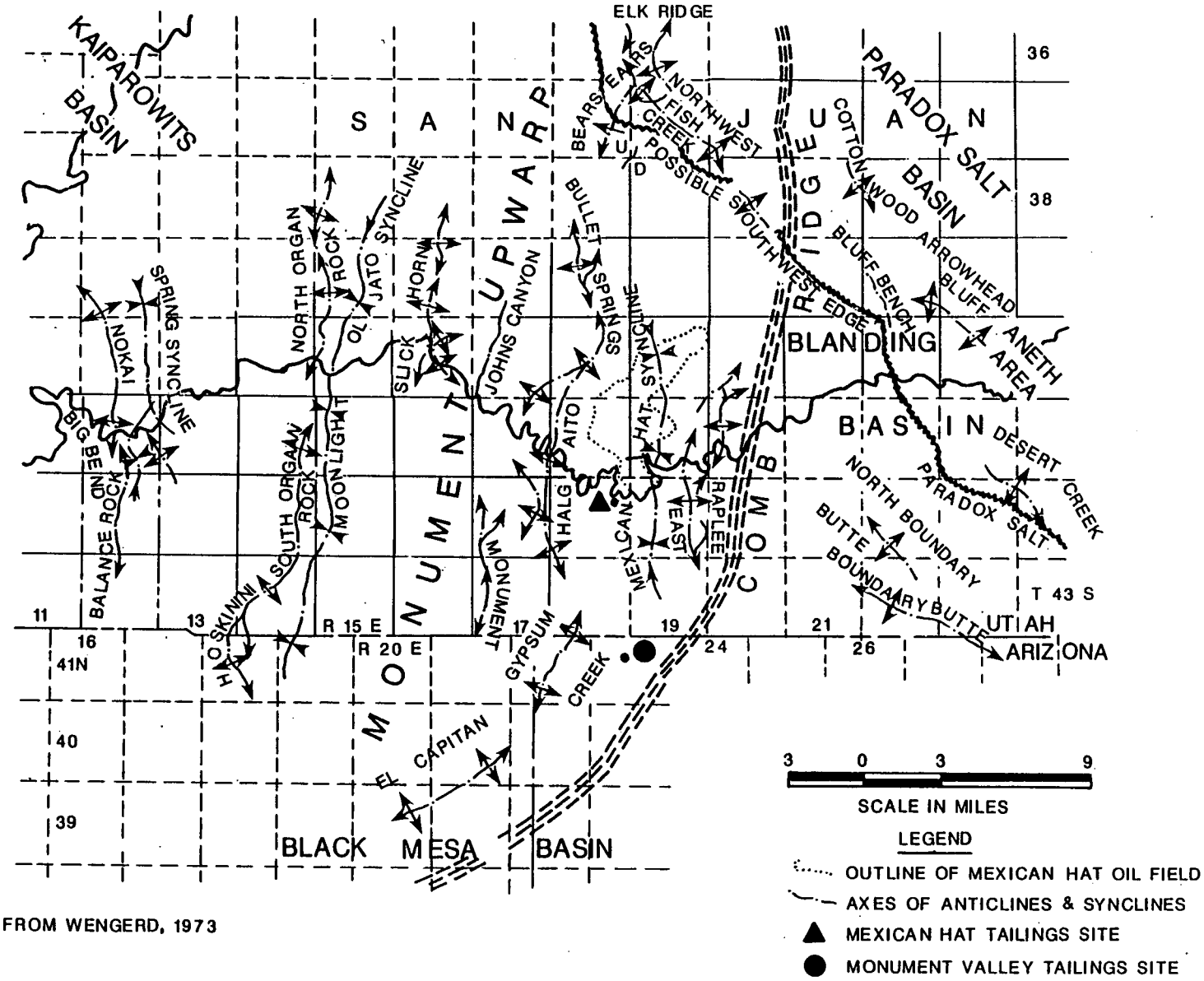


LEGEND

Ti	TERTIARY IGNEOUS ROCKS
Ped	DECHELLY SANDSTONE MEMBER OF CUTLER GROUP
Pco	ORGAN ROCK TONGUE OF CUTLER GROUP
Pcc	CEDAR MESA SANDSTONE MEMBER OF CUTLER GROUP
Pch	HALGAITO SHALE FORMATION OF CUTLER GROUP
IPh	HERMOSA GROUP

FIGURE D.3.3

GENERALIZED GEOLOGIC MAP OF THE MEXICAN HAT REGION



FROM WENGERD, 1973

FIGURE D.3.4

GEOLOGIC STRUCTURE OF THE MEXICAN HAT REGION

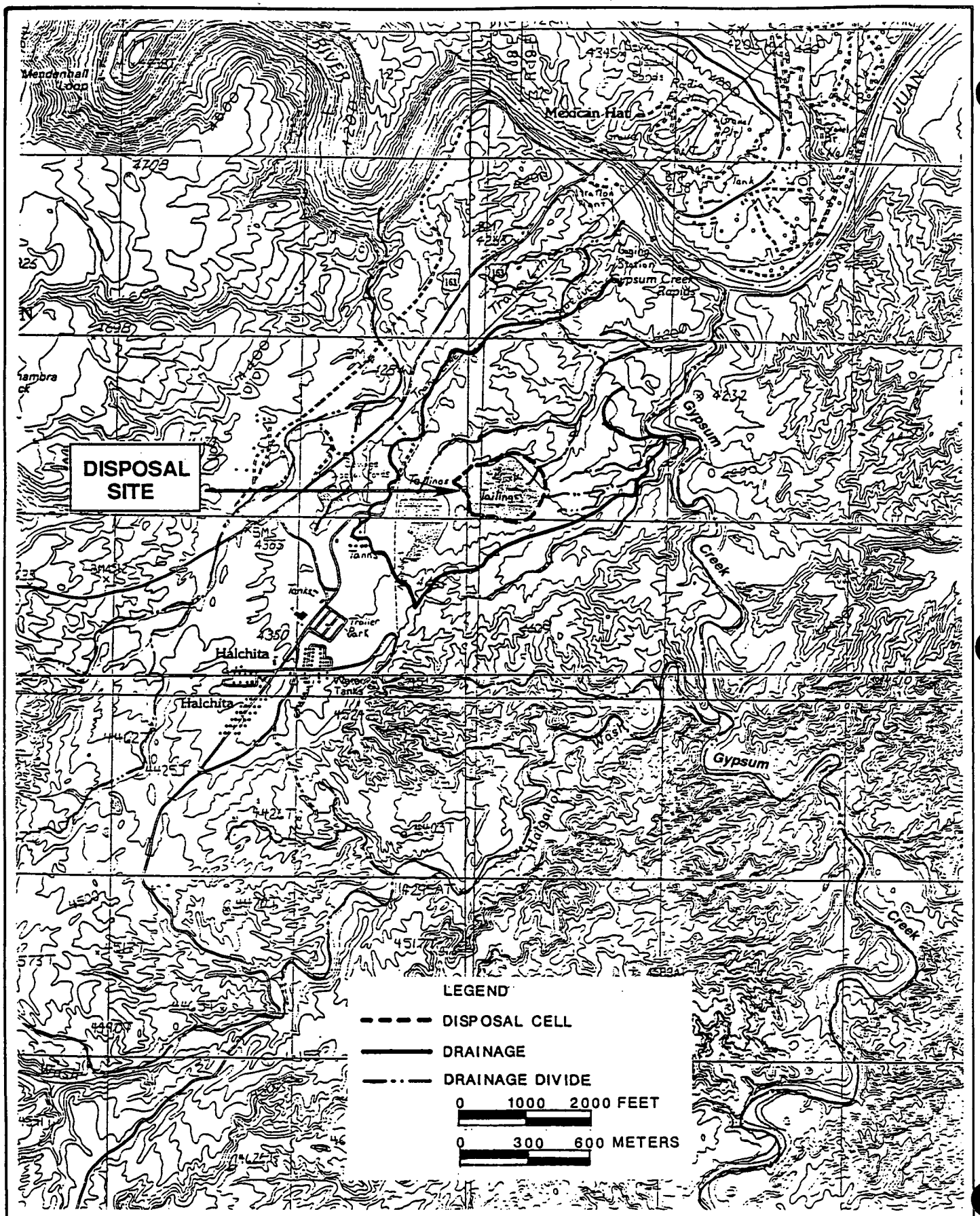


FIGURE D.3.5
DRAINAGES AT THE MEXICAN HAT, UTAH, UMTRA PROJECT SITE

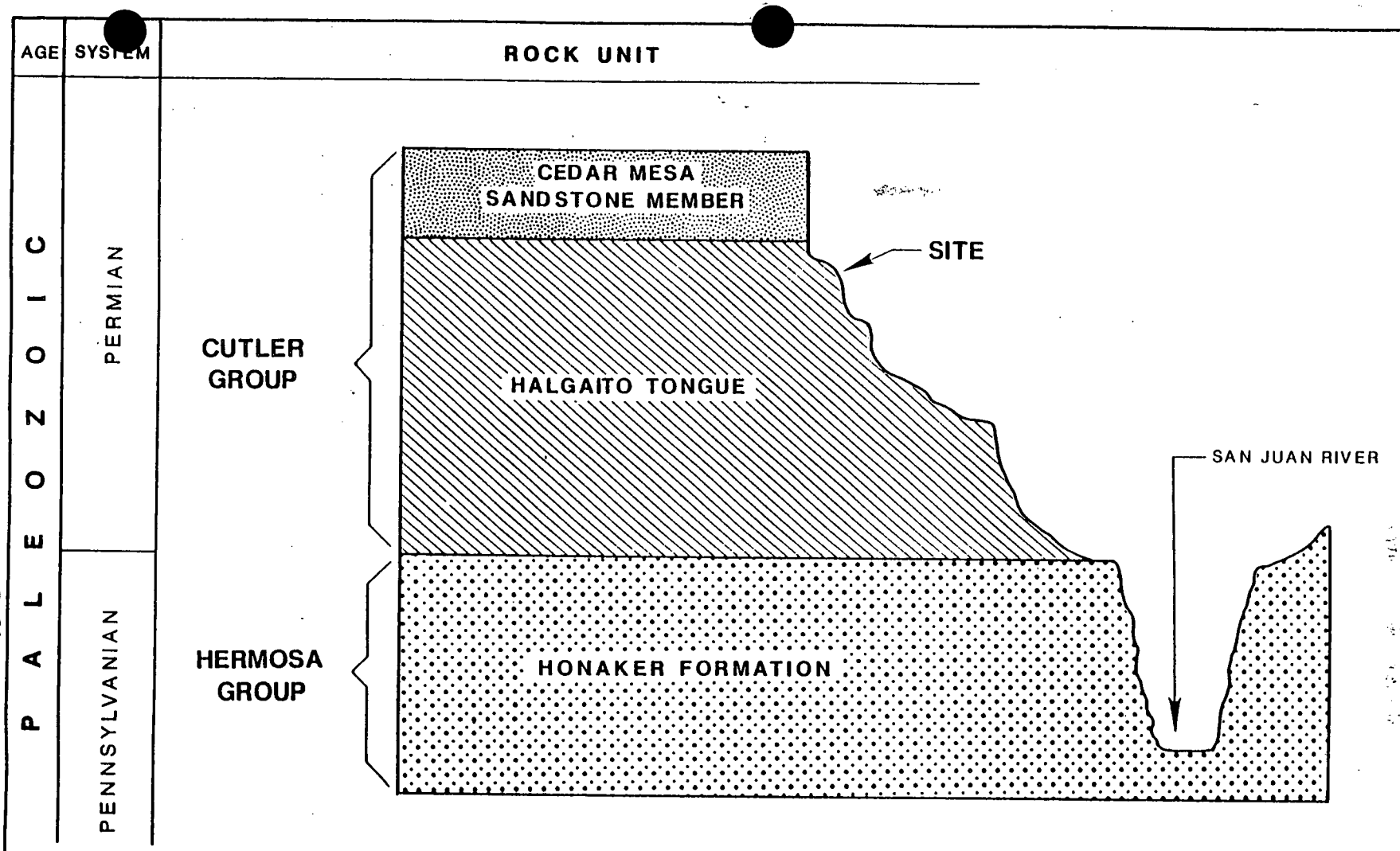
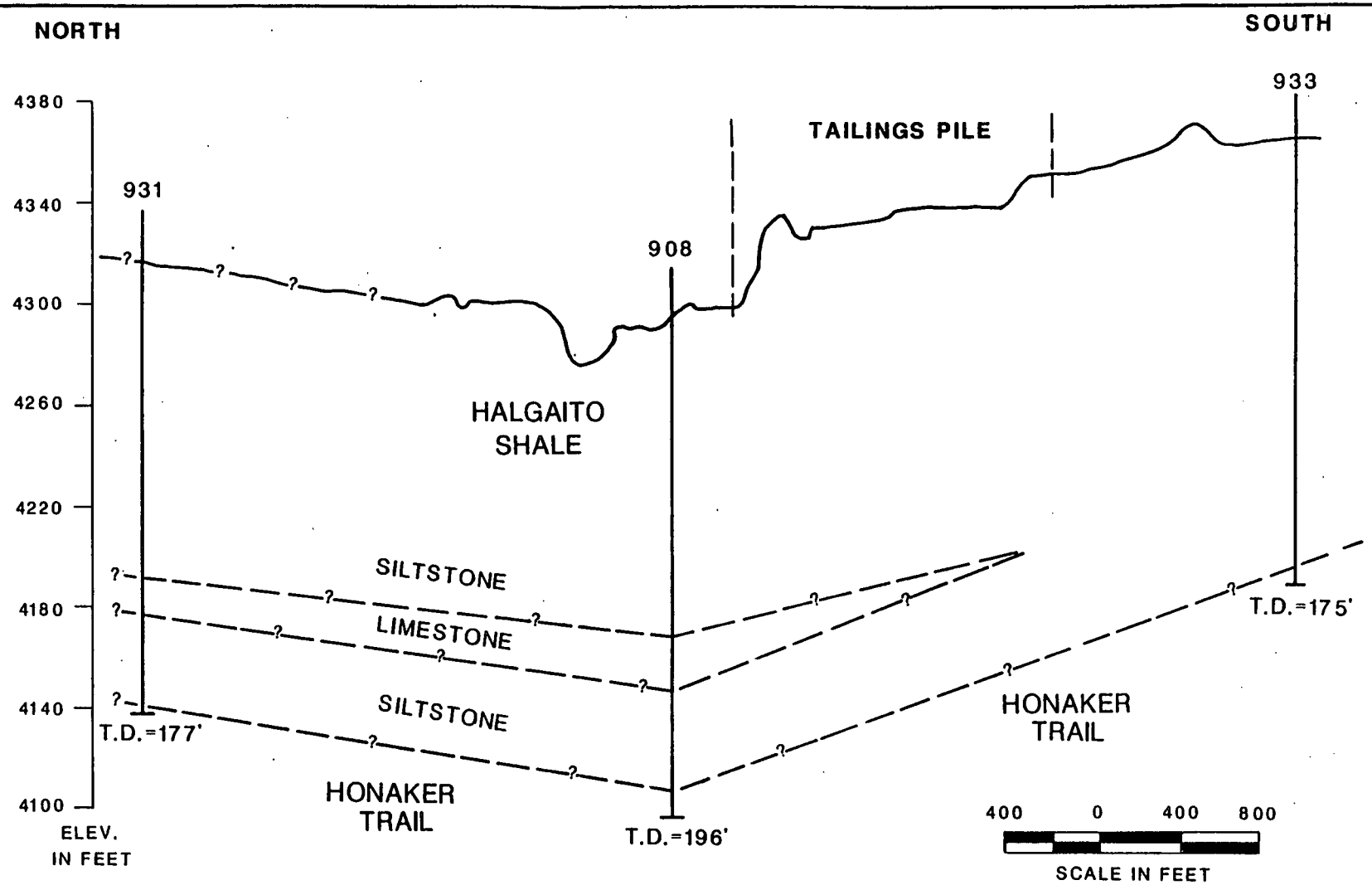


FIGURE D.3.6
GENERALIZED STRATIGRAPHIC COLUMN
FOR THE MEXICAN HAT SITE REGION



PENNSYLVANIAN	HALGAITO SHALE	BROWN TO ORANGE-BROWN AND RED-BROWN SILTSTONE AND SILTY SAND-STONE WITH THIN BEDS OF GRAY LIMESTONE
PERMIAN	HONAKER TRAIL	LT. GRAY, LT. YELLOW GRAY TO OLIVE INTERBEDDED LIMESTONES, SHALES, SILTSTONES AND SANDSTONES

FIGURE D.3.7
TYPICAL GEOLOGIC CROSS SECTION AT MEXICAN HAT

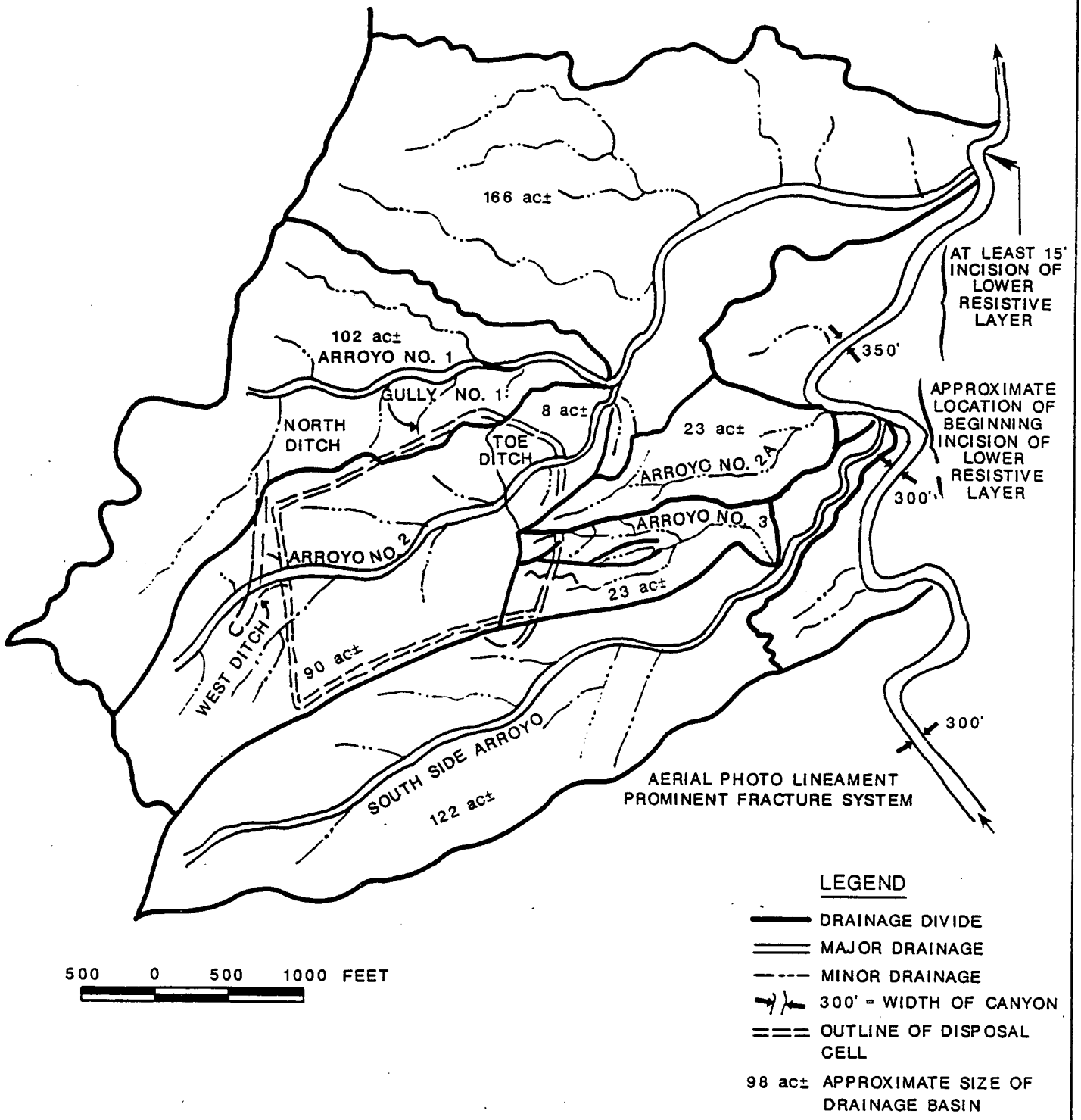
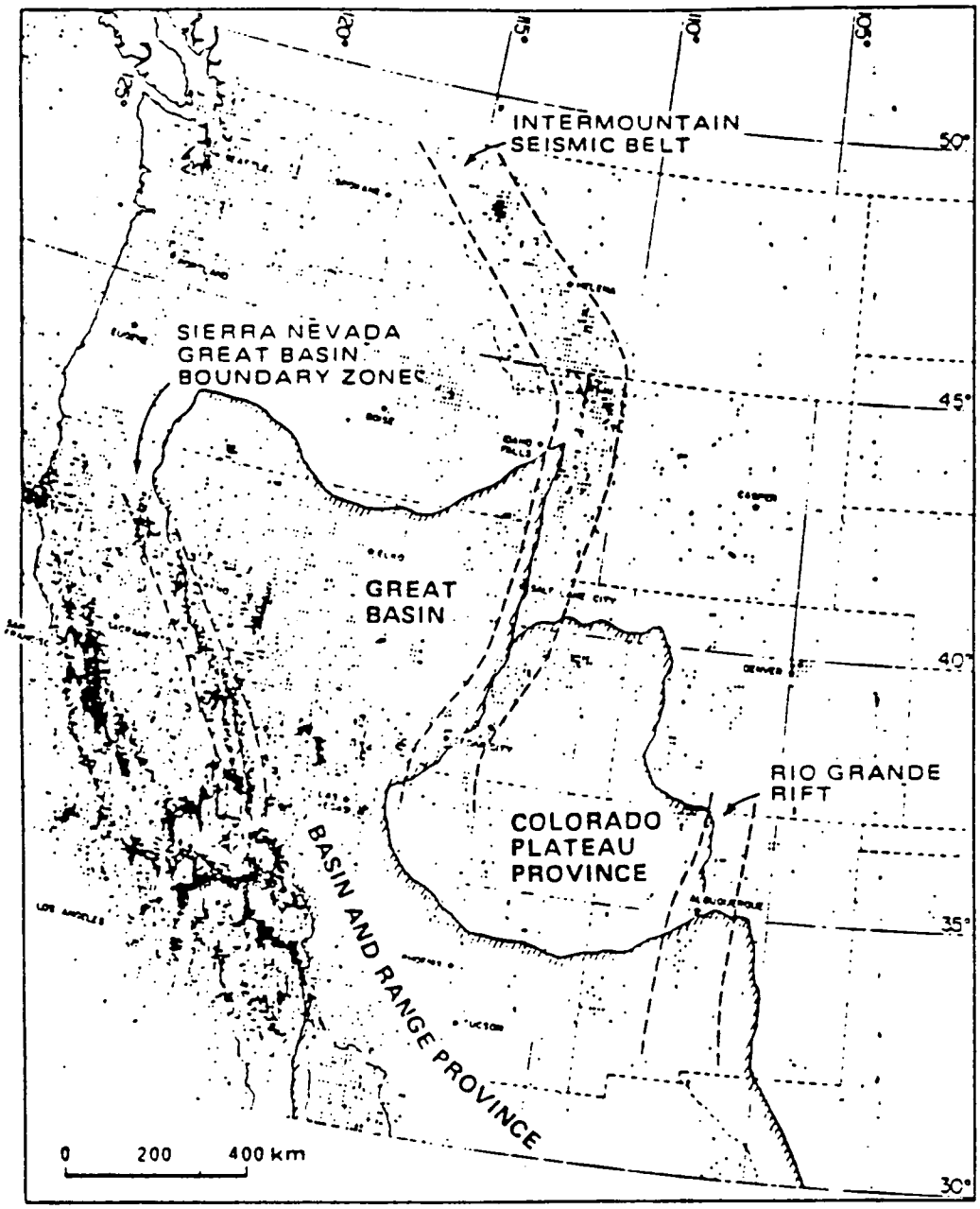


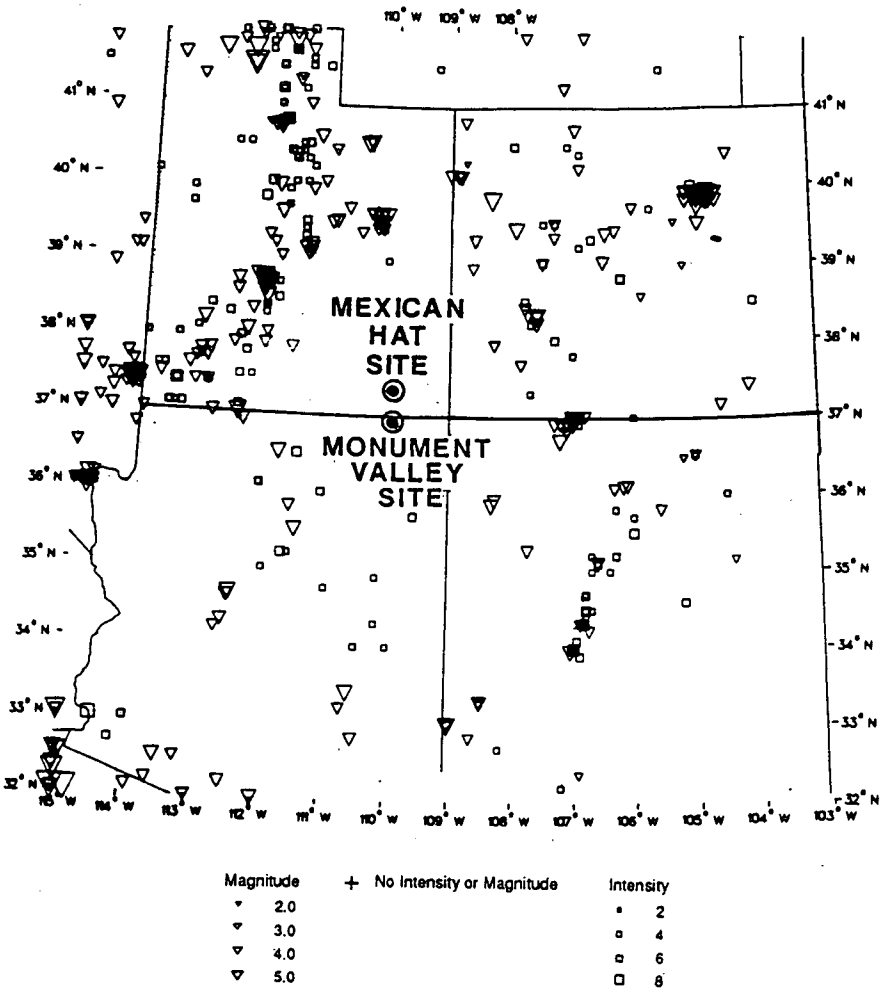
FIGURE D.3.8
DETAIL OF DRAINAGE SYSTEM
MEXICAN HAT SITE, UTAH



REF: WONG ET AL., 1982.

FIGURE D.3.9

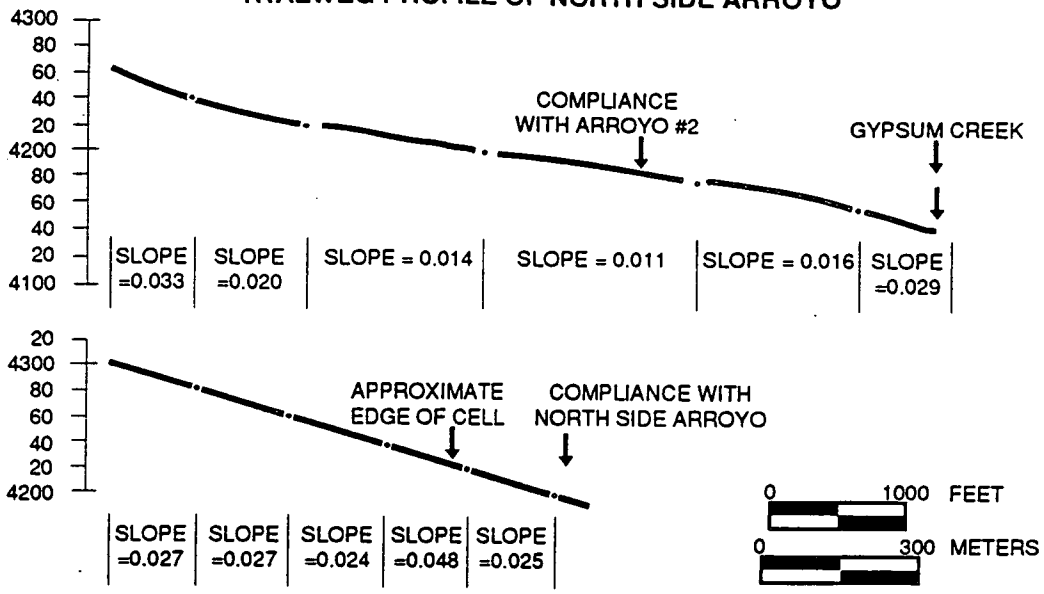
MAJOR SEISMIC ZONES OF THE BASIN AND RANGE - COLORADO PLATEAU PROVINCES



AFTER NGDC/NOAA, 1985

FIGURE D.3.10
MAP OF HISTORICAL AND INSTRUMENTALLY LOCATED EARTHQUAKE EPICENTERS OF THE SOUTHWESTERN UNITED STATES EPICENTRAL COMPILATION LIMITED TO EVENTS OF MAGNITUDE >4 AND/OR INTENSITY (MMI) > V.

THALWEG PROFILE OF NORTH SIDE ARROYO



STRATIGRAPHY OF RESIDENT LAYERS BELOW NORTH EDGE OF CELL, THAT FORMS DRAINAGE DIVIDE OF ARROYOS 1 & 2

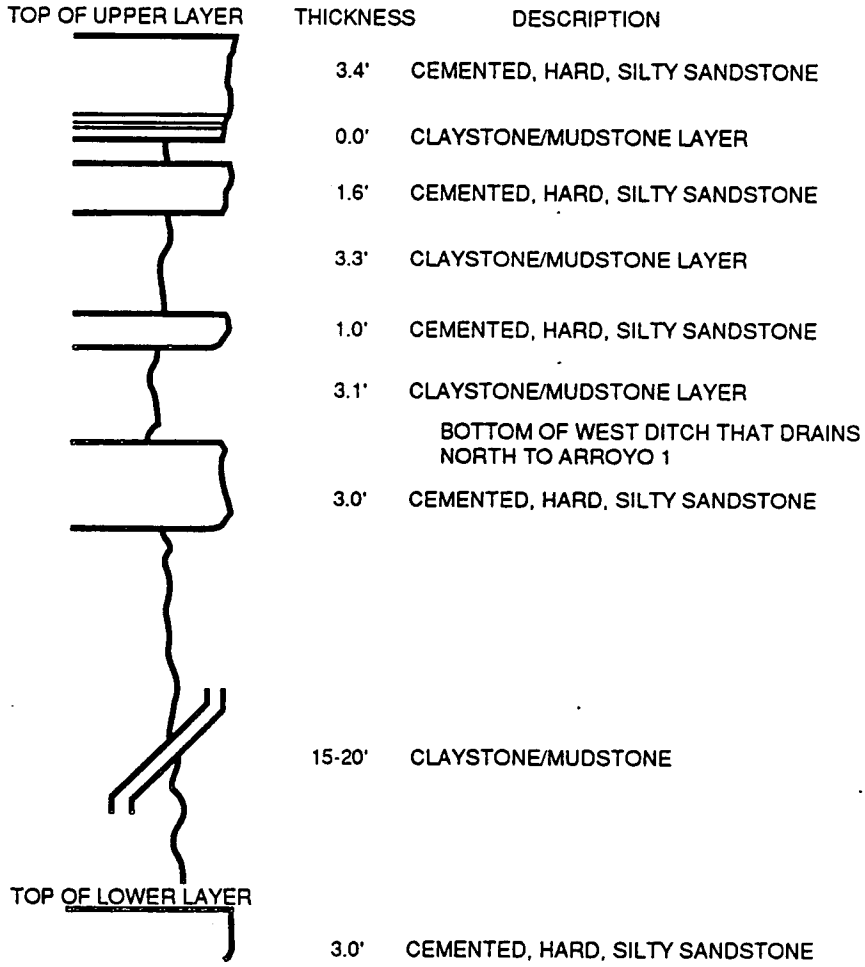


FIGURE D.3.11
THALWEG PROFILE AND RESISTANT STRATA LOG
MEXICAN HAT SITE, UTAH

PATH: MATERIAL FOLDER 93*

THALWEG 2.DRW

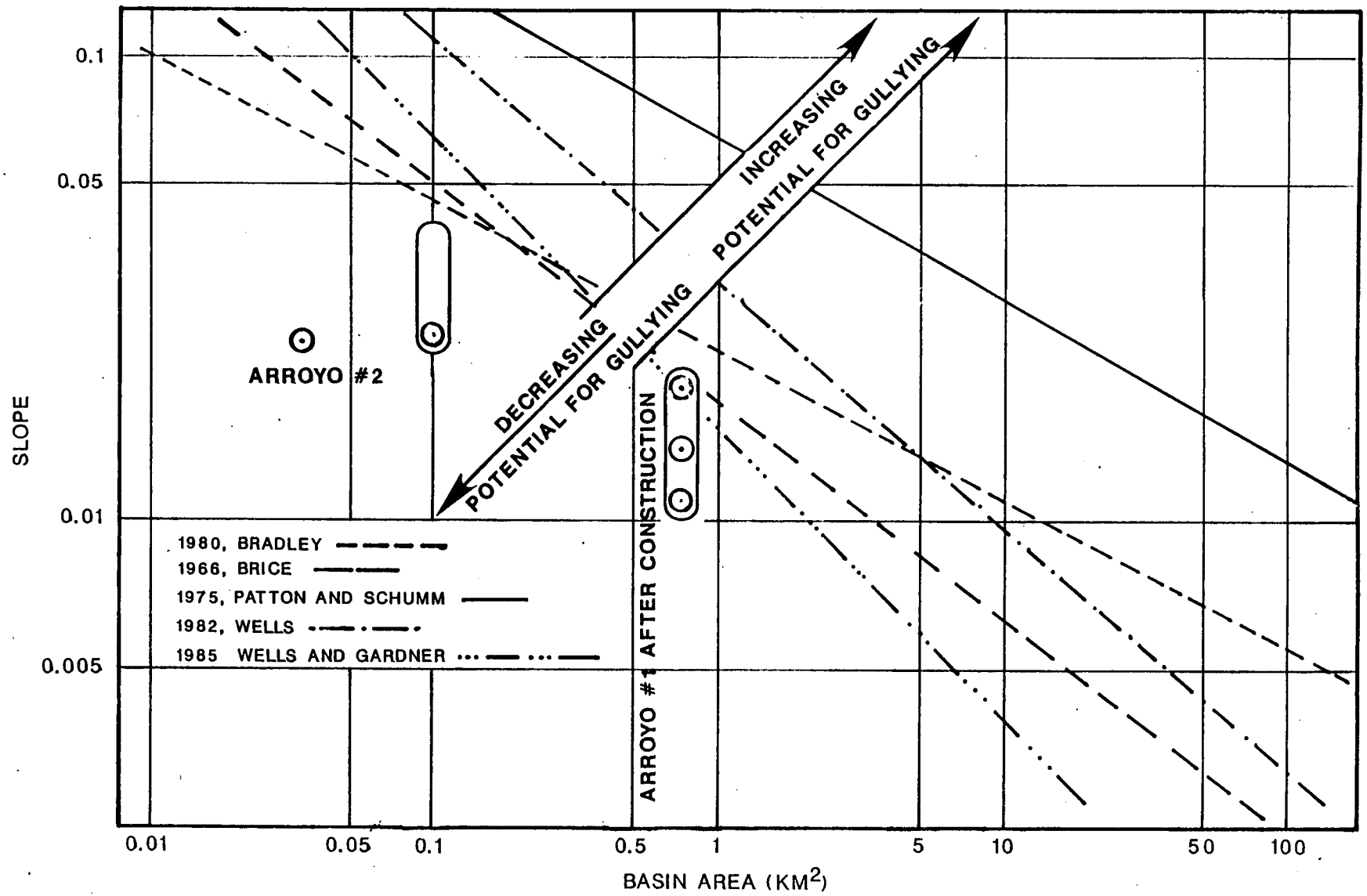


FIGURE D.3.12
POTENTIAL FOR GULLYING
MEXICAN HAT SITE, UTAH

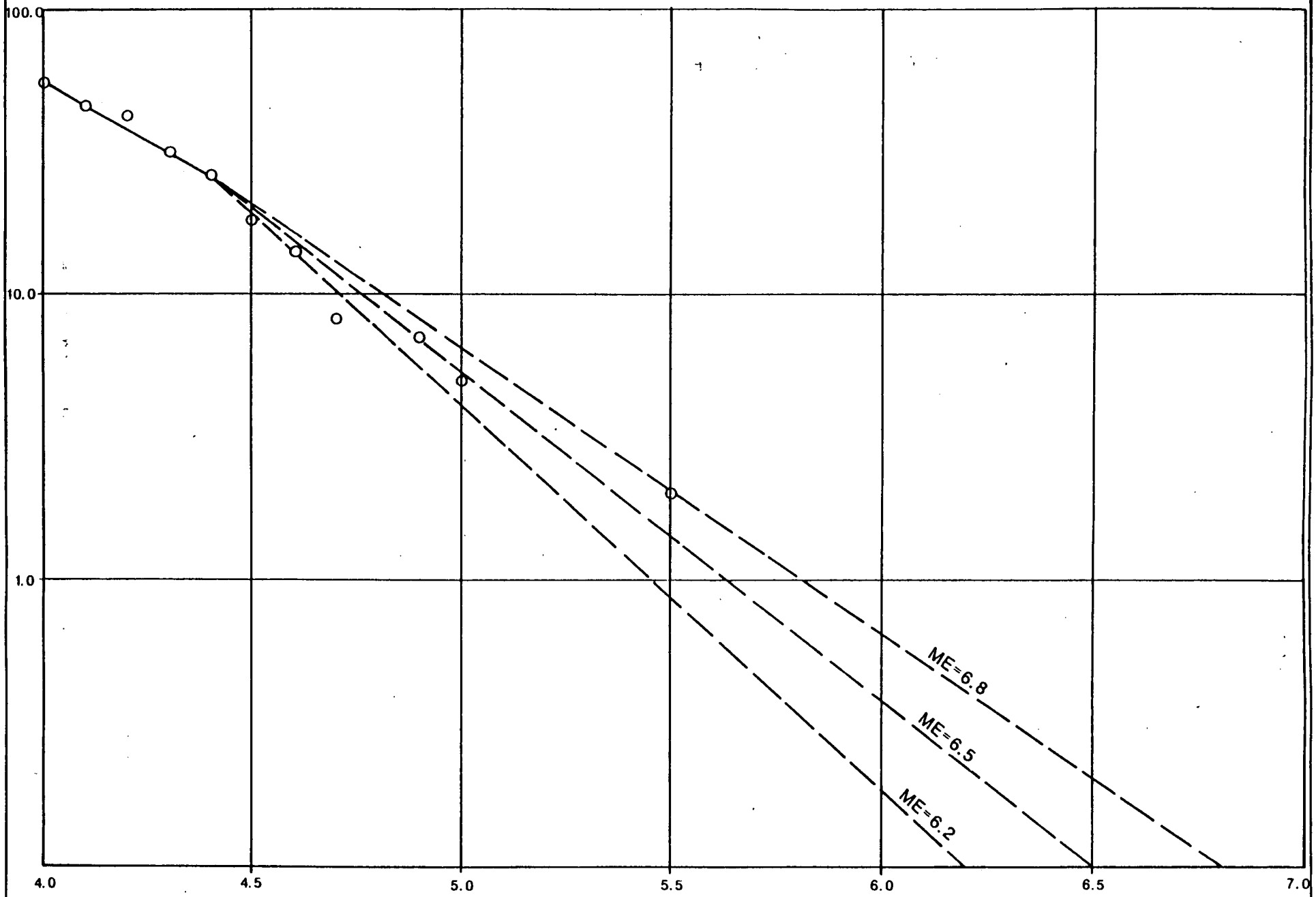


FIGURE D.3.13

GRAPHICAL DETERMINATION OF ME MAGNITUDE, COLORADO PLATEAU INTERIOR AND BORDER ZONES

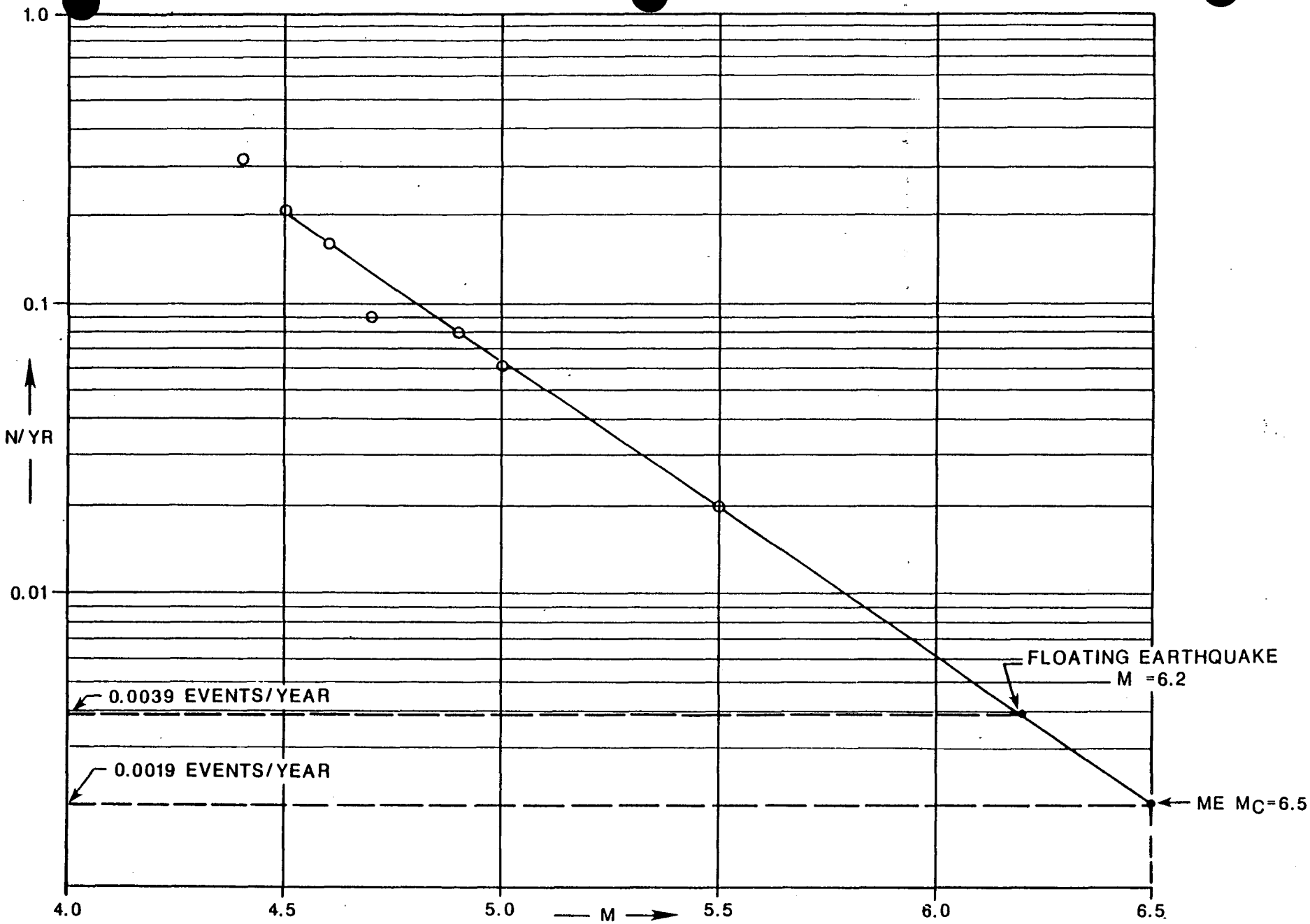
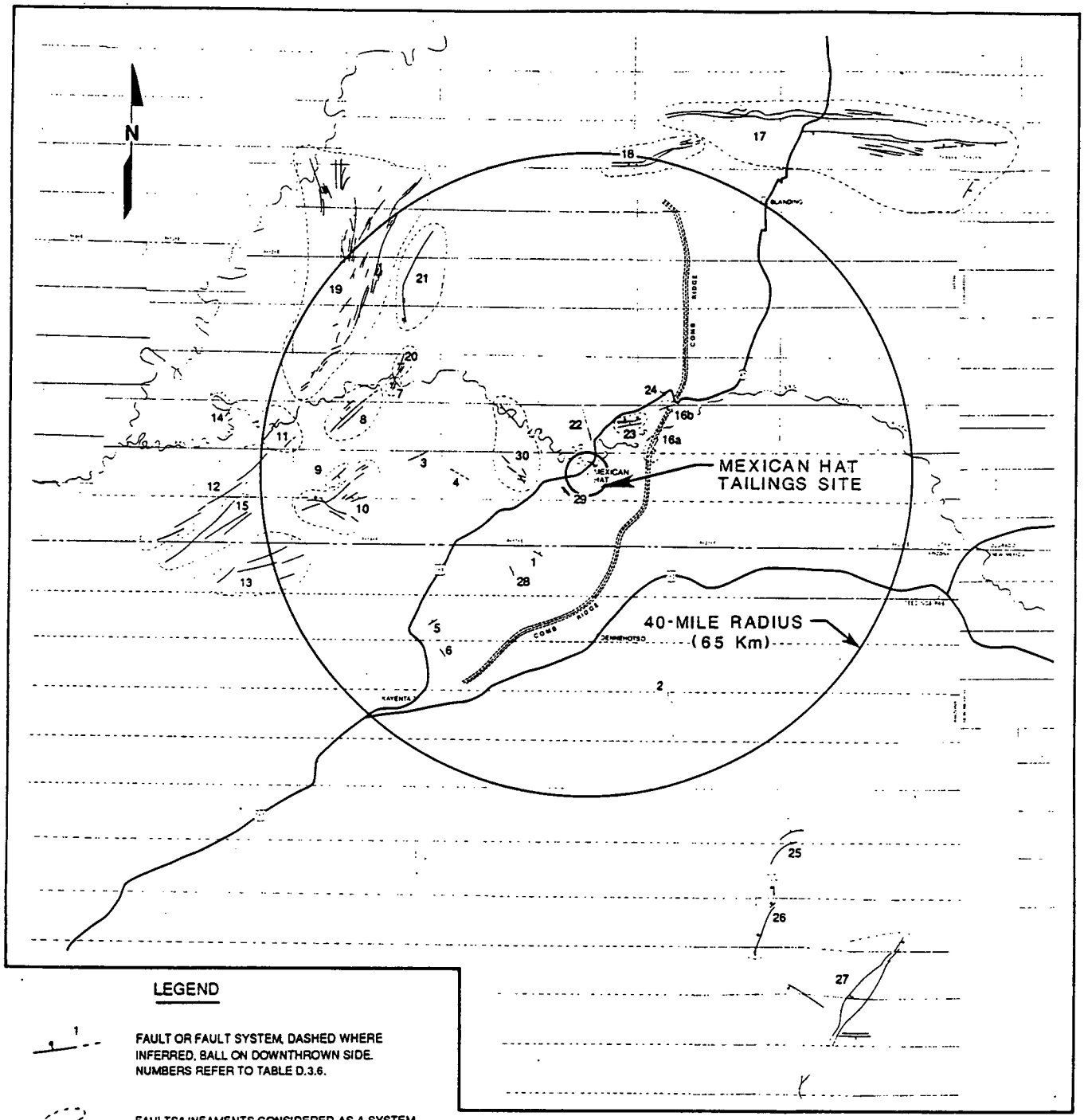


FIGURE D.3.14
GRAPHICAL DETERMINATION OF RECURRENCE INTERVALS FOR FLOATING EARTHQUAKE AND ME, COLORADO PLATEAU INTERIOR AND BORDER ZONES



AFTER: USGS 1° x 2° SHEETS: SHIPROCK (1969), CORTEZ (1969), ESCALANTE (1970), MARBLE CANYON (1970).

10 0 10 20
SCALE IN MILES

FIGURE D.3.15
EPICENTRAL AND FAULT COMPILATION

Table D.3.1 Existing aerial photography of the site area

Location	Type of photography	Approx. scale
BLM - Monticello, UT	conventional black-and-white	1:24,000
SCS - Kayenta, AZ	conventional black-and-white	1:24,000
SCS - Shiprock, AZ	conventional black-and-white	1:24,000
SCS - Monticello, UT	conventional black-and-white	1:24,000
USFS - Monticello, UT	conventional color	1:16,000

Notes: BLM - Bureau of Land Management.
SCS - Soil Conservation Service.
USFS - U.S. Forest Service.

Table D.3.2 Probabilistic estimates of maximum acceleration, velocity, and intensity at the Mexican Hat site area from various published sources

Source	Return period or probability	Maximum acceleration G-units	Maximum velocity cm/s	Maximum Modified Mercali Intensity
Liu and DeCapua (1975)	100 years	0.02-0.03[a]	--	IV-V
Algermissen and Perkins (1976)	90% probability of not being exceeded in 50 years	<0.04[b]	--	--
Applied Technology Council (1978)	--	0.05[c]	--	--
Algermissen et al. (1982)	90% probability of not being exceeded in 10 years	<0.04[b]	<2	--
Algermissen et al. (1982)	90% probability of not being exceeded in 50 years	<0.04[b]	2-3	--
Algermissen et al. (1982)	90% probability of not being exceeded in 250 years	0.07-0.10[b]	3-4	--

[a]Peak horizontal ground acceleration.
[b]Maximum acceleration in rock.
[c]Effective peak acceleration.

Table D.3.3 Earthquakes of M≥4.0 since 1960 in the Colorado Plateau

Date			Time			Location			Depth	Magnitude			Intensity
YR	MO	DA	HR	MIN	SEC	LAT(N)	LONG(W)		km	m_b	m_s	other	local
1960	10	11	08	05	30.5	38.3	107.6	Montrose, CO (Colorado Plateau/WMP Border Zone)		5.5			VI
1963	06	19	08	38	47.5	37.9	112.6	SW Utah (IMSB Border Zone)	33	4.2			
1963	07	07	19	20	42.4	39.5	111.9	Wasatch Zone, Utah (IMSB Border Zone)		4.9			VI
1963	07	09	20	25	27.5	40.0	111.2	Wasatch Zone, Utah (IMSB Border Zone)	33	4.1			
1963	07	10	18	32	50.6	39.9	111.4	Wasatch Zone, Utah (IMSB Border Zone)	33	4.2			V
1963	09	02	17	40	15.4	39.6	110.1	EUT Coal Mining Belt (Mining-Induced ?)	33	4.1			
1963	09	11	11	59	41.0	33.2	110.7	Globe, AZ (AZ Border Zone)	33	4.2			
1964	06	06	12	46	59.9	39.4	110.2	EUT Coal Mining Belt (Mining-Induced ?)	30	4.2			
1965	01	18	20	08	14.4	37.4	113.1	SW Utah (IMSB Border Zone)	33	4.0			IV
1965	03	21	22	56	39.7	39.5	110.3	EUT Coal Mining Belt (Mining-Induced ?)		4.0			IV
1965	03	26	00	51	24.5	39.5	110.3	EUT Coal Mining Belt (Mining-Induced ?)		4.3			V
1966	01	23	01	56	38.0	37.0	107.0	Dulce, NM (RGR Border Zone)	14	5.5			VII
1966	01	23	06	14	15.6	36.9	107.2	Dulce, NM (RGR Border Zone)	5	4.2			V
1966	01	23	07	44	35.7	36.9	107.3	Dulce, NM (RGR Border Zone)	5	4.6			
1966	01	25	10	38	05.0	36.8	107.1	Dulce, NM (RGR Border Zone)	5	4.0			
1966	01	23	11	01	07.1	36.9	107.2	Dulce, NM (RGR Border Zone)	5	4.3			V
1966	01	23	23	48	08.1	36.9	107.0	Dulce, NM (RGR Border Zone)	5	4.6			V
1966	01	23	19	43	19.7	36.9	107.1	Dulce, NM (RGR Border Zone)	5	4.5			V
1966	04	23	20	20	54.5	39.2	111.4	Wasatch Zone, Utah (IMSB Border Zone)	33	4.4			

Table D.3.3 Earthquakes of M≥4.0 since 1960 in the Colorado Plateau (Continued)

Date			Time			Location			Depth	Magnitude			Intensity
YR	MO	DA	HR	MIN	SEC	LAT(N)	LONG(W)		km	m_b	m_s	other	local
1966	04	30	18	29	13.8	39.6	110.4	EUT Coal Mining Belt (Mining-Induced ?)	3	4.0			V
1966	05	04	05	40	37.5	36.8	107.1	Dulce, NM (RGR Border Zone)	5	4.1			
1966	05	08	17	23	37.8	36.9	106.9	Dulce, NM (RGR Border Zone)	5	4.5			V
1966	05	08	17	50	35.6	37.0	106.8	Dulce, NM (RGR Border Zone)	5	4.2			V
1966	05	09	02	08	53.5	36.9	106.9	Dulce, NM (RGR Border Zone)	5	4.2			V
1966	05	09	02	57	23.6	37.0	106.9	Dulce, NM (RGR Border Zone)	5	4.4			V
1966	05	19	00	26	42.2	36.9	107.0	Dulce, NM (RGR Border Zone)	5	4.6			
1966	05	20	13	40	48.8	37.9	112.1	SW Utah (IMSB Border Zone)	18	4.3			
1966	06	02	21	59	11.5	36.9	107.0	Dulce, NM (RGR Border Zone)	5	5.0			VI
1966	06	21	05	24	38.2	36.9	107.1	Dulce, NM (RGR Border Zone)	5	4.2			
1966	06	04	10	29	39.3	37.0	107.0	Dulce, NM (RGR Border Zone)	5	4.1			V
1966	07	06	05	47	08.3	40.2	108.9	Rangely, CO (Oil & gas withdrawal ?)	5	4.5			V
1966	09	04	09	52	34.5	38.3	107.6	SW CO (Colorado Plateau/ WMP Border Zone)	33	4.2			
1966	10	03	16	03	50.8	35.8	111.6	Coconino Co., AZ (AZ Border Zone)	33	4.4			V
1966	12	16	02	00	44.0	37.0	107.0	Dulce, NM (RGR Border Zone)	33	4.2			
1967	01	06	15	41	15.5	36.9	107.0	Dulce, NM (RGR Border Zone)	33	4.3			V
1967	01	12	03	52	06.2	39.0	107.5	SW CO (Colorado Plateau/ WMP Border Zone)	33	4.4			V
1967	01	16	09	22	45.9	37.7	107.9	Silverton CO (WMP Border Zone)	33	4.1			V
1967	02	15	03	28	03.6	40.1	109.1	Rangely, CO (Oil & gas withdrawal ?)	5	4.5			V
1967	04	04	22	53	39.5	38.3	107.7	SW CO (Colorado Plateau/ WMP Border Zone)	33	4.5			V

Table D.3.3 Earthquakes of M≥4.0 since 1960 in the Colorado Plateau (Continued)

Date			Time			Location			Depth	Magnitude			Intensity
YR	MO	DA	HR	MIN	SEC	LAT(N)	LONG(W)		km	m_b	m_s	other	local
1967	10	25	02	41	34.4	39.4	110.3	EUT Coal Mining Belt (Mining-Induced ?)		4.0			V
1967	10	25	05	53	08.4	39.4	110.3	EUT Coal Mining Belt (Mining-Induced ?)		4.0			V
1968	01	16	09	42	54.2	39.2	112.0	Wasatch Zone, Utah (IMSB Border Zone)	33	4.0			V
1968	08	04	06	23	36.4	39.1	111.4	Wasatch Zone, Utah (IMSB Border Zone)	15	4.0			V
1968	08	29	09	31	48.1	39.5	110.2	EUT Coal Mining Belt (Mining-Induced ?)		4.2			V
1968	09	24	02	10	51.8	38.0	112.1	SW Utah (IMSB Border Zone)	33	4.0			V
1968	11	17	14	33	37.5	39.5	110.9	EUT Coal Mining Belt (Mining-Induced ?)	6	4.6			V
1969	03	13	07	03	14.8	39.4	110.2	EUT Coal Mining Belt (Mining-Induced ?)	2	4.1			V
1969	05	23	05	24	53.6	39.0	111.8	Wasatch Zone, Utah (IMSB Border Zone)	31	4.0			V
1969	12	25	12	49	10.1	33.4	110.6	San Carlos, AZ (AZ Border Zone)	15	4.4		5.1	
1970	02	03[a]	05	59	35.6	37.9	108.3	Paradox Basin, CO (Colorado Plateau Interior)	33	4.0			V
1970	04	14	10	40	54.2	39.7	110.8	EUT Coal Mining Belt (Mining-Induced ?)	13	4.2			
1970	04	18	10	42	11.9	37.8	111.6	SW Utah (IMSB Border Zone)	10	4.4			
1970	04	21	08	53	52.4	40.1	108.9	Rangeley, CO (Oil & gas withdrawal)	4	4.3		3.9	V
1970	04	21	15	05	47.5	40.1	108.9	Rangeley, CO (Oil & gas withdrawal)	4	4.6			V
1970	05	23	22	55	22.4	38.0	112.3	SW Utah (IMSB Border Zone)	3	4.6		4.9	
1970	10	25	07	46	42.1	39.2	111.4	Wasatch Zone, Utah (IMSB Border Zone)	5	4.3			V

Table D.3.3 Earthquakes of M≥4.0 since 1960 in the Colorado Plateau (Continued)

Date			Time			Location			Depth	Magnitude			Intensity
YR	MO	DA	HR	MIN	SEC	LAT(N)	LONG(W)		km	m_b	m_s	other	local
1970	11	28	07	40	11.6	35.0	106.7	Albuquerque, NM (RGR Border Zone)	9	4.5			V
1971	01	04	07	39	06.7	35.0	106.7	Albuquerque, NM (RGR Border Zone)	9	4.7			
1971	01	07	20	39	52.1	39.4	107.3	Colorado Plateau (WMP Border Zone)	33	4.3		3.8	
1973	07	16	06	36	42.8	39.1	111.5	Wasatch Zone, Utah (IMSB Border Zone)	10	4.2			
1973	12	24	02	20	14.9	35.3	107.7	Mt. Taylor Region, NM (RGR Border Zone)	18	4.4			V
1975	01	30[a]	14	48	40.3	39.2	108.6	Grand Junction, CO (Colorado Plateau Interior-Noncompahgre Uplift)	5	4.4		3.7	
1975	10	06	15	50	46.9	39.0	111.4	Wasatch Zone, Utah (IMSB Border Zone)	005	4.2		3.2	II
1976	01	05	06	23	32.9	35.8	108.3	Crown Point, NM (RGR Border Zone)	25	5.0		4.6	VI
1976	02	04	00	04	58.1	34.6	112.5	Chino Valley, AZ (AZ Border Zone)	12	4.9	5.1	5.2	VI
1976	02	09	03	07	22.0	34.6	112.5	Chino Valley, AZ (AZ Border Zone)	10	4.6		3.3	
1977	03	05	03	00	54.7	35.9	108.2	Crown Point, NM (RGR Border Zone)	22	4.6		4.2	VI
1977	09	24	11	16	48.4	39.3	107.3	Colorado Plateau/ WMP Border Zone	005	4.0		3.0	
1980	05	24	10	03	36.3	39.9	111.9	Wasatch Zone, Utah (IMSB Border Zone)	005	5.0		4.2	V
1980	05	14	05	11	04.1	39.4	111.0	Wasatch Zone, Utah (IMSB Border Zone)	1	4.0	4.0	3.5	V

Table D.3.3 Earthquakes of M≥4.0 since 1960 in the Colorado Plateau (Concluded)

Date			Time			Location		Depth	Magnitude			Intensity
YR	MO	DA	HR	MIN	SEC	LAT(N)	LONG(W)	km	m_b	m_s	other	local

[a]Colorado Plateau Interior.

Ref. NOAA earthquake data, NGDC/NOAA, 1985.

EUT (Eastern Utah)

Table D.3.4 Accelerations calculated for the site

Source/source area	Maximum earthquake	Distance to site[a]	Expected maximum peak horizontal acceleration at the site[b]
Basin and Range (Intermountain Seismic Belt)	7.6[c]	160 km (99 miles)	less than 0.04 g
Basin and Range of New Mexico - Arizona	7.3[d]	270 km (168 miles)	less than 0.02 g
Rio Grande Rift	7.5[e]	160 km (99 miles)	less than 0.04 g
Floating Earthquake for the Colorado Plateau Interior	6.2[d]	15 km (9.3 miles)	0.21 g

[a]From edge of stable interior portion of Colorado Plateau bordering seismotectonic province (i.e., source area).
[b]Calculated from Campbell (1981), using formula for constrained ground acceleration, as a fraction of gravity (g).
[c]From Bucknam et al. (1980).
[d]This study (Section D.3.8.3).
[e]Kirkham and Rogers (1981).

Table D.3.5 Estimated on-site accelerations resulting from MEs in remote seismotectonic provinces, subprovinces, or domains

Source area	ME[a]	Distance from site area	Peak horizontal acceleration expected at site (fraction of unit gravity)[b]
San Francisco volcanic field fault domain	6.5	50 km	0.06 - 0.07
Intermountain Seismic Belt	7.5	200 km	<0.018
Rio Grande Rift Border Zone	6.5	125 km	<0.01 g

[a]See test for derivation of ME values.
[b]Using acceleration/attentuation relationship of Campbell (1981).

Table D.3.6 Compilation of mapped faults within a 65-km radius of Mexican Hat

Fault/ lineament number	Source	Examined by: low-sun-angle Aerial recon.	Aerial recon.	Ground recon.	Comments
1	Witkind and Thaden, 1963	X	X		Shorter than mapped. No Late Quaternary offset.
2	This study	X	X		Not faulted - lineament from exposure by erosion of resistant stratigraphy.
3	Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
4	Cooley et al., 1969	X			No Late Quaternary offset.
5	Haynes and Hackman, 1978	X			No Late Quaternary offset.
6	Haynes and Hackman, 1978	X			No Late Quaternary offset.
7	Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
8	Hackman and Wyant, 1973 and this study	X	X		No Late Quaternary offset.
9	Cooley et al., 1969	X	X	X	No Late Quaternary offset.
10	Hackman and Wyant, 1973	X	X	X	No Late Quaternary offset.
11	Cooley et al., 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
12	Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
13	Hackman and Wyant, 1973 Haynes and Hackman, 1978 This study	X	X	X	No Late Quaternary offset.
14	This study	X	X		No Late Quaternary offset.
15	Hackman and Wyant, 1973 Haynes and Hackman, 1978 Cooley et al., 1969	X	X		No Late Quaternary offset.
16a	Haynes et al., 1972	X	X	X	No Late Quaternary offset.
16b	Haynes et al., 1972	X	X		No Late Quaternary offset.
17	Haynes et al., 1972	X	X	X	No Late Quaternary offset.
18	Haynes et al., 1972	X	X		No Late Quaternary offset.

Table D.3.6 Compilation of mapped faults within a 65-km radius of Mexican Hat (Continued)

Fault/ lineament number	Source	Examined by: low-sun-angle Aerial recon.	Aerial recon.	Ground recon.	Comments
1	Witkind and Thaden, 1963	X	X		Shorter than mapped. No Late Quaternary offset.
19	Cooley et al., 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
20	Cooley et al., 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
21	Cooley et al., 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
22	This study	X	X	X	Not a fault-dike emplacement.
23	Haynes et al., 1972 and this study	X	X	X	Excavated scarps in resistant Rico Fm.
24	This study	X	X		Excavated scarps in resistant Rico Fm.
25	This study	X	X		Possibly Quaternary displacement but probably erosion-exposed fault line. Not critical as length is only about 12 km (7.5 miles).
26	O'Sullivan & Beikman, 1963	X	X		No Late Quaternary offset.
27	O'Sullivan & Beikman, 1963 and this study	X	X		No Late Quaternary offset.
28	This study	X			No Late Quaternary offset.
29	This study		X		No Late Quaternary offset.
30	Cooley et al., 1969 Haynes and Hackman, 1973	X	X		No Late Quaternary offset.
26	O'Sullivan & Beikman, 1963	X	X		No Late Quaternary offset.
27	O'Sullivan & Beikman, 1963 and this study	X	X		No Late Quaternary offset.
28	This study	X			No Late Quaternary offset.
29	This study		X		No Late Quaternary offset.

Table D.3.6 Compilation of mapped faults within a 65-km radius of Mexican Hat (Concluded)

Fault/ lineament number	Source	Examined by: low-sun-angle			Comments
		Aerial recon.	Aerial recon.	Ground recon.	
1	Witkind and Thaden, 1963	X	X		Shorter than mapped. No Late Quaternary offset.
30	Cooley et al., 1969 Haynes and Hackman, 1973	X	X		No Late Quaternary offset.

Table D.3.7 Selected cases of induced macroearthquakes

Reservoir	Location	Depth, m	Volume x 10^6, m^3	Largest earthquake
Hoover (Lake Mead)	U.S.A.	166	35,000	M_L=5.0
Kariba	Zambia/Rhodesia	122	175,000	m_b=5.8
Kremasta	Greece	120	4750	M_s=6.3
Koyna	India	103	2780	M_s=6.5
Kurobe	Japan	186	149	M_s=4.9
Manic 3	Canada	98	10,423	m_b=4.3
Hsinfengkiang	China	80	10,500	M_s=6.1
Nurek	U.S.S.R.	215	11,000	M_s=4.5

Ref. Adapted from Meade, 1982.

D.4 SITE FOUNDATION CHARACTERISTICS

The parameters recommended for use in the design process with regard to the foundation material are summarized in Table D.4.1. It is recommended that the surface natural soils not be considered, since they are thin and of similar properties to the sand tailings. Thus, only parameters for the siltstone/sandstone are provided. Any parameters not provided should be determined by further laboratory testing or assumed to be some typical conservative value as found in the literature.

D.4.1 FOUNDATION MATERIAL PROPERTIES

D.4.1.1 In situ data

In situ data from exploratory borings indicate that competent bedrock underlies the tailings and a thin (approximately one foot thick) natural soil veneer. Of 120 borings conducted by MSRD (Addendum D4) where sampling was attempted at the soil/bedrock interface, all experienced sampler refusal. Of seven borings conducted by the TAC where sampling was attempted at the soil/bedrock interface, all experienced sampler refusal. Examinations of rock cores obtained during the TAC drilling programs indicate that it is appropriate to use typical properties for the siltstone/sandstone bedrock in all analyses.

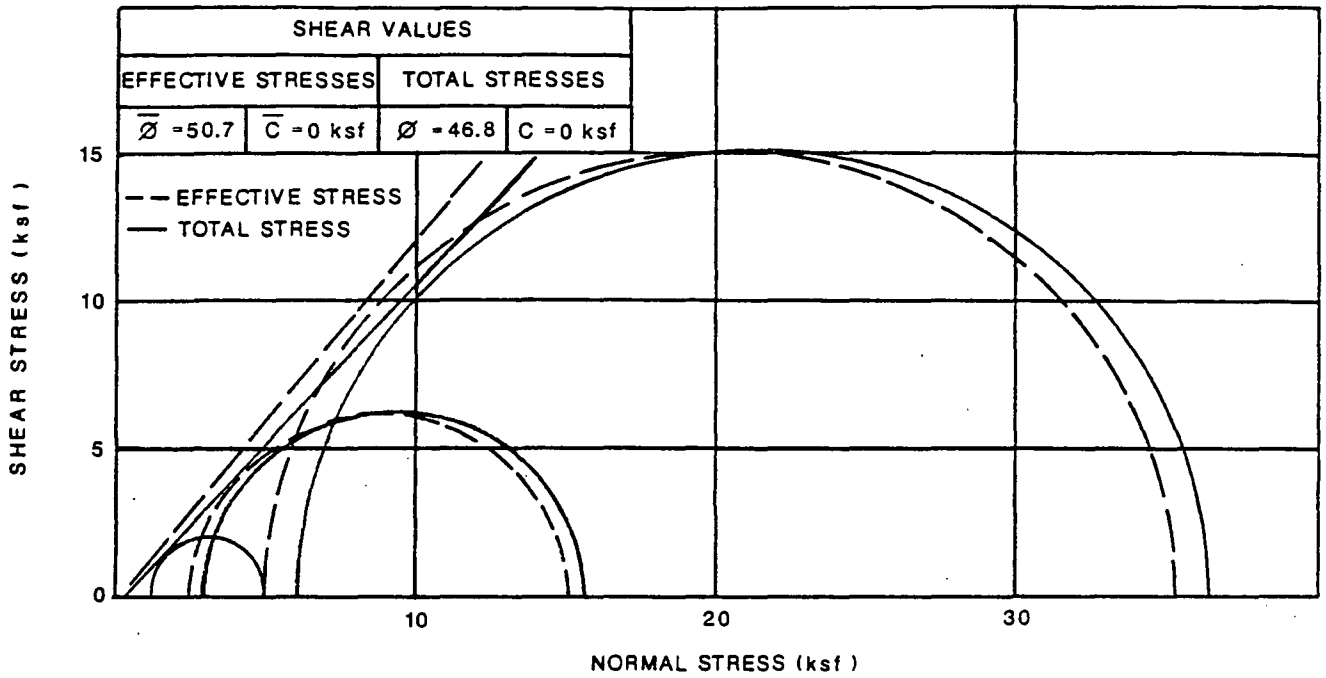
D.4.1.2 Elastic parameters

Table D.4.2 shows typical values of the ratio of the modulus of deformation (E) to the unconfined compressive strength (q_u) for various sedimentary rocks, as well as typical values of unconfined compressive strength and Poisson's ratio (Goodman, 1980). The resulting calculated modulus of deformation is also presented. However, these values are not based on tests of the actual foundation materials at the site. The horizontal fracturing and presence of clay zones will cause the rock mass to display anisotropic (most likely orthotropic) stress-strain behavior.

Using the typical values presented in Table D.4.2 for the rock and typical values of the modulus of elasticity for clays (Duncan and Buchignani, 1976), it is possible to calculate the equivalent deformation modulus and Poisson's ratio of the jointed rock mass using a procedure outlined by Goodman (1976). Using this method, it is estimated that the modulus of deformation would be on the order of 3.5×10^4 per square inch. One of the assumptions of this method is that Poisson's ratio is 0.0. However, it is recommended that some small value (i.e., 0.001) be used to avoid computational difficulties in some theory of elasticity-based calculations.

D.4.1.3 Strength

Testing of a siltstone sample from borehole HAT01-132 indicated that the strength mobilized at failure can be described by an effective friction angle (ϕ) of 46° with no cohesion (see Figure D.4.1 for a summary of test results). Typical values of ϕ for sandstones and siltstones reported by Goodman (1980) range from 27.8° to 45.2°. This would indicate that the test results are most likely not valid. It is recommended that an average value of 37° be used in design. Weaker clay zones are too deep to influence the stability of the pile.

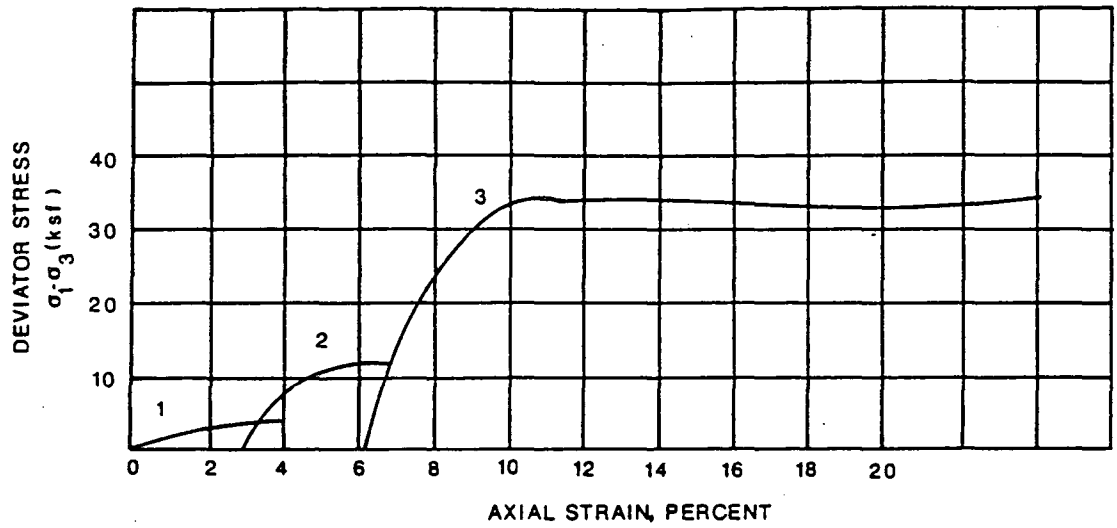


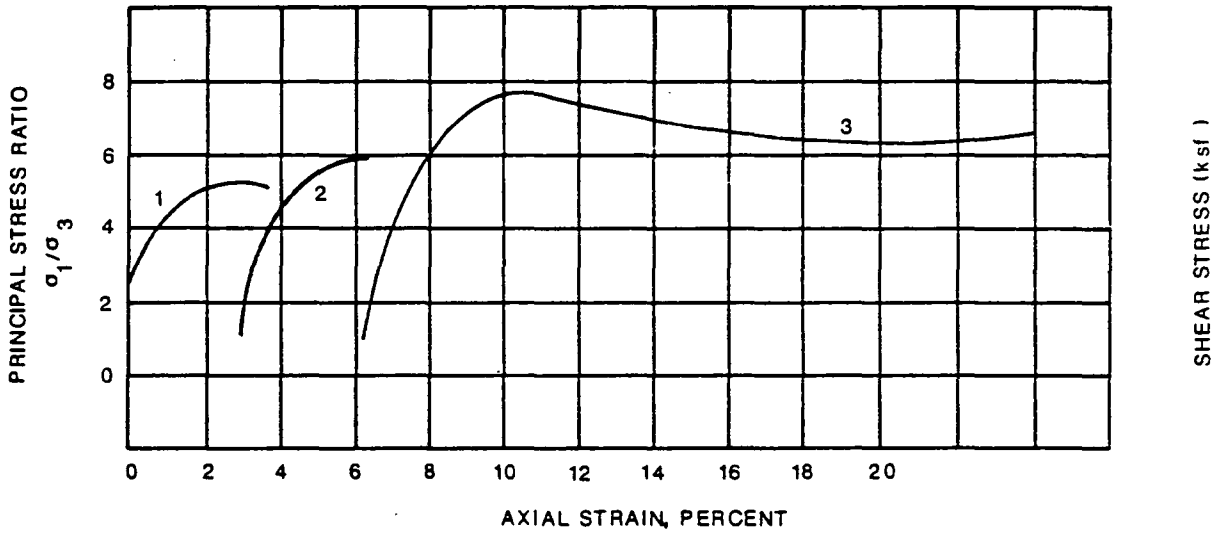
STAGE NO.	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	MATERIAL DESCRIPTION
1	129.4	9.7	RED SILTSTONE
2	131.4	11.1	RED SILTSTONE
3	133.9	10.2	RED SILTSTONE

SAMPLE TYPE UNDISTURBED RING SAMPLE

FIGURE D.4.1

SHEAR STRENGTH OF ROCK IN STAGED TRIAXIAL COMPRESSION
HAT01-132 27 - 28 FT.





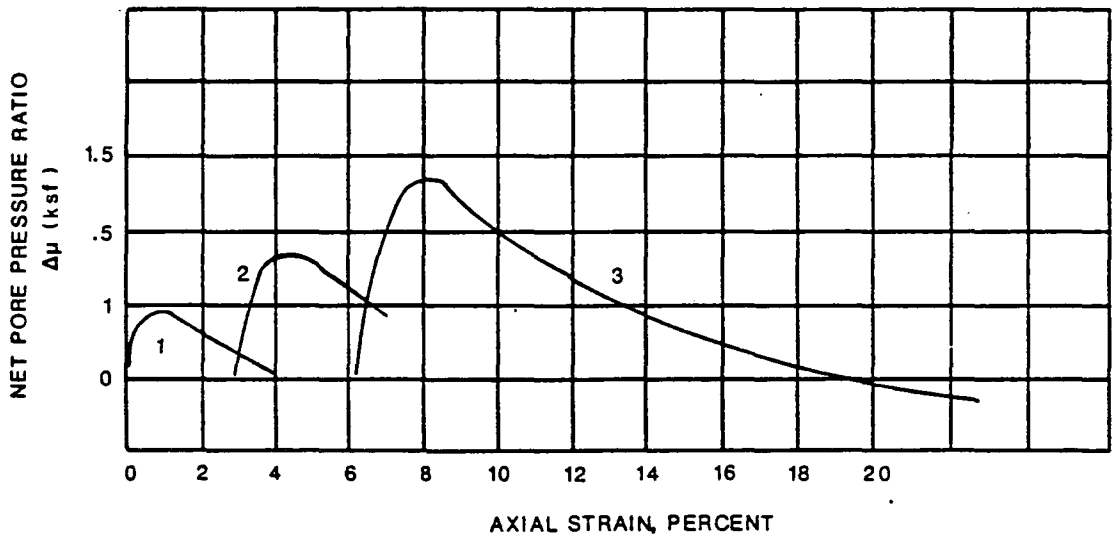


FIGURE D.4.1 CONT.

SHEAR STRENGTH OF ROCK IN STAGED TRIAXIAL COMPRESSION
HAT01-132 27 - 28 FT.

Table D.4.1 Design parameters - foundation

Material description	Design parameters	Method of determination
Siltstone/sandstone	Elastic parameters:	
$\Upsilon_d = \Upsilon_s = 150$ pcf	$E = 3.5 \times 10^4$ psi $V = 0.001$	Calculated from typical values
	Shear strength:	
	$\phi = 37°$ $c = 0$	Average of typical values

Table D.4.2 Typical properties of unfractured sedimentary rock

Rock description[a]	Modulus ratio q_u/E	Unconfined compressive strength (q_u)(psi)	Modulus of deformation (E) (psi)	Poisson's ratio
Berea Sandstone	261	1.07×10^4	2.79×10^6	0.38
Navajo Sandstone	183	3.10×10^4	5.68×10^6	0.46
Tensleep Sandstone	264	1.05×10^4	2.77×10^6	0.11
Hackensack Siltstone	214	1.78×10^4	3.81×10^6	0.22
Monticello Dam Greywacke	253	1.15×10^4	2.91×10^6	0.08
Average			3.59×10^6	0.25

[a]Ref. Goodman, 1980.

D.5 TAILINGS CHARACTERISTICS

The results of the characterization efforts performed on the tailings materials at the Mexican Hat site prior to final design are presented in this section. For specific design parameters and material properties used in the final design, refer to Calculation 9-239-01-01 (Volume III, Appendix B) for the Mexican Hat materials and Calculation 19-349-04-01 for Monument Valley materials.

D.5.1 MATERIAL PROPERTIES OF IN SITU TAILINGS

Classification

A total of 52 samples had grain size-distribution determinations made via sieve analysis (ASTM C136). Of these, 28 were further analyzed using the hydrometer method (ASTM D422) to determine the grain size distribution of particles smaller than the No. 200 sieve (approximately 0.127 mm). Where possible, the samples were classified from the grain size distribution and in several cases Atterberg limits (ASTM D4318) were determined to aid in classification. The results of these analyses are summarized in Table D.5.1 and grain size distribution curves are presented in Addendum D5.

The Atterberg limits test (ASTM D4318) is used to determine the water contents at which the soil behaves as a viscous liquid, as a plastic material, and as a brittle solid. The lowest water content at which the soil behaves as a liquid is called the liquid limit (W_L). At water contents below the liquid limit, the soil behaves as a plastic. The lowest water content at which the soil behaves as a plastic material is called the plastic limit (W_P). The liquid limit minus the plastic limit is defined as the plasticity index (PI), and is the range of water contents over which the soil reacts as a plastic material.

Twenty Atterberg limits tests were performed; the results are presented in Table D.5.1. Only those soils which classify as slime (except for one foundation soil sample, HAT01-131 16.5 ft to 17 ft) were tested for Atterberg limits. The average slime soil has $W_L = 37$, $W_P = 22$, and PI = 15, and classifies as CL (medium plasticity clay) in the USCS.

One common indicator of a clay's mechanical behavior is its activity. Activity is defined as the PI divided by the percent of clay-size particles (<0.002 mm) (Lambe and Whitman, 1969). The average activity of the slimes (CL) is about 1.4. It is interesting to compare this with illite, which has an average activity of 0.9, and montmorillonite with an average activity of 7.2 (Lambe and Whitman, 1969). Thus, it is likely that the slimes will behave similarly to an illite (e.g., low to moderate shrinking and swelling due to changes in water content, moderate susceptibility to frost heave, and the like).

Natural moisture content, specific gravity, and unit weight

The average values determined from laboratory testing of natural moisture content, specific gravity, and unit weight have been selected for use as design parameters.

The natural water content (W_n) was determined for 85 tailings samples. The results are presented in Table D.5.1, while Figures D.5.1 through D.5.14 show how water content varied with depth. The sands had an average moisture content of 18 percent, sand-slimes were found to be at an average moisture content of 21 percent, and slimes, W_n = 37 percent. The slimes in the upper pile had a higher average moisture content (about 54 percent) than did the slimes in the lower pile (about 34 percent). No direct measurements were made on sand tailings, but calculations indicate that the saturation is about 70 percent, while test results for undisturbed samples of sand-slime and slime indicated average saturations of 47 percent and 77 percent, respectively. (Calculations based on average properties indicate that sand-slime tailings may have an average saturation as high as 64 percent.) The saturation level of slimes varied greatly from a low of 29 percent to a high of 100 percent (Table D.5.1).

In addition to the activity of clay (mentioned earlier), another indicator of clay behavior is the liquidity index. The Liquidity Index is defined as the natural water content minus the plastic limit divided by the PI or

$$\frac{W_n - W_P}{PI} \qquad \text{(Lambe and Whitman, 1969).}$$

This is a measure of how close the in situ soil is to the liquid limit. This can be an indicator of the stability of a soil, since the soil flows at the liquid limit, and thus may be susceptible to flow movement if subjected to a change in stress. The average slime sample had a liquidity index slightly greater than 1.0, and thus has an in situ water content slightly greater than the liquid limit.

The specific gravities of the tailings soils were determined and are presented in Table D.5.3. One sand sample tested had a specific gravity of 2.70 (quartz has an average specific gravity of 2.65) while both the sand-slime and the slime tailings have an average specific gravity of 2.76 (illite has an average specific gravity of about 2.73 - Lambe and Whitman, 1969).

The in situ dry density was determined using Shelby tube samples of slime tailings. The values for in situ dry density, as determined from laboratory testing, are presented in Table D.5.1. The average in situ dry densities of sand-slime and slime tailings were found to be about 87 pounds per cubic foot (pcf) and 75 pcf, respectively.

The SPT data can be used to estimate the relative density (D_r). This can then be used in conjunction with values for maximum and minimum densities to calculate the in situ density of the sand and sand-slime

tailings. Laboratory tests (ASTM D4253 and D4254) of sand-slime tailings indicate an average maximum density of 100 pcf and an average minimum density of 75 pcf. Average SPT blow count for sand-slimes was approximately nine, indicating a relative density of about 52 percent, and resulting in an average in situ dry density of about 86 pcf. This coincides with the values determined in laboratory tests of undisturbed samples of sand-slime tailings.

Lambe and Whitman (1969) indicate values of maximum and minimum densities for silty sands (SM) of 127 pcf and 87 pcf, respectively. The average SPT blow count for the sand tailings (SM) is about 12. This results in a D_r = 59 percent and a calculated in-place dry density of about 107 pcf.

Using the piezocone and lab test results, correlations between point stress and the relative density (D_r) of sands have been obtained by Robertson and Campanella (1984). These were used to estimate the relative densities of the sand and coarse-grained sand-slimes. Piezocone test results (Addendum D6) indicate that the sands had an average D_r of 58 percent, while sand-slimes had an average D_r of about 48 percent. Thus, using the same maximum and minimum densities used with the SPT data, the in situ dry density of sand tailings was again found to be about 107 pcf. The in situ dry density of the sand-slimes was calculated to be about 85 pcf, which is in agreement with both laboratory results and SPT estimates.

Hydraulic conductivity

The hydraulic conductivity (permeability) of the various soil layers is a necessary factor in determining groundwater flow patterns, and contributes to the analysis of settlements, slope stability, and liquefaction.

Both constant head and triaxial permeability tests were performed on six Shelby tube samples. The results are presented in Table D.5.2. The one sand tailings sample tested showed a hydraulic conductivity of 1.2 x 10^{-2} centimeters per second (cm/s) which, although on the high side, is within the expected range for sands (Lambe and Whitman, 1969). A sand-slime sample had a hydraulic conductivity of about 3.0 x 10^{-6} and is about average for silty soils (Lambe and Whitman, 1969). The average hydraulic conductivity of the slime soils tested was 1.7 x 10^{-6} cm/s. All four samples tested produced results that were close to this average. Again, this is well within the expected range for clayey soils (Lambe and Whitman, 1969).

Although the values obtained for the hydraulic conductivity of the slime tailings are fairly consistent and are thought to be reliable, it is interesting and informative to compare the hydraulic conductivity of similar samples as calculated from consolidation tests. These calculated hydraulic conductivities are presented in Table D.5.2. Two slime samples, HAT01-126, 22.5 to 25 feet, and HAT01-136, three to 5.5 feet, had hydraulic conductivities of 6.1 x 10^{-7} cm/s and 1.3 x 10^{-7} cm/s,

respectively, as determined in permeability tests. The hydraulic conductivity, as calculated from consolidation test data, averaged 9.2 x 10^{-8} cm/s and 7.9 x 10^{-8} cm/s, respectively. The calculated values are about an order of magnitude less than the permeability test values. This would be expected since the consolidation test values reflect much higher confining pressures and lower void ratios than those found in the tailings deposit, and thus tend to confirm the permeability test data for these two samples.

Capillary moisture relationship

Capillary moisture data are useful in determining the long-term moisture content of the soil, its wilting point, and can also be used to calculate the unsaturated hydraulic conductivity.

The capillary moisture test is performed in order to determine the amount of water a soil can hold under a given pressure difference and thus indirectly measures the moisture content of the soil as a function of the capillary tensions developed within the soil matrix. Six undisturbed soil samples were tested and the results are presented in Figures D.5.15 through D.5.22.

Consolidation parameters

The most commonly used equation for calculating the consolidation settlement of a saturated soil layer is one adapted from the original differential equation developed by Terzaghi (Lambe and Whitman, 1969). This equation uses the coefficient of compressibility C_c, which is the slope of the void ratio (e) versus log of effective stress (log p') curve, to estimate consolidation settlement. Znidarcic and Schiffman, date unknown, state that the simplified Terzaghi equation was developed by assuming that only infinitesimal strains will occur in response to the increased loading and ignoring the effects of the self weight of the soil. A further assumption was that the coefficient of permeability remains constant as the void ratio decreases during consolidation. These assumptions do not result in substantial differences in calculated settlements in most natural soil deposits. However, tailings may exist at relatively large void ratios. Thus, settlements can become a large percentage of original soil height. Therefore, tailings may violate the assumption of infinitesimal strains and can have such large void ratio changes as to cause permeability to decrease with decreasing void ratio.

For use in the standard or infinitesimal strain consolidation calculations, Figures D.5.23 through D.5.32 are reproductions of the laboratory consolidation curves. Data related to the laboratory consolidation tests and calculated values of the coefficient of consolidation and the secondary compression index are found in Table D.5.3.

Consolidation tests indicate that the average overconsolidation ratio for slime tailings is about 3.5. To help determine whether the slimes are normally consolidated or overconsolidated, the undrained

strength (Su) of the slimes based on piezocone data was estimated to be about 1100 psf. If this value for Su is compared to that for the average normally consolidated clay (200 to 400 psf), it is evident that the piezocone data support the contention that the slime tailings are overconsolidated.

Table D.5.3 summarizes the various time rate settlement parameters obtained through consolidation tests performed in the laboratory on six samples of slime tailings and a sand-slime sample.

The coefficient of consolidation (C_v) is used to estimate the percent of total consolidation settlement that will occur over a given time period following application of the load to the soil deposit. The value to be used in design calculations must take into account the load applied to the soil, since C_v will change with loading. Thus, to estimate the values of C_v for slimes tailings for use in design, the laboratory-determined values of C_v for each load increment from one to 32 ksf were averaged for all slime samples for which C_v data were available.

Strength

The shear strengths of the various soils in the tailings pile are a key aspect of slope stability analysis. To determine the shear strengths of the tailings, two types of laboratory tests were used: (1) the unconsolidated-undrained, or "Quick" (Q) test; and (2) the consolidated-undrained test with pore pressure measurements, or "Rapid" (R) test. In addition to the lab testing, empirical correlations between SPT, piezocone data, and shear strength parameters were used.

The Q test is generally performed only on cohesive fine-grained, low permeability soils that are expected to show intermediate to long-term increases in pore pressures in response to loading. Since this test was performed on undisturbed soil samples that were not initially saturated, the shear stress (τ) vs normal effective stress (σ') relationship is highly nonlinear. This nonlinearity is maintained until the stresses become high enough to drive all the air in the voids into the water, causing the soil to become 100 percent saturated. Thus, a "Q" triaxial test on an initially unsaturated sample will yield a value for both the friction angle (ϕ) and cohesion (C).

When a sample that is completely saturated remains undrained during loading (Q test), the normal effective stress remains zero since changes in stress are reflected only in increased pore pressures. If effective normal stresses go to zero in the Mohr-Coulomb equation, the only shear strength available to the soil is cohesion and, in a saturated clay sample, this value remains the same for all confining pressures near the in situ confining pressure. This value, known as the saturated-undrained (Su) strength, tends to increase linearly with depth in normally consolidated deposits.

The R triaxial shear test is performed on a soil sample that is nearly 100 percent saturated. If the sample is not saturated as it comes

from the field, it is saturated in the testing apparatus by forcing water, under pressure, through the sample until nearly 100 percent saturation is reached. In this test both total stress (c, ϕ) and effective stress (c, ϕ) parameters can be obtained.

A summary of the Q and R triaxial testing results is presented in Figures D.5.33 through D.5.36.

D.5.2 MATERIAL PROPERTIES OF REMOLDED TAILINGS AND CONTAMINATED WINDBLOWN MATERIAL

Relative density

Samples from five test pits were tested to establish their maximum and minimum densities for use in relative density calculations. The results are presented in Table D.5.4.

Moisture-density relationships

To determine the compaction characteristics of the remolded tailings and contaminated windblown material, the standard Proctor compaction test (ASTM D698) was performed on a number of tailings samples excavated from test pits on the Mexican Hat tailings pile.

The results of these compaction tests on various samples of sand-slime and slime tailings are presented in Table D.5.4. Also presented in Table D.5.4 are the physical characteristics of these samples, including grain size distribution, natural water content, Atterberg limits, specific gravity of solids, and USCS classification.

Hydraulic conductivity and capillary moisture relations

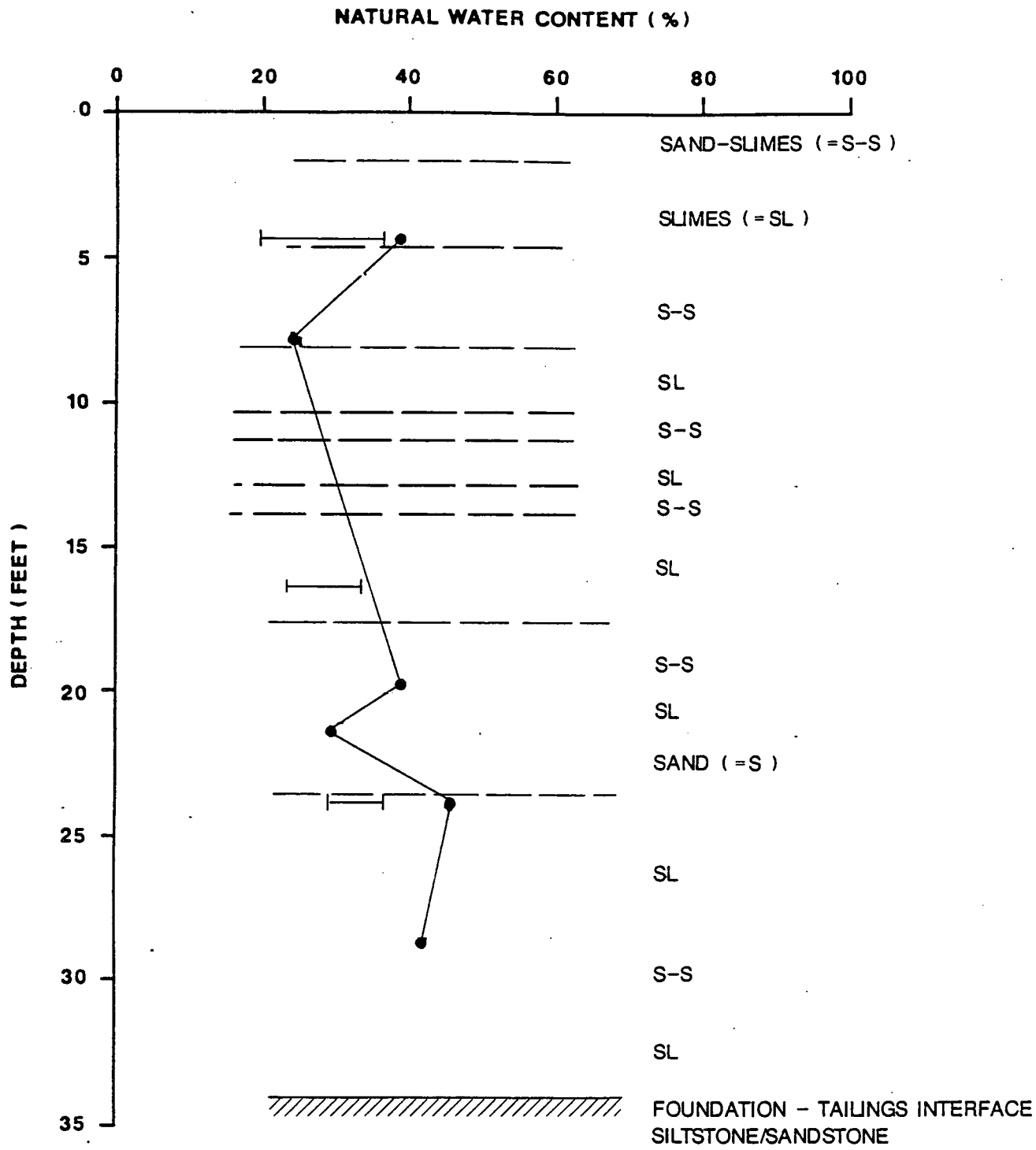
Data presented by the U.S. Navy (1982) and Sowers (1979) indicate that silty sands and silts can be expected to have hydraulic conductivities in the range of 10^{-2} to 10^{-6} cm/s. Since the recompacted tailings are expected to have a large percentage of silt size particles, it is recommended that a hydraulic conductivity of 10^{-5} cm/s be used in design.

Portions of seven of the bulk samples were recompacted to approximately 90 percent of standard Proctor maximum density in metal rings. Capillary moisture tests were performed on these specimens. The results of these tests are presented in Figures D.5.37 through D.5.41.

Shear strength

An R test was performed on a specimen recompacted from a composite sample of sand-slime (obtained by combining test pit samples HAT01-001 [0.0' - 1.5'] and HAT01-002 [3.0' - 4.5']). This sample was recompacted to a dry density of 90.2 pcf (D_r = 68 percent) in order to approximate the

in-place densities of the sand and sand-slime (SM) tailings. These tailings are in such a loose state in situ that the laboratory could not successfully remold a specimen to the average in situ density. The test results (ϕ = 31.7°, c = 0 in Figure D.5.42) probably indicate the upper bound in situ strength of the sand and sand-slime tailings, as well as giving a good indication of the expected strength of the recompacted tailings.

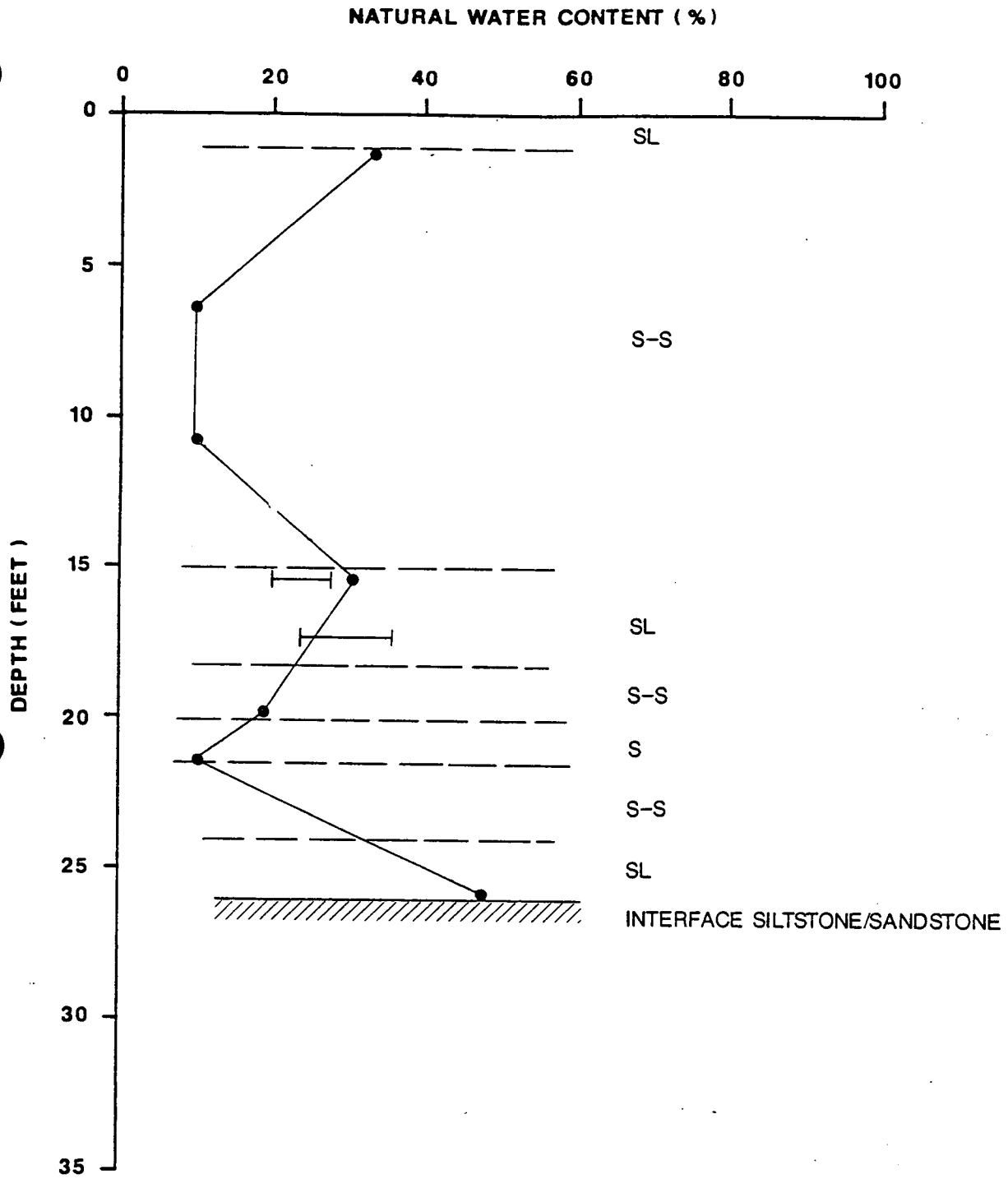


LEGEND

● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.1
WATER CONTENT VS DEPTH
HAT01-126

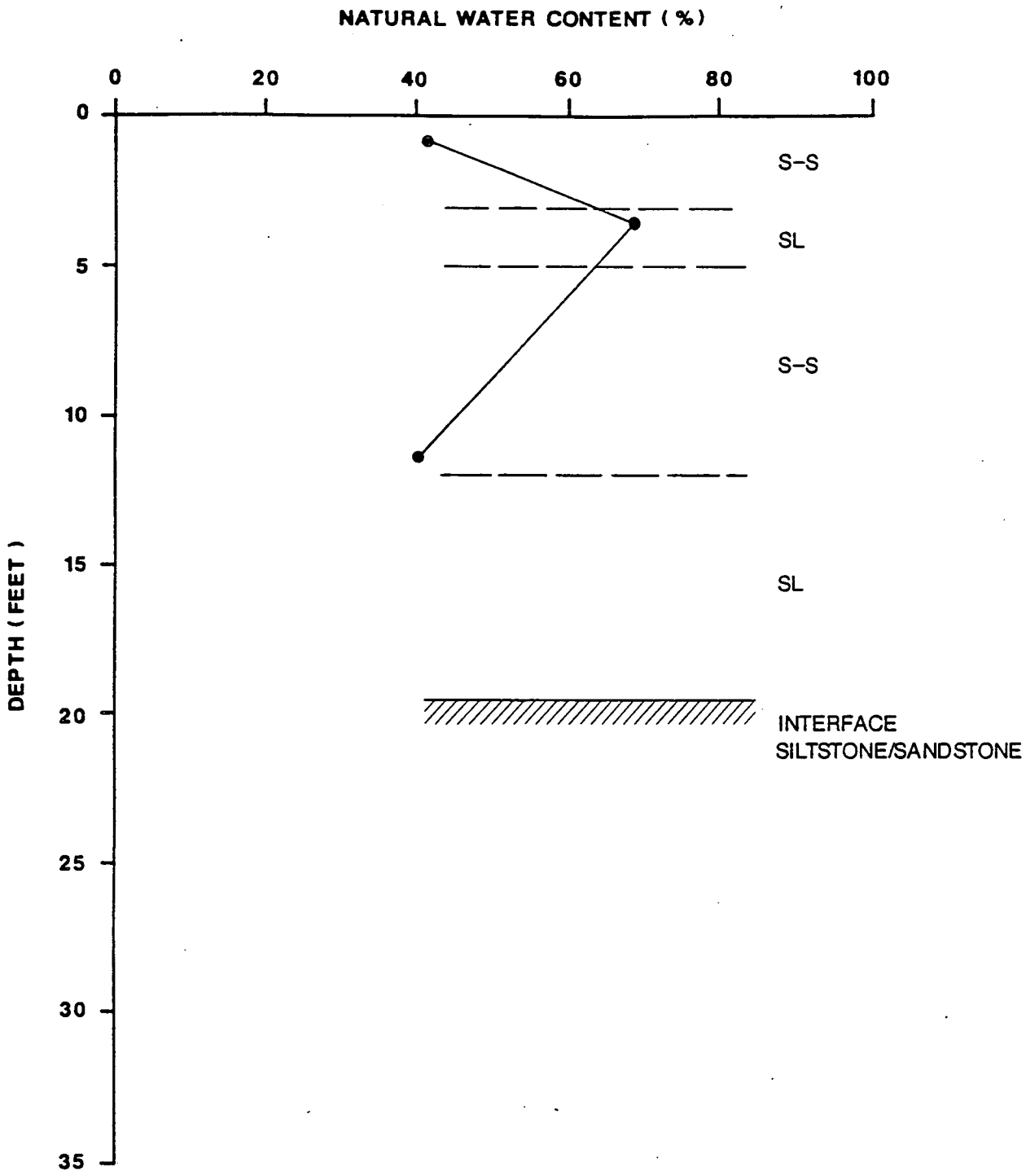


LEGEND

● — LABORATORY WATER CONTENT DATA

⊢⊣ — RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.2
WATER CONTENT VS DEPTH
HAT01-127



LEGEND

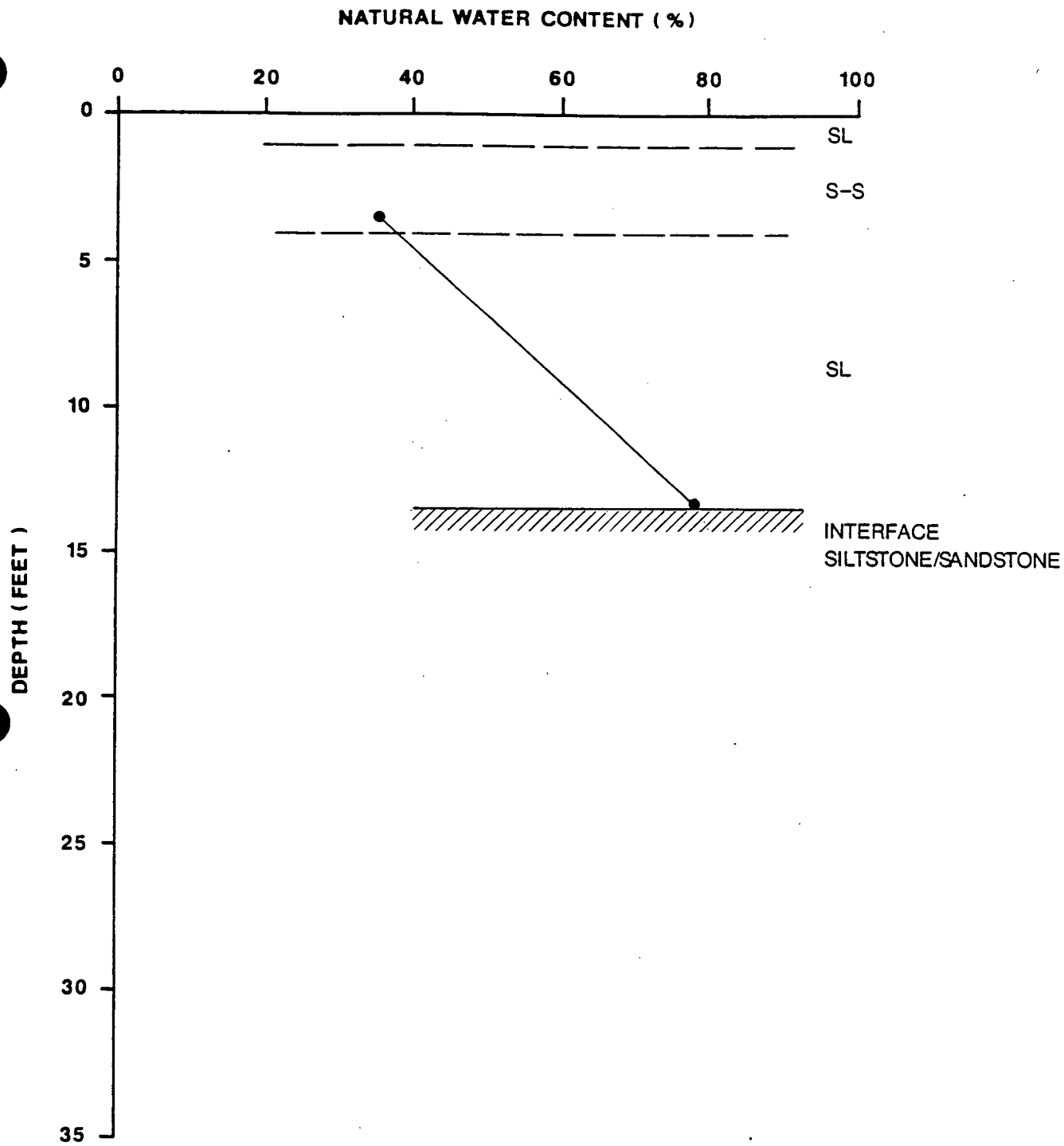
● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.3

WATER CONTENT VS DEPTH

HAT01-128

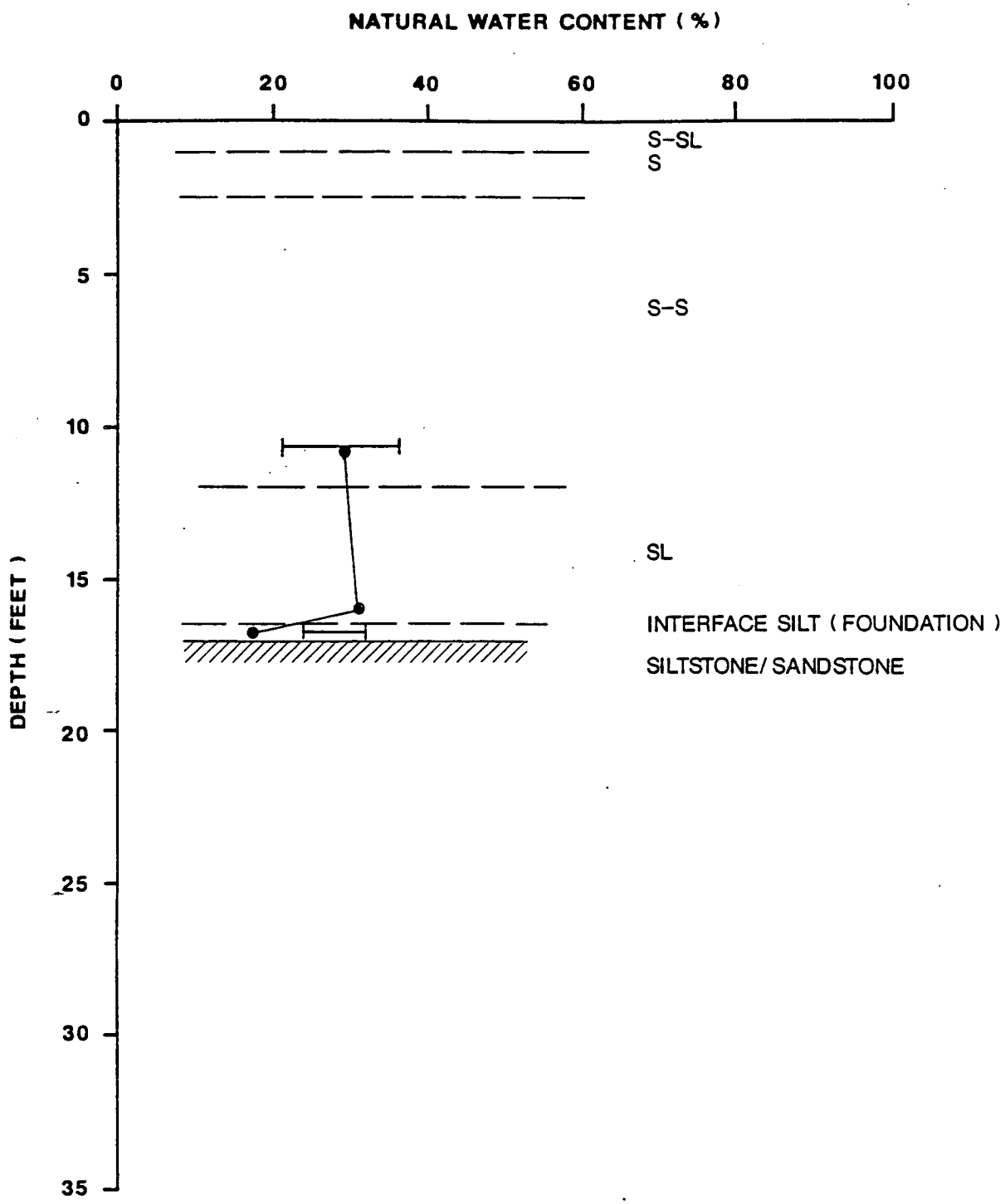


LEGEND

● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.4
WATER CONTENT VS DEPTH
HAT01-129

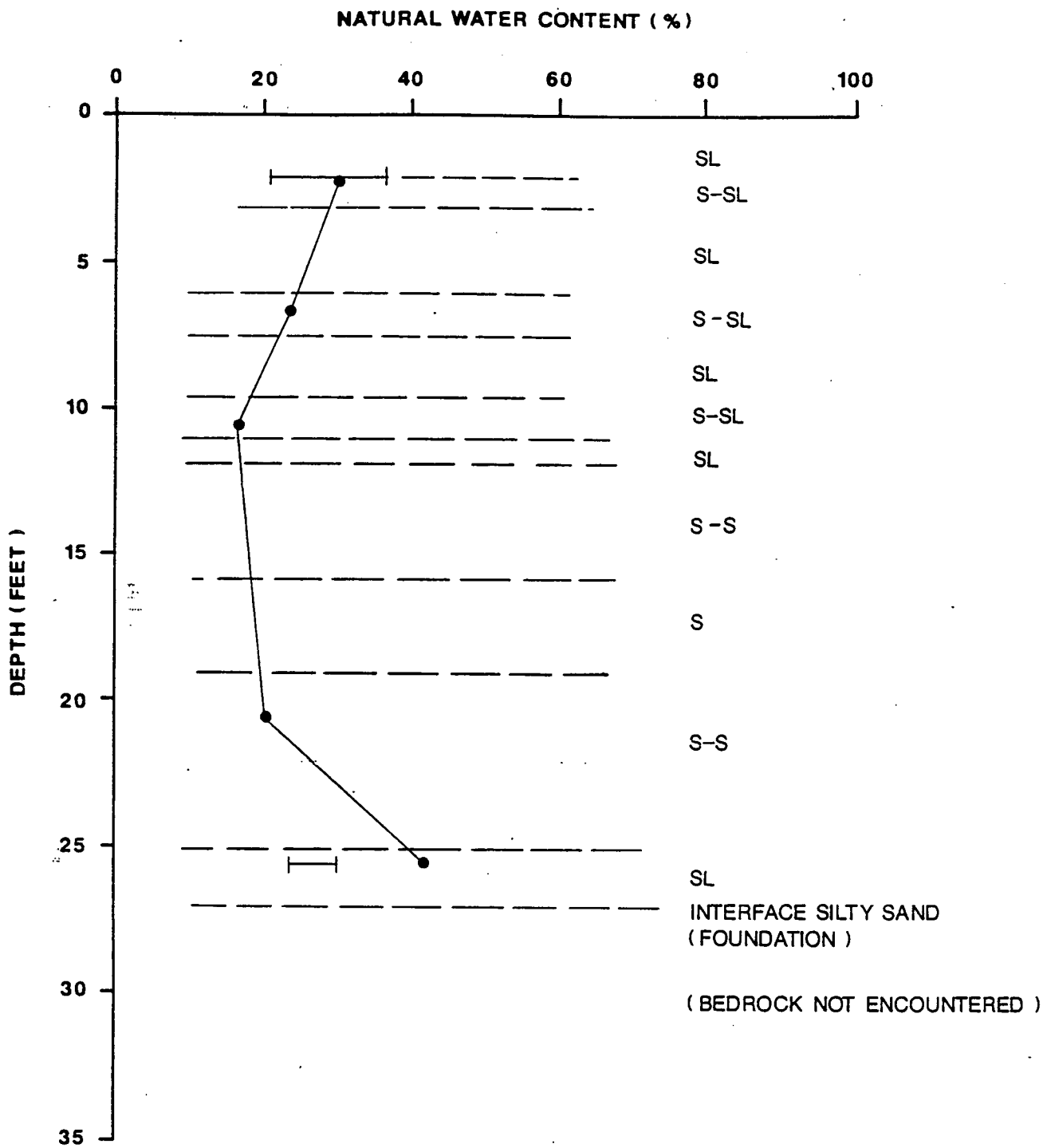


LEGEND

● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.5
WATER CONTENT VS DEPTH
HAT01-131



LEGEND

● — LABORATORY WATER CONTENT DATA

|—| — RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.6
WATER CONTENT VS DEPTH
HAT01-132

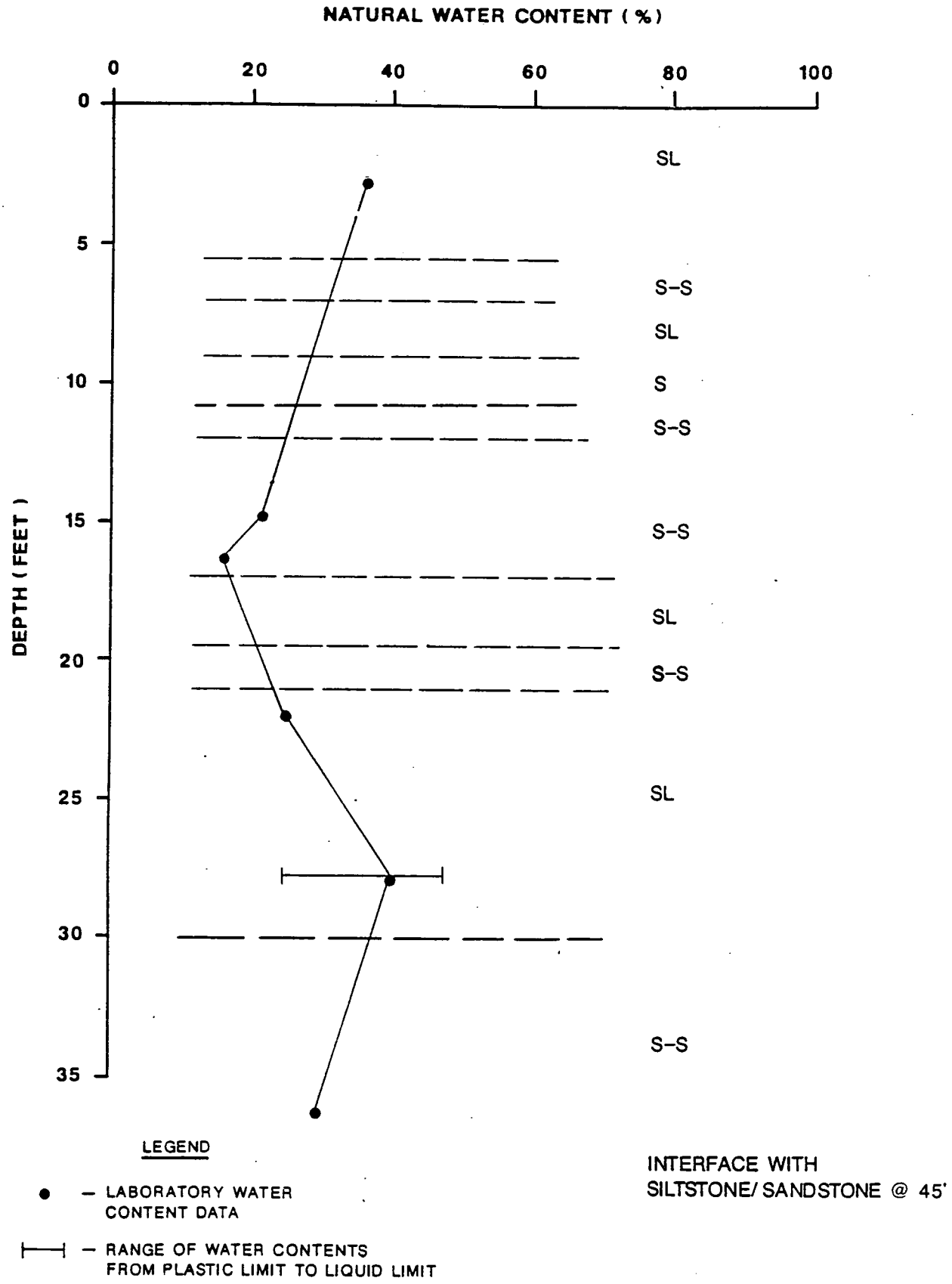


FIGURE D.5.7
WATER CONTENT VS DEPTH
HAT01-133

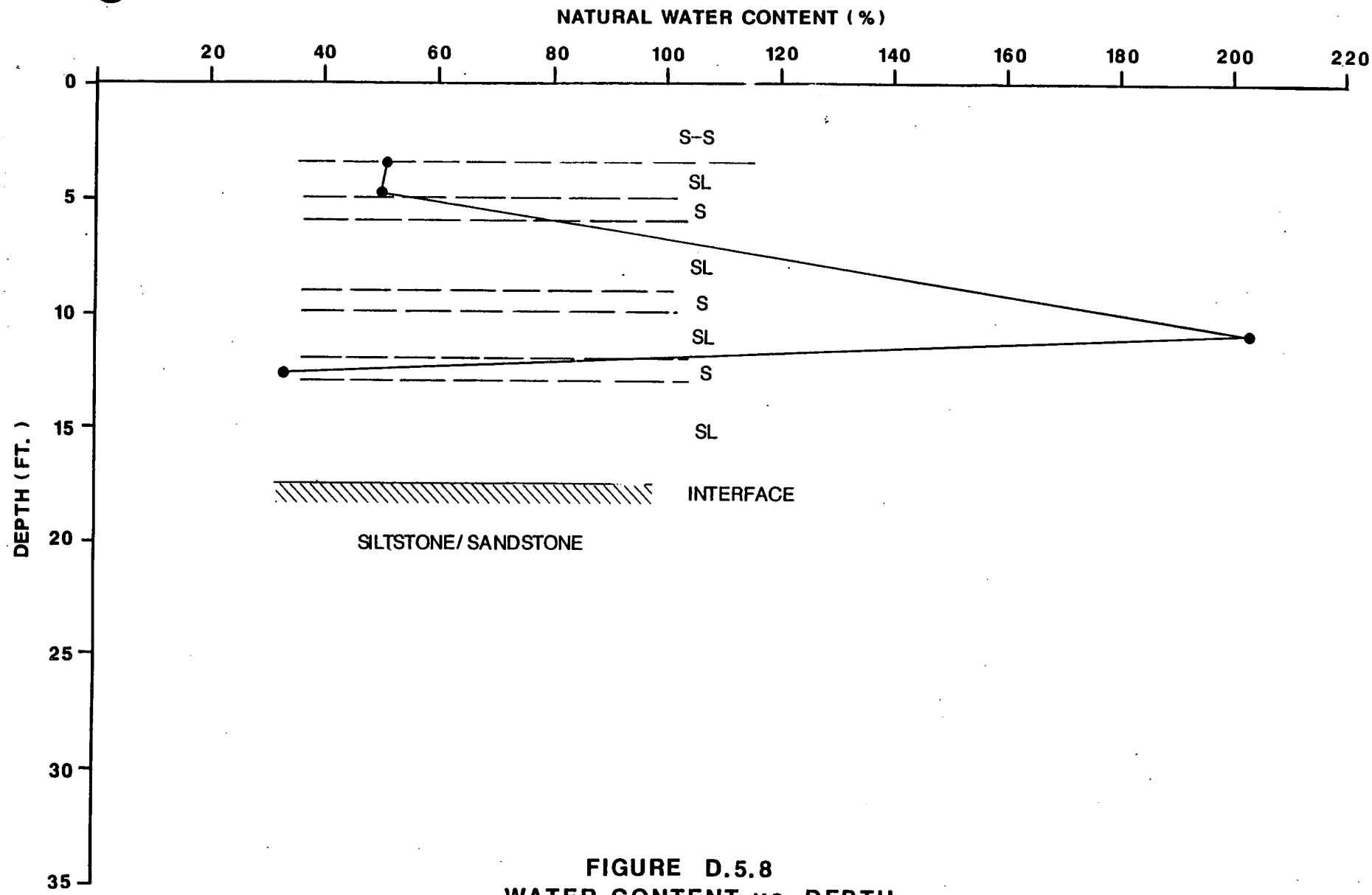


FIGURE D.5.8
WATER CONTENT vs. DEPTH
HAT01-130

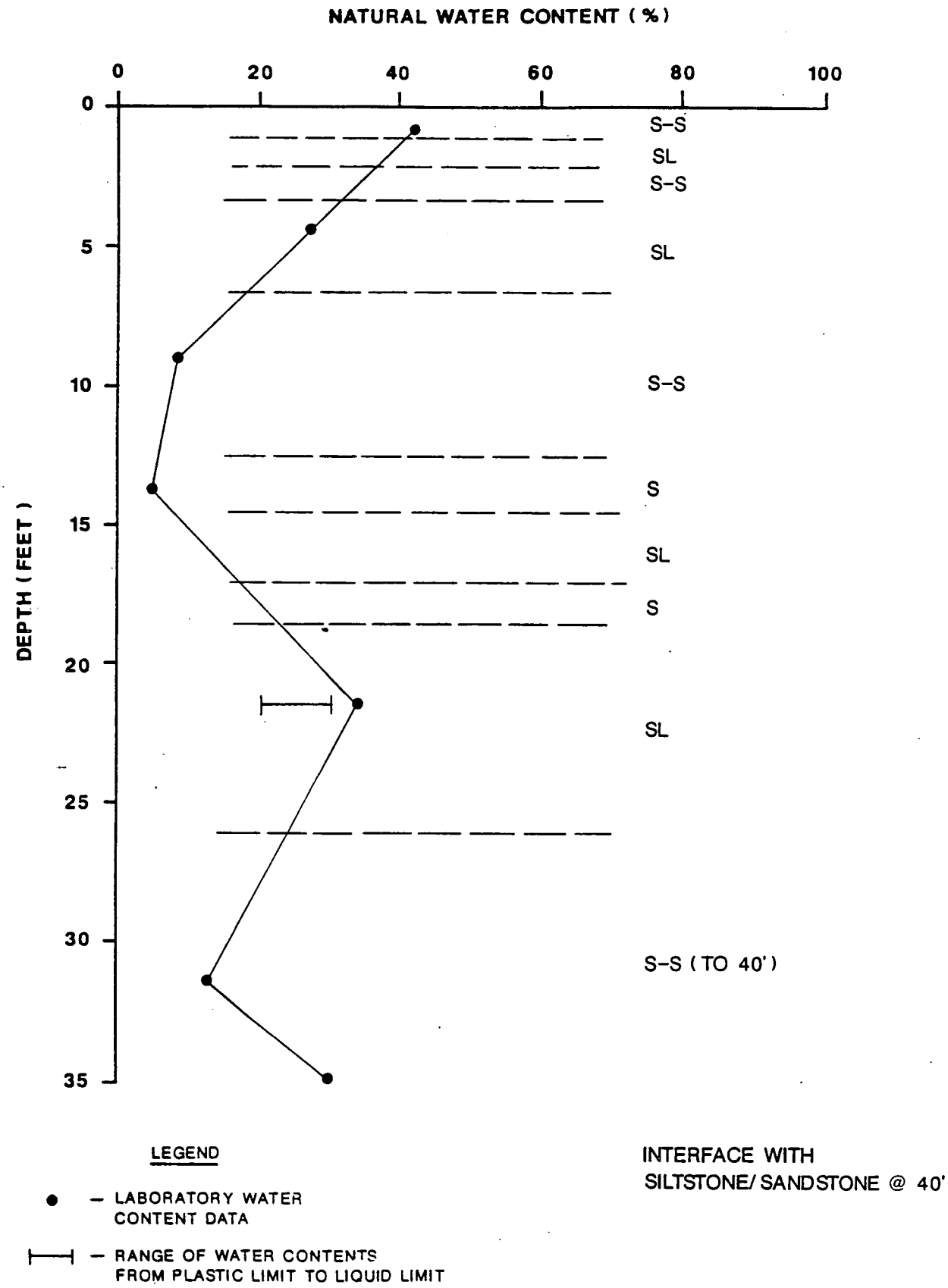
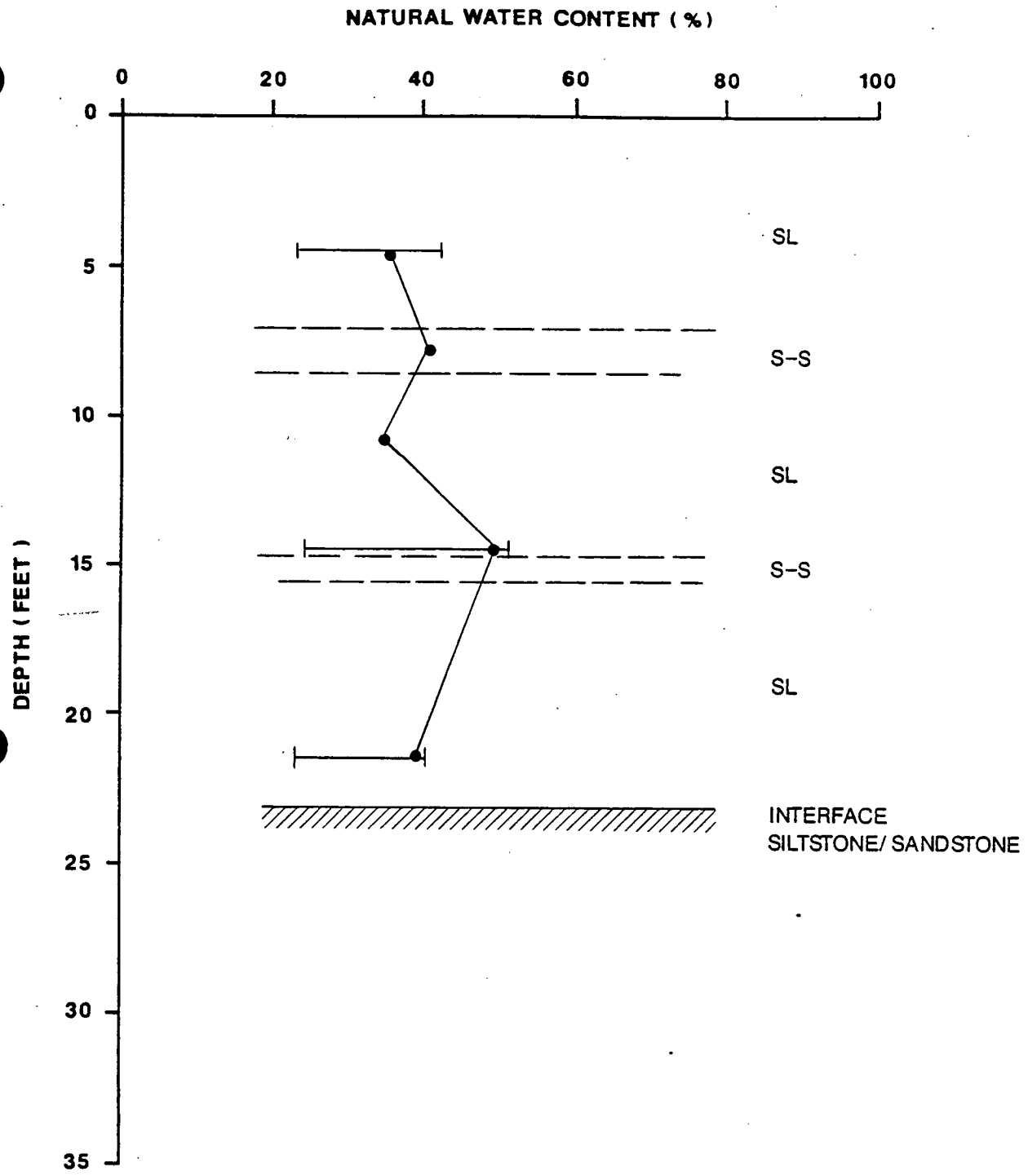


FIGURE D.5.9
WATER CONTENT VS DEPTH
HAT01-135

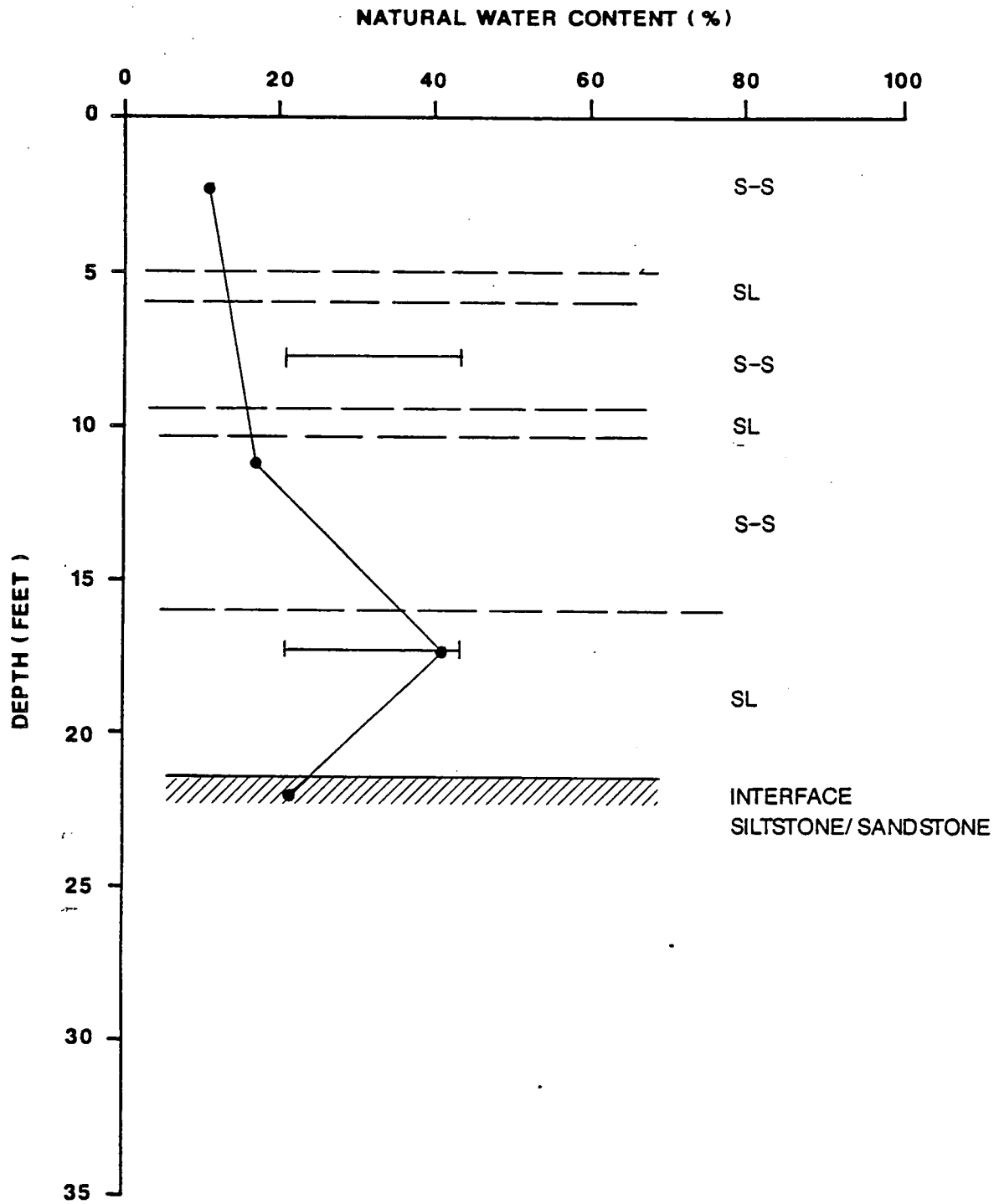


LEGEND

● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.10
WATER CONTENT VS DEPTH
HAT 01-136



LEGEND

● — LABORATORY WATER CONTENT DATA

|—| — RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.11
WATER CONTENT VS DEPTH
HAT01-137

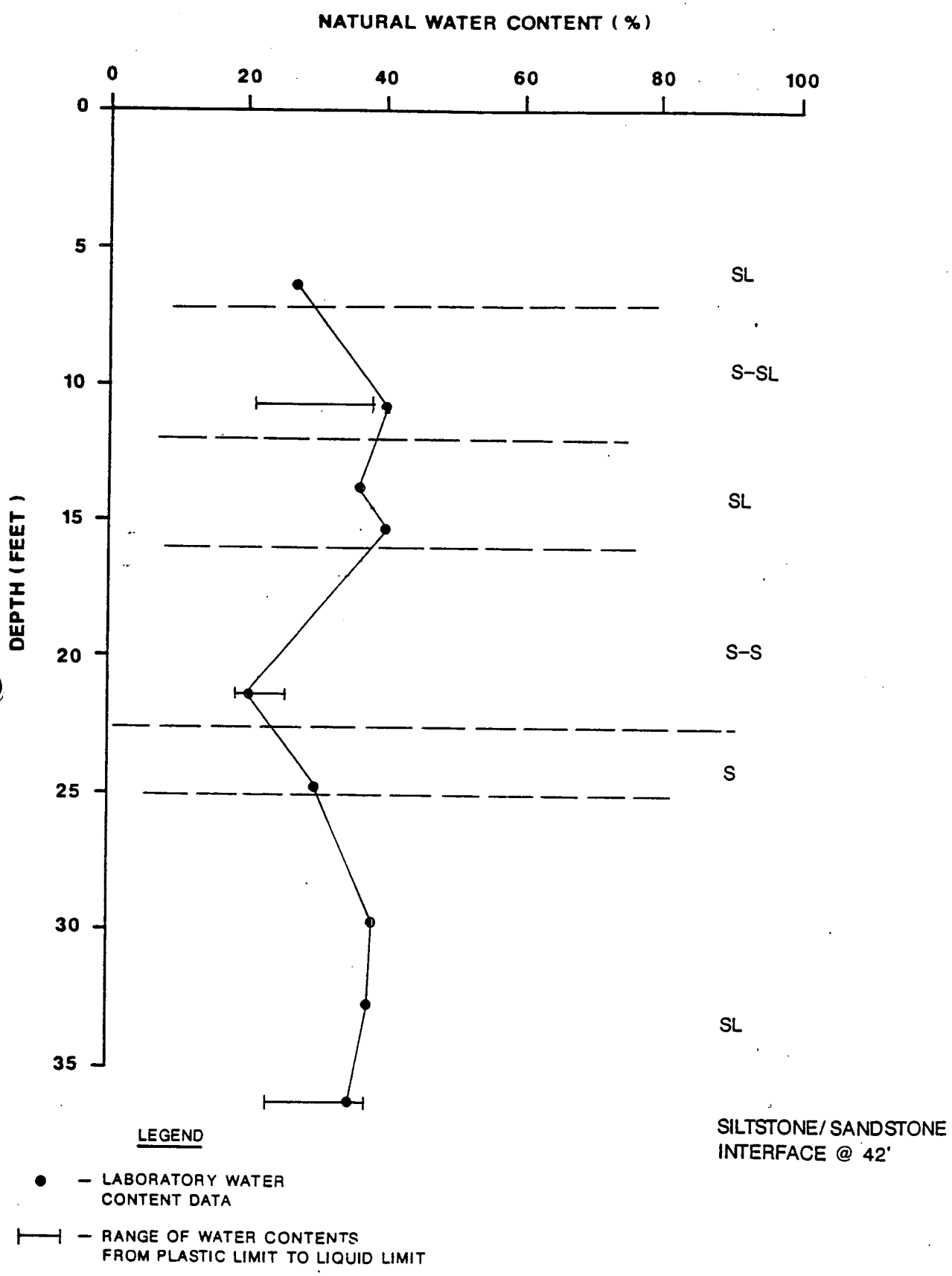
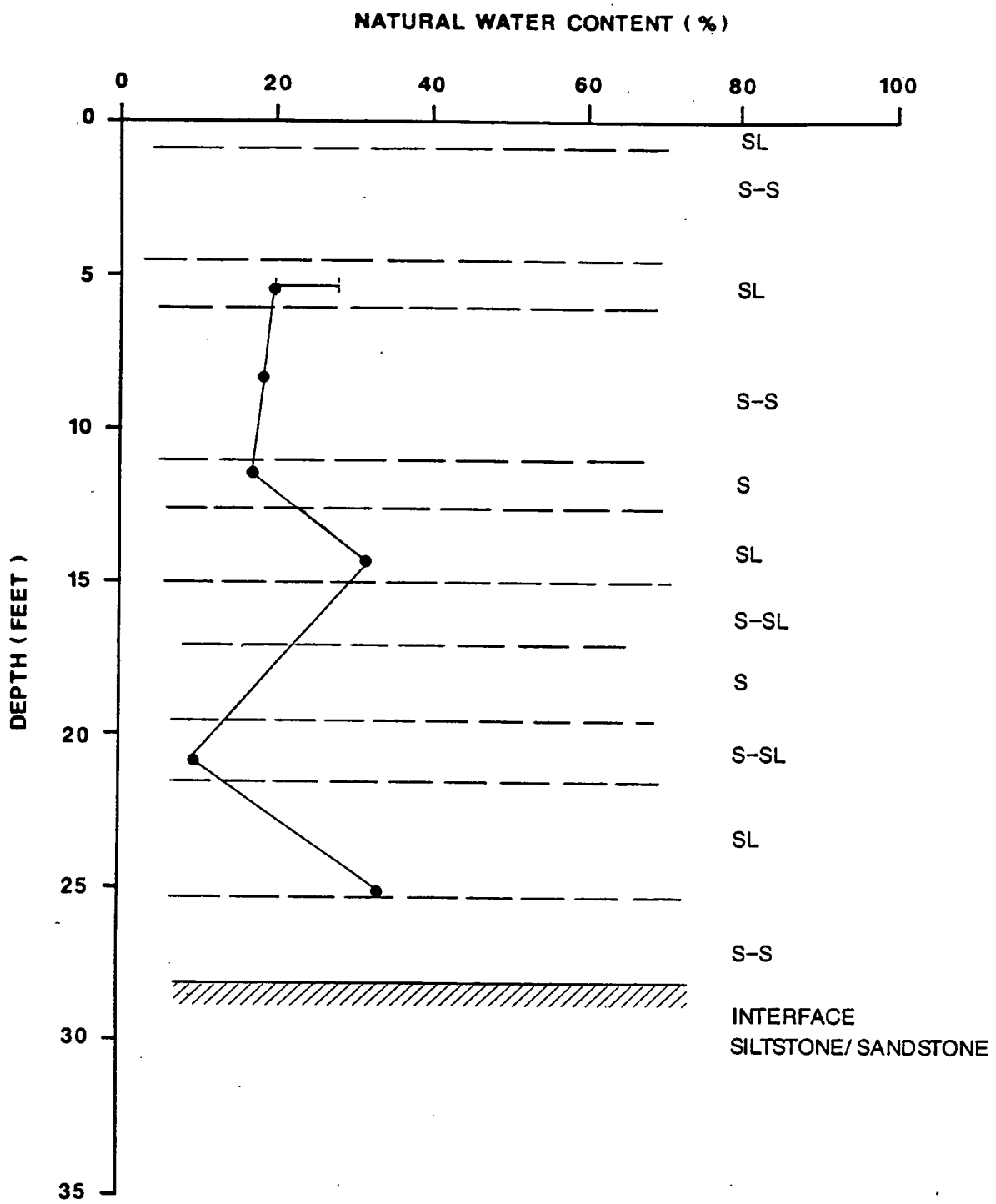


FIGURE D.5.12
WATER CONTENT VS DEPTH
HAT01-138

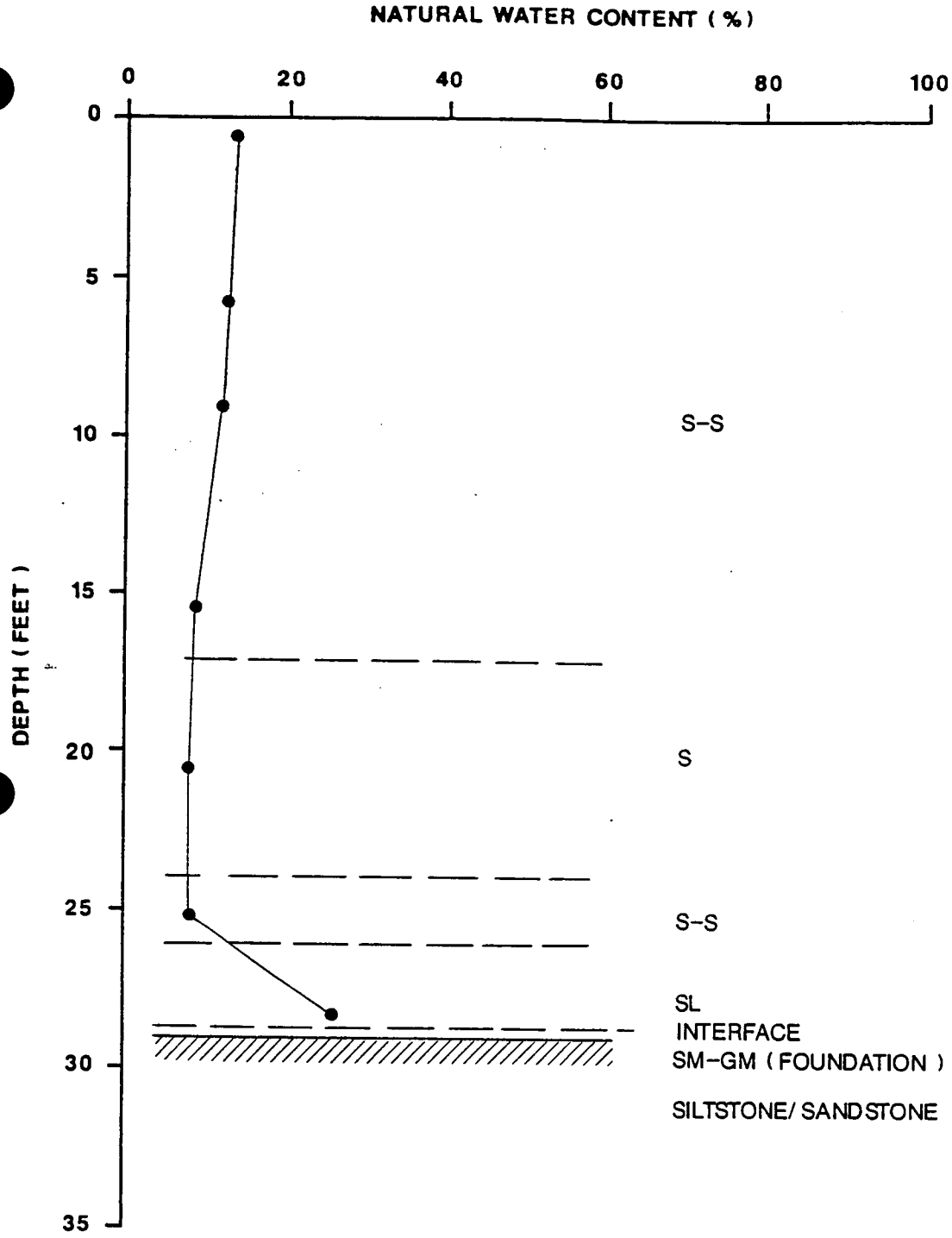


LEGEND

● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.13
WATER CONTENT VS DEPTH
HAT01-139



LEGEND

● – LABORATORY WATER CONTENT DATA

|—| – RANGE OF WATER CONTENTS FROM PLASTIC LIMIT TO LIQUID LIMIT

FIGURE D.5.14
WATER CONTENT VS DEPTH
HAT01-181

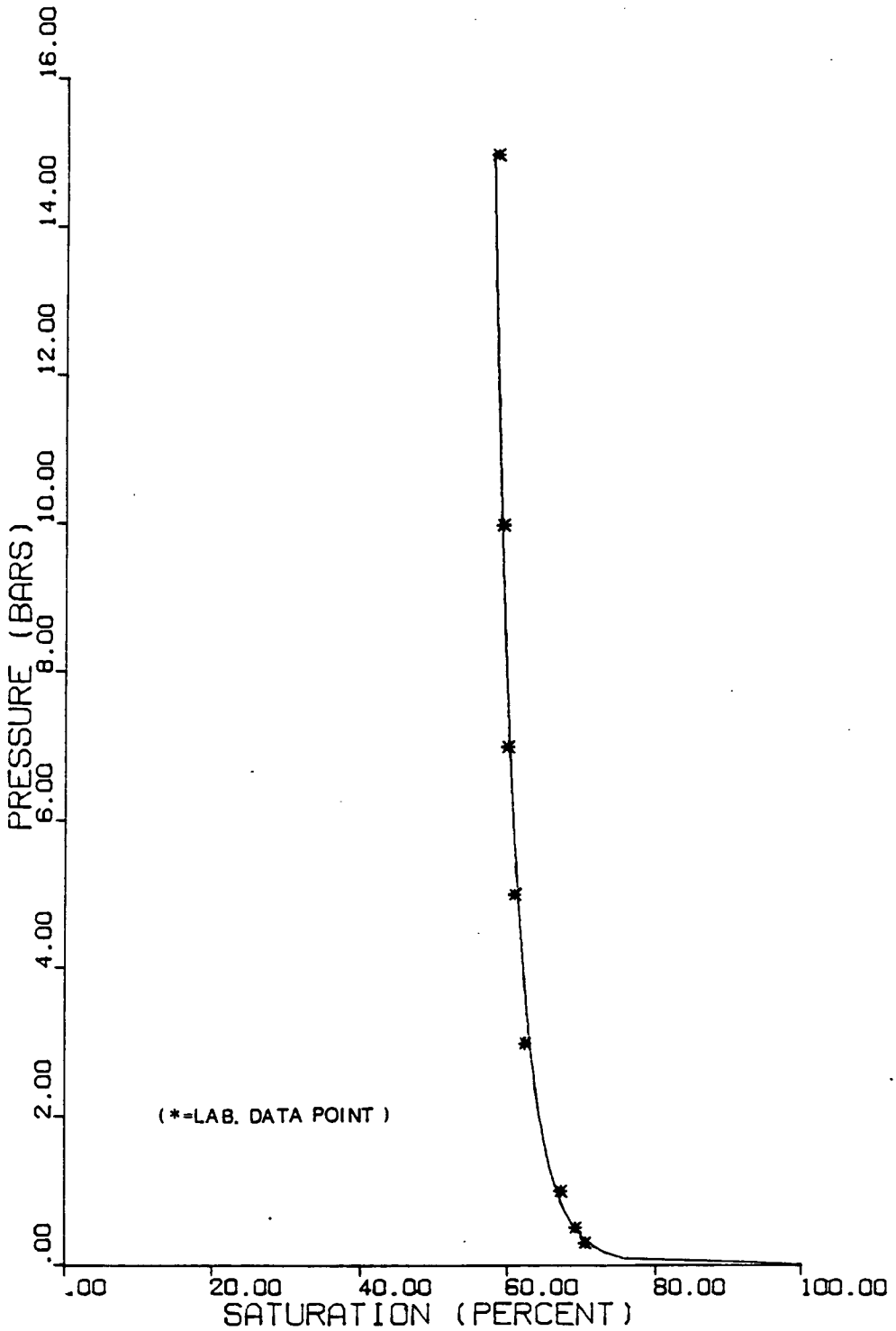


FIGURE D.5.15
CAPILLARY MOISTURE CURVE
HAT01-126 15 - 17.5 FT. (SAMPLE 1)

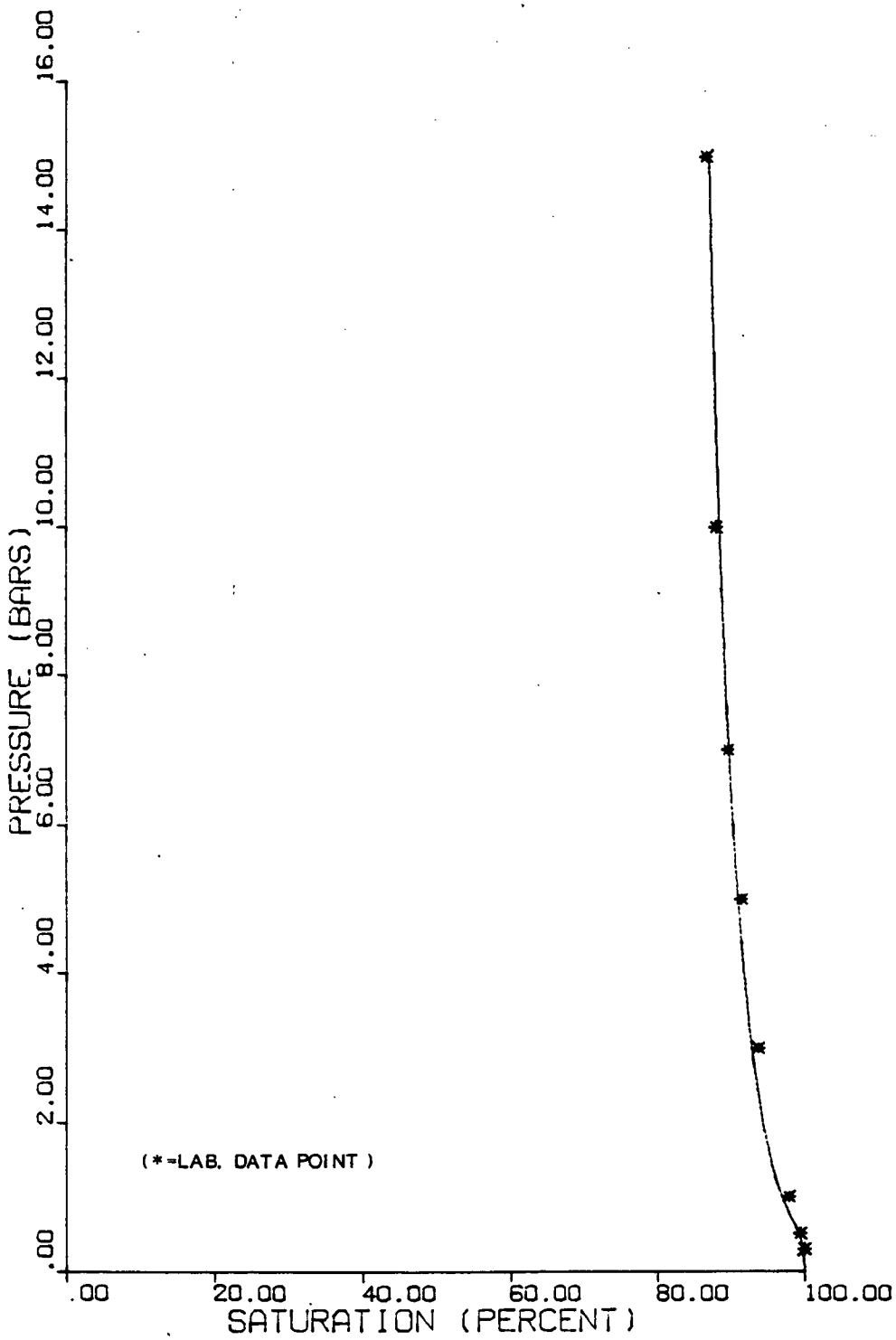


FIGURE D.5.16
CAPILLARY MOISTURE CURVE
HAT01-126 15 - 17.5 FT. (SAMPLE 2)

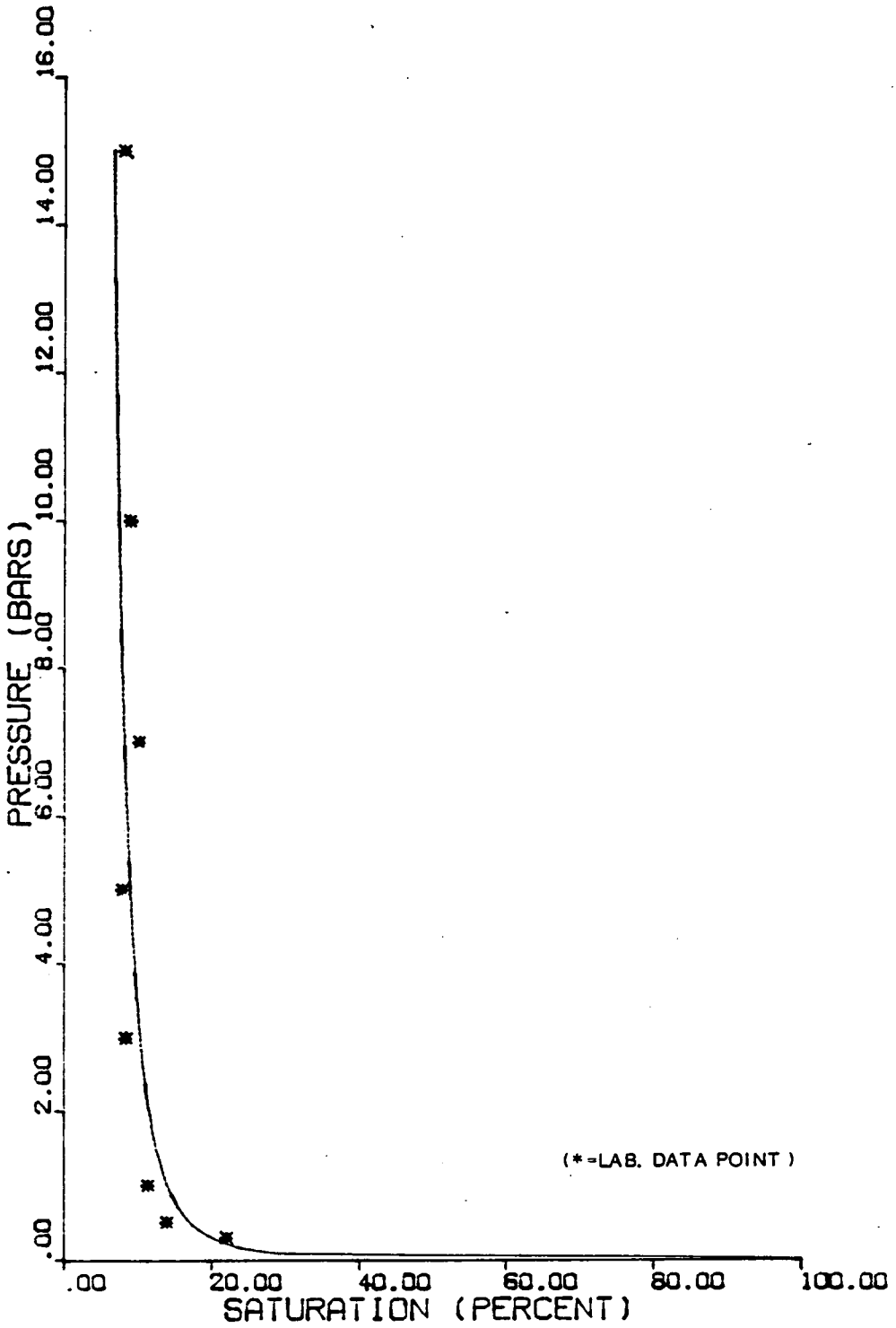


FIGURE D.5.17
CAPILLARY MOISTURE CURVE
HAT01-131 10 - 12.5 FT. (SAMPLE 1)

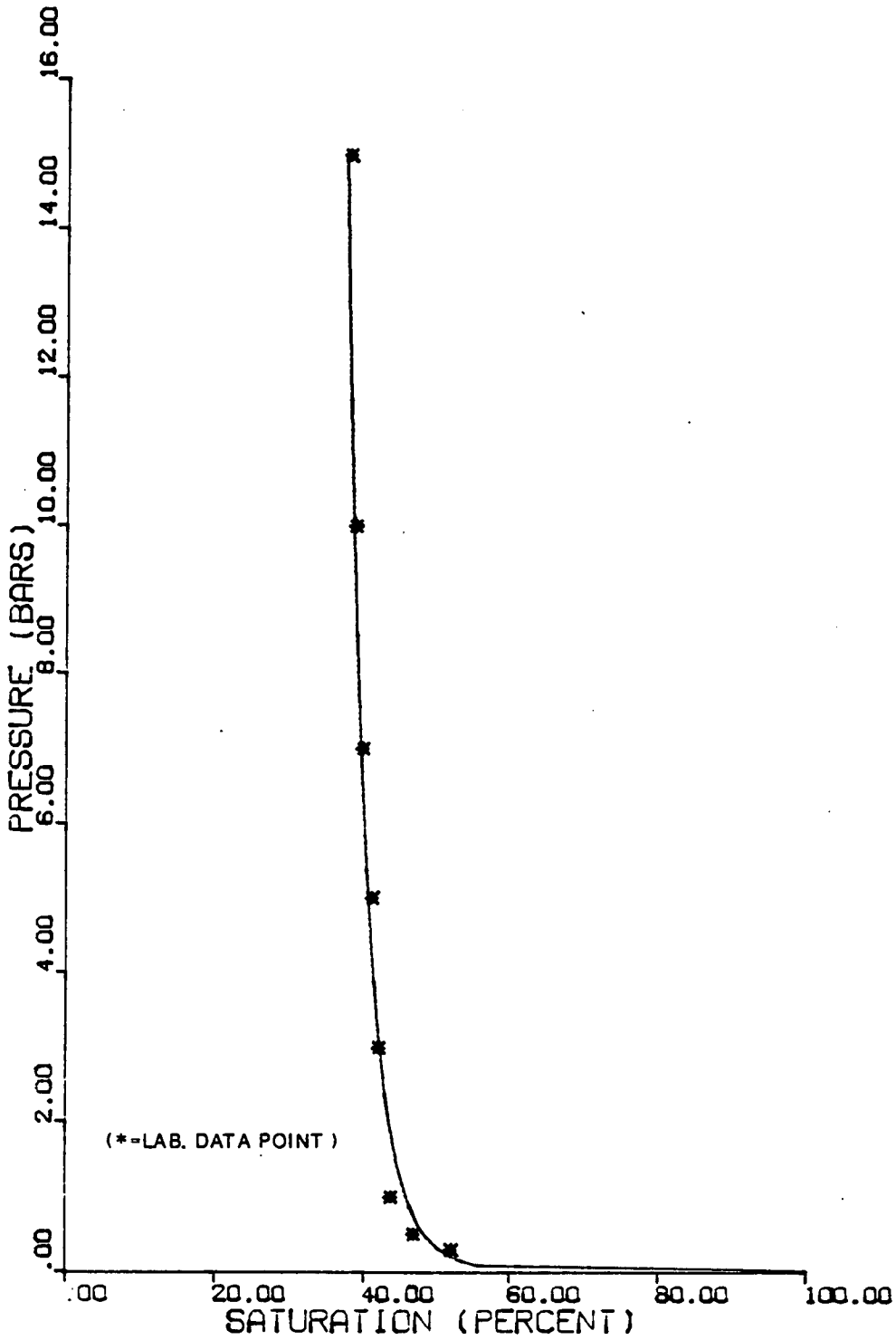


FIGURE D.5.18
CAPILLARY MOISTURE CURVE
HAT01-131 10 - 12.5 FT. (SAMPLE 2)

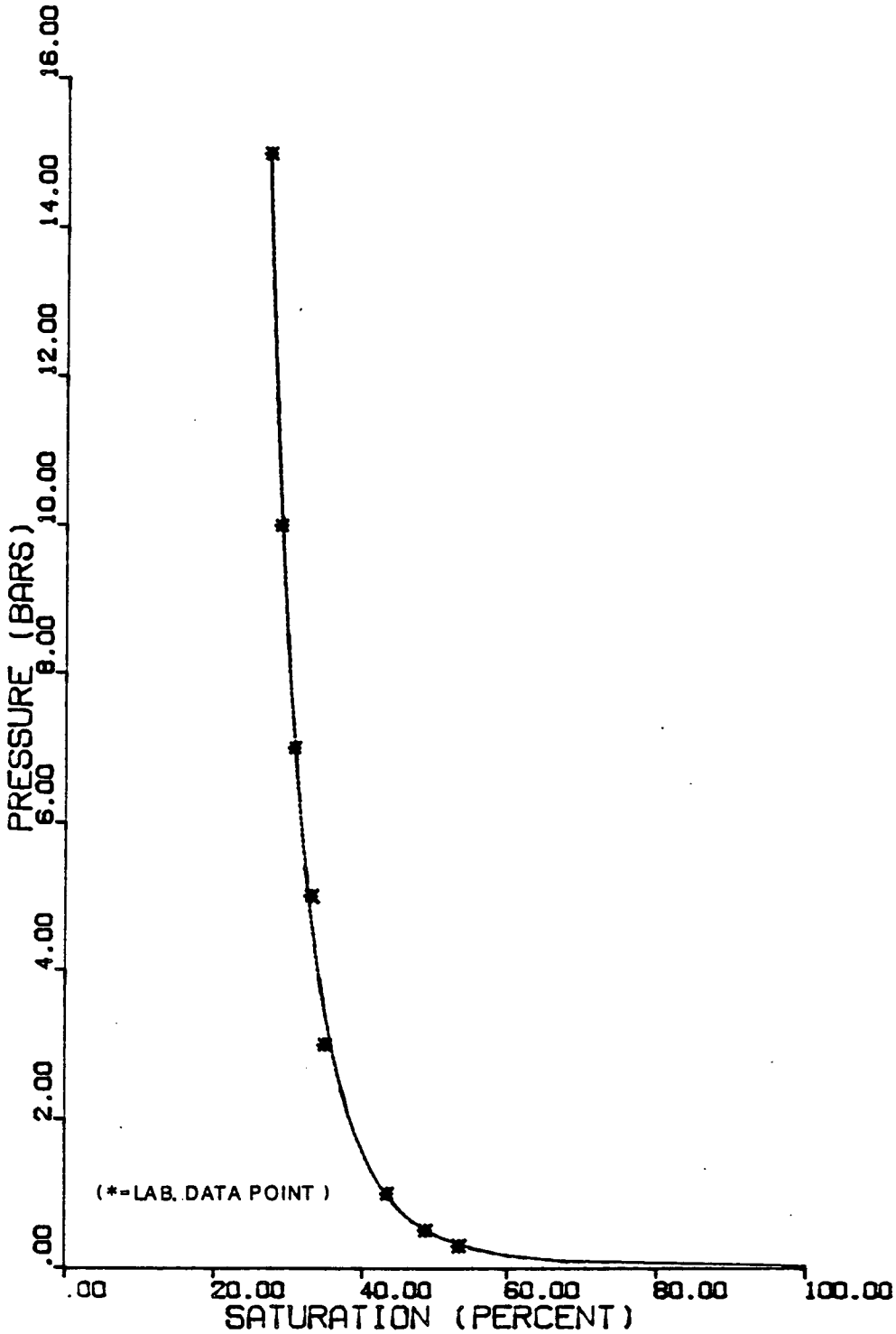


FIGURE D.5.19
CAPILLARY MOISTURE CURVE
HAT01-134 35 - 37.5 FT.

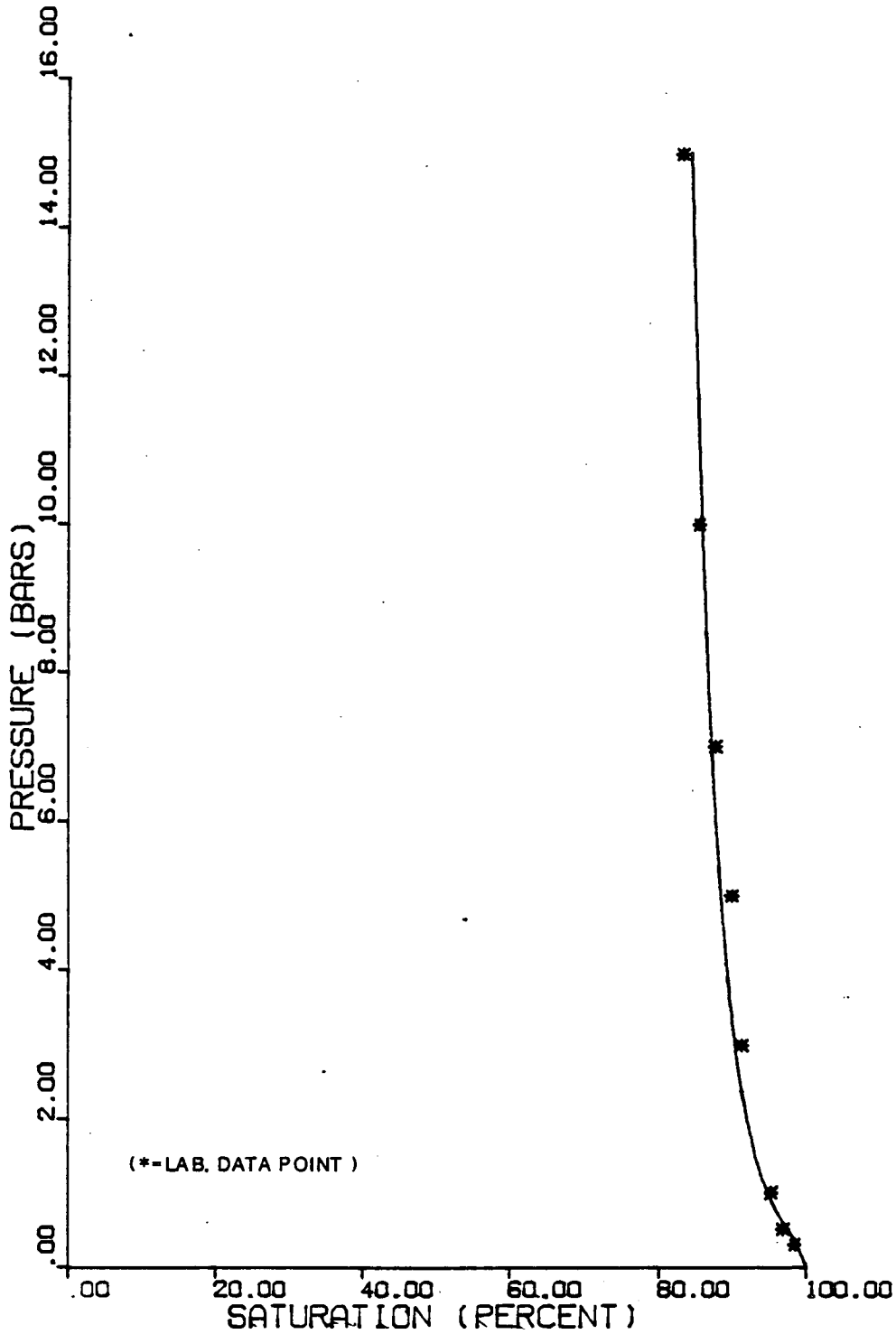


FIGURE D.5.20
CAPILLARY MOISTURE CURVE
HAT01-135 20 - 22.5 FT.

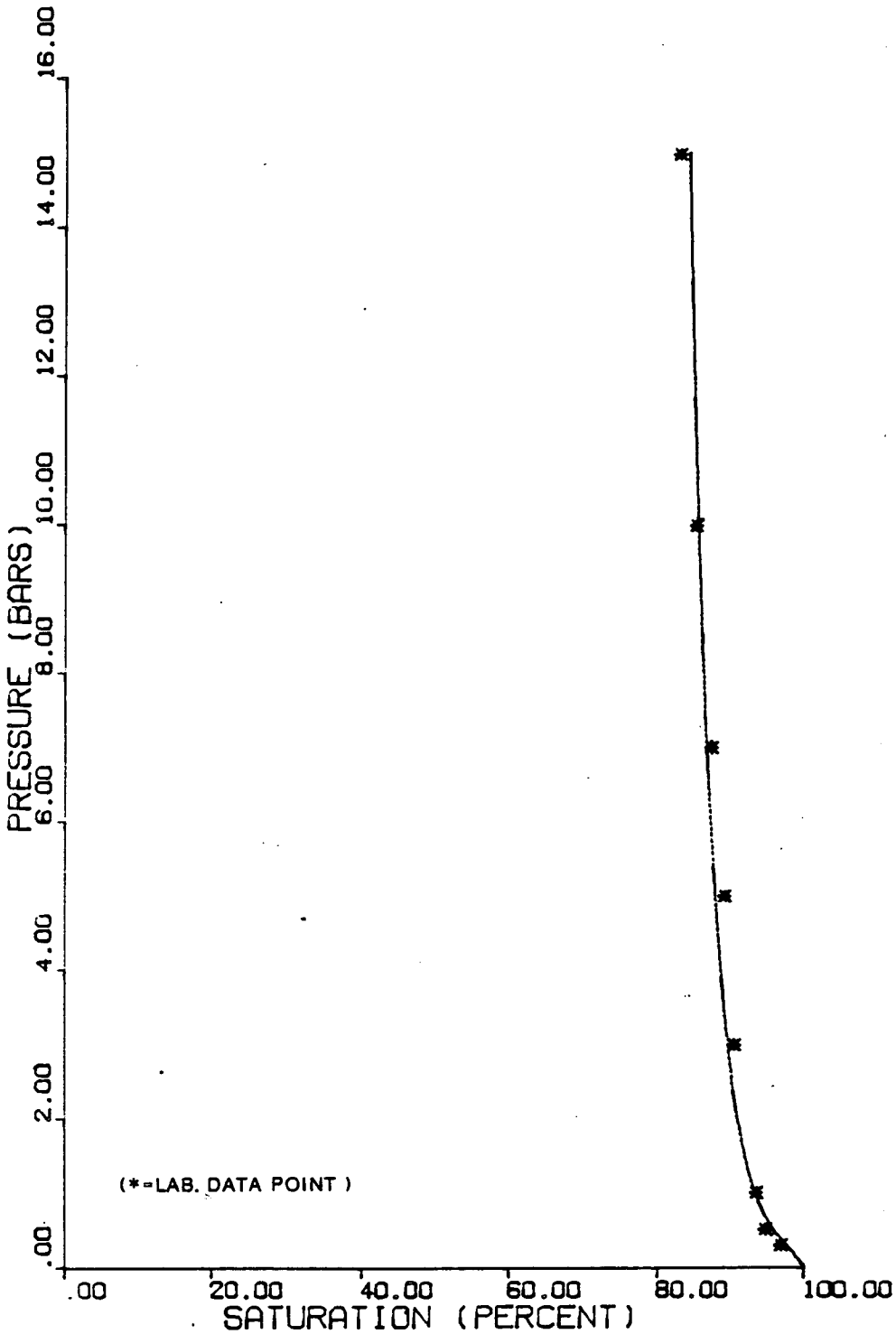


FIGURE D.5.21
CAPILLARY MOISTURE CURVE
HAT01-136 20 - 22.5 FT.

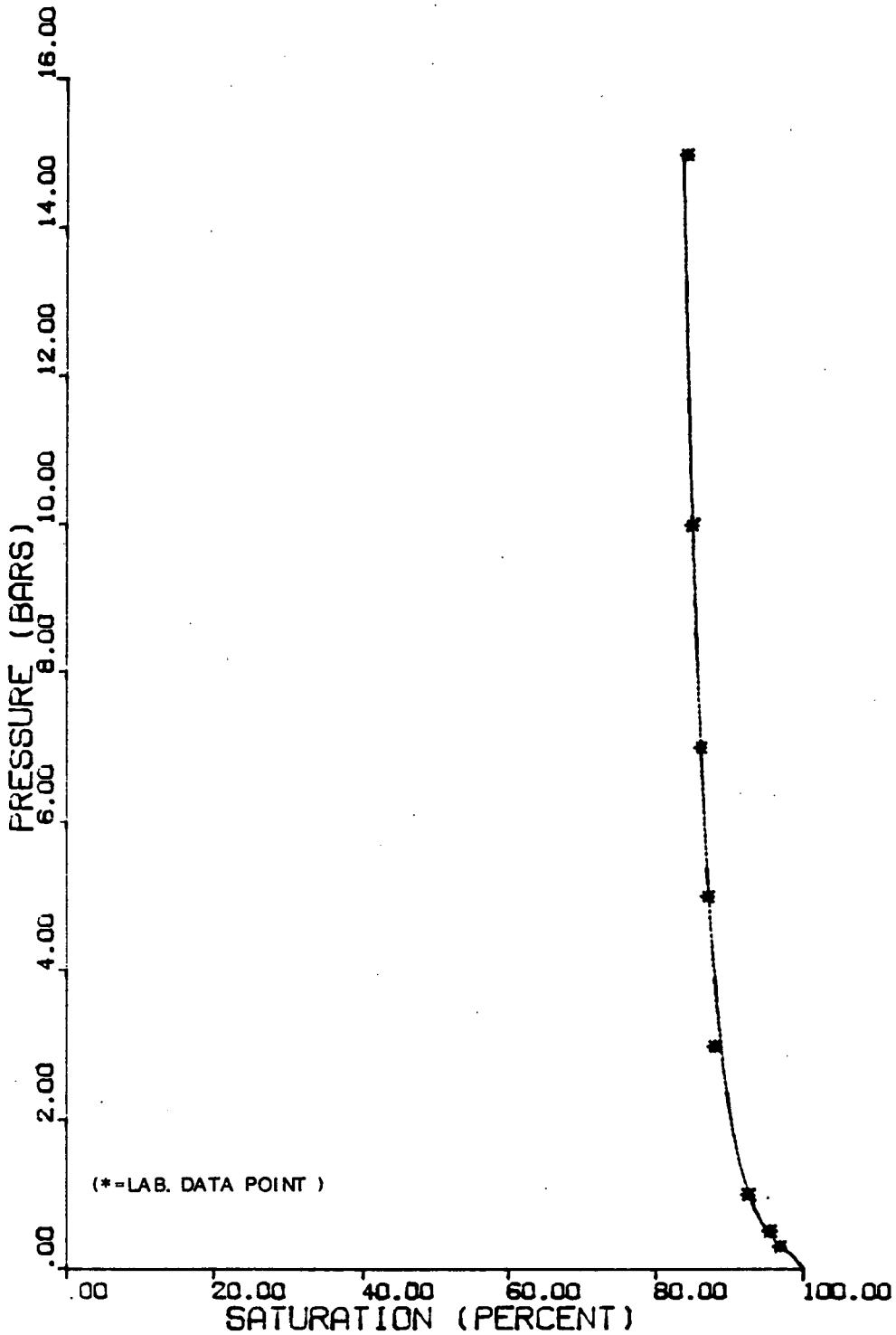
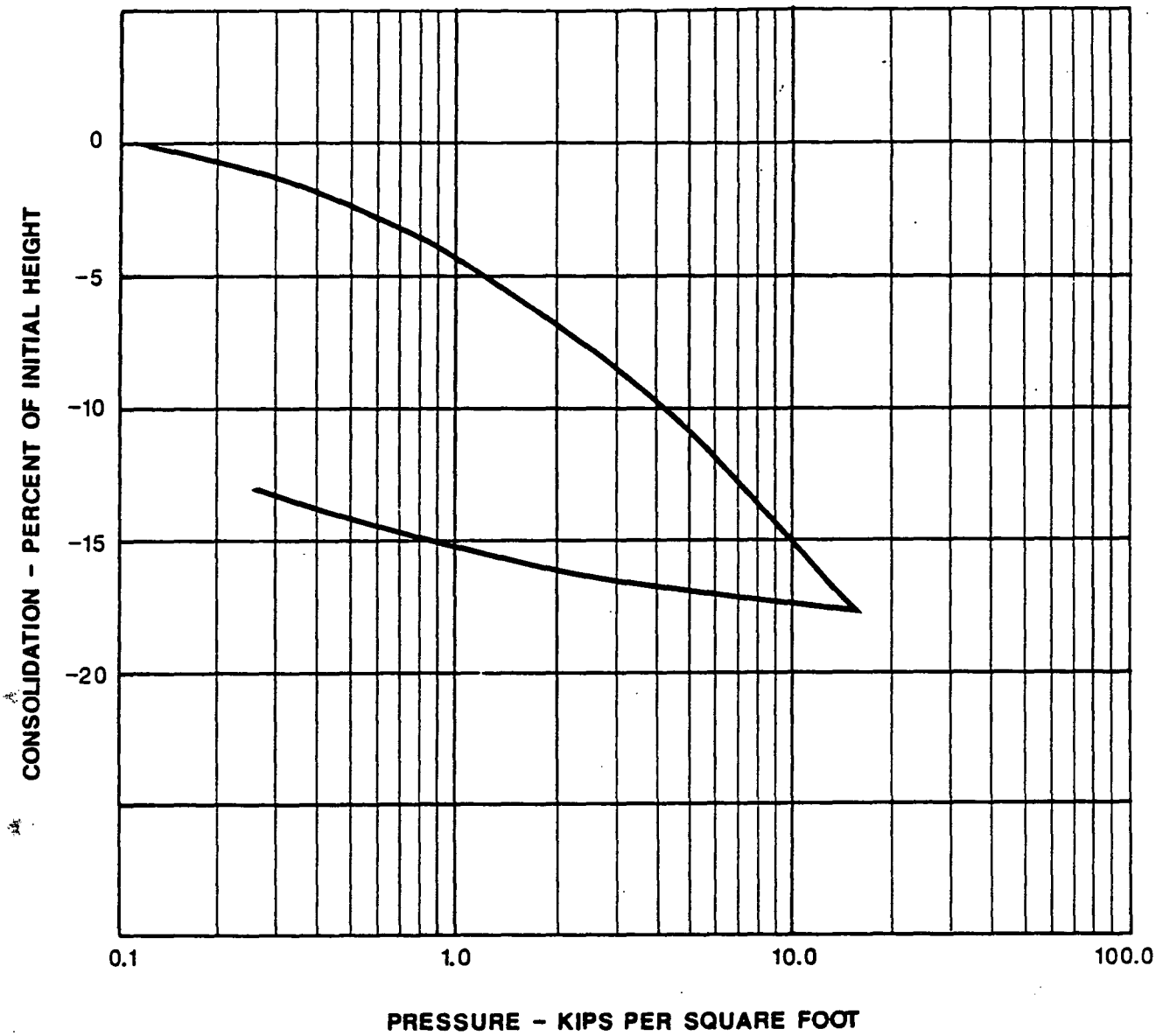


FIGURE D.5.22
CAPILLARY MOISTURE CURVE
HAT01-137 6.5 - 9 FT.

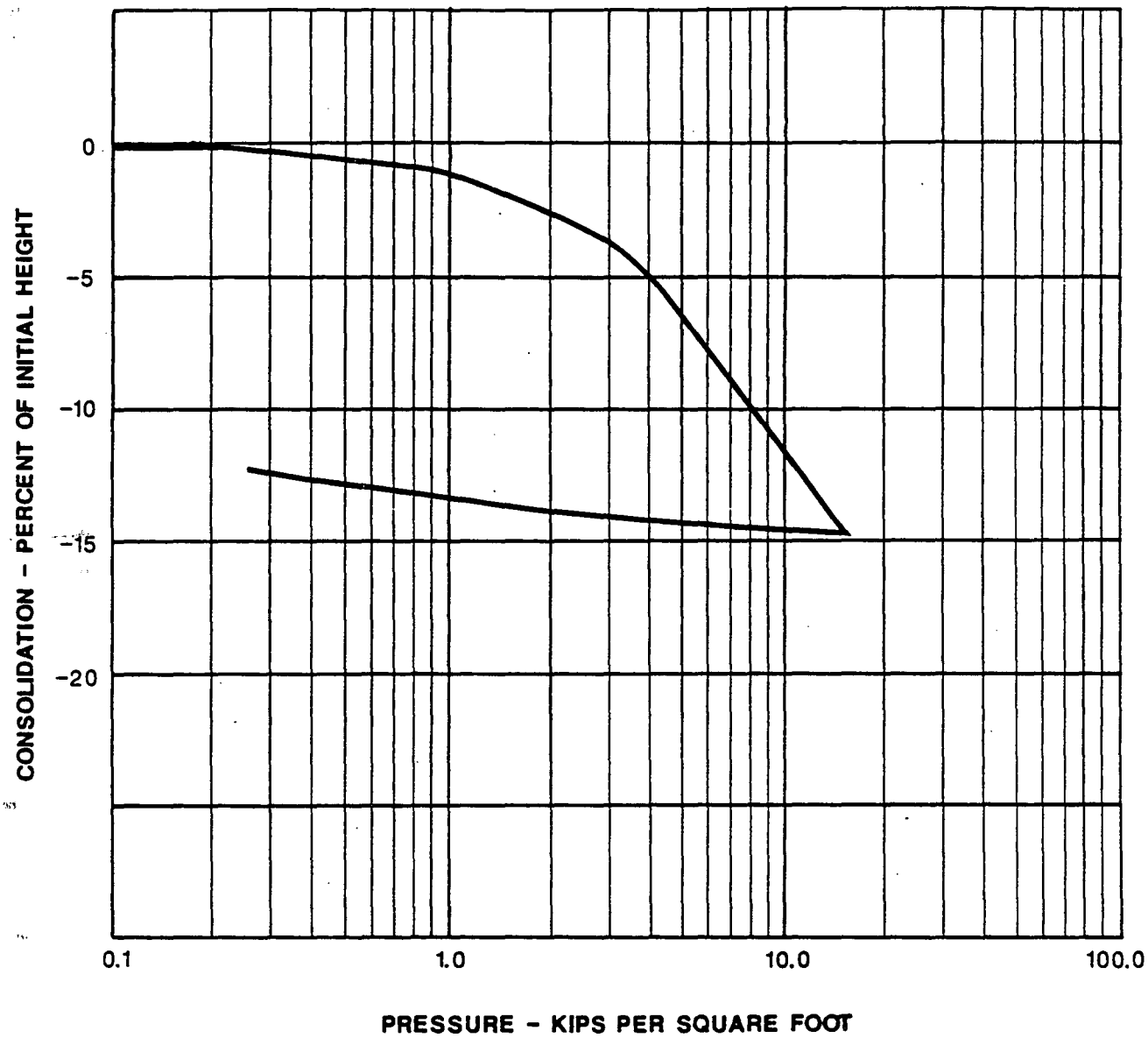


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT01-126	3.0-5.5	81.7	94.2	38.4	29.0	CL

TESTED SUBMERGED

FIGURE D.5.23

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT01-126 3 - 5.5 FT.

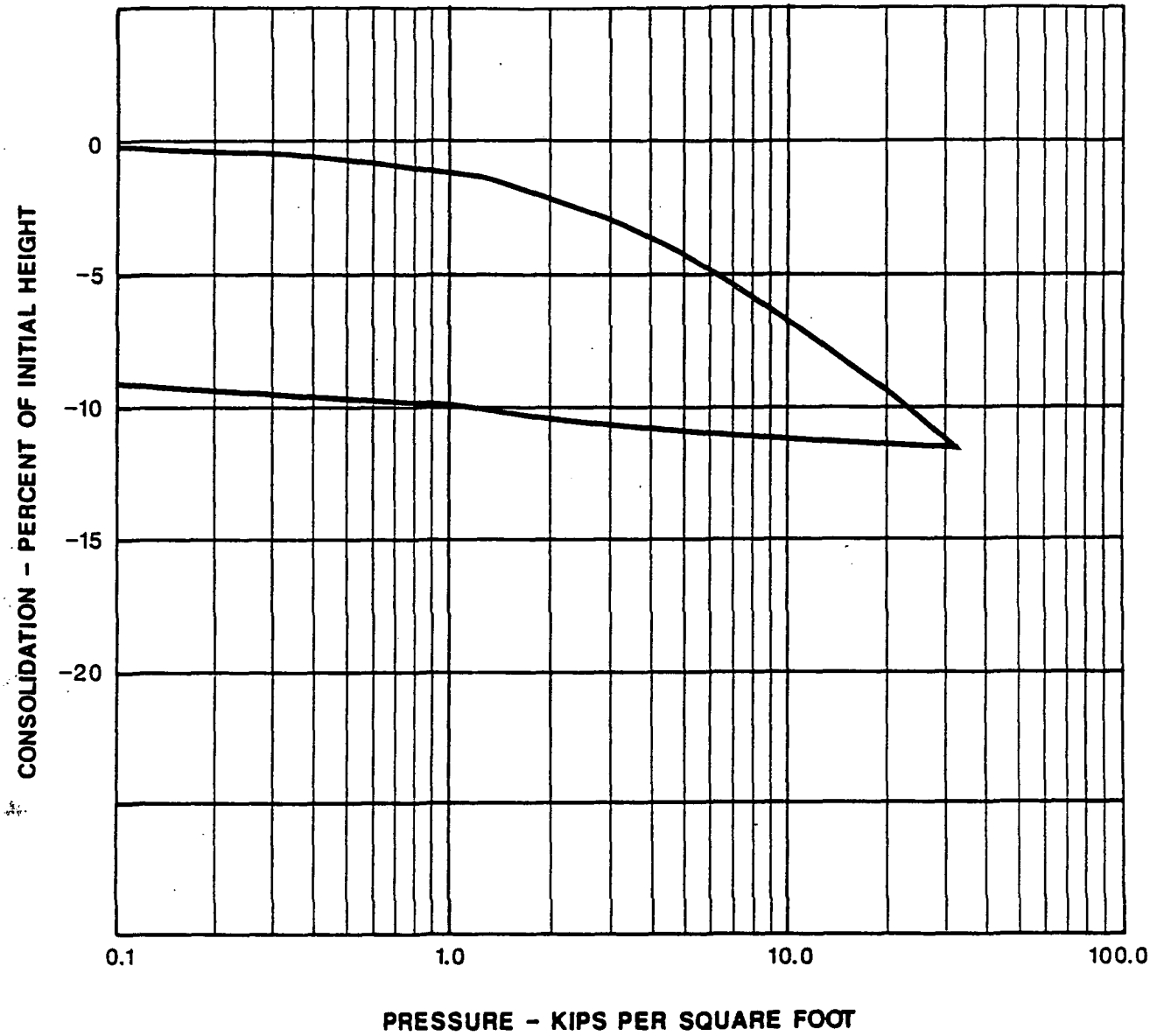


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT01-126	22.5-25.0	67.4	77.1	46.3	43.7	ML

TESTED SUBMERGED

FIGURE D.5.24

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT01-126 22.5 - 25 FT.

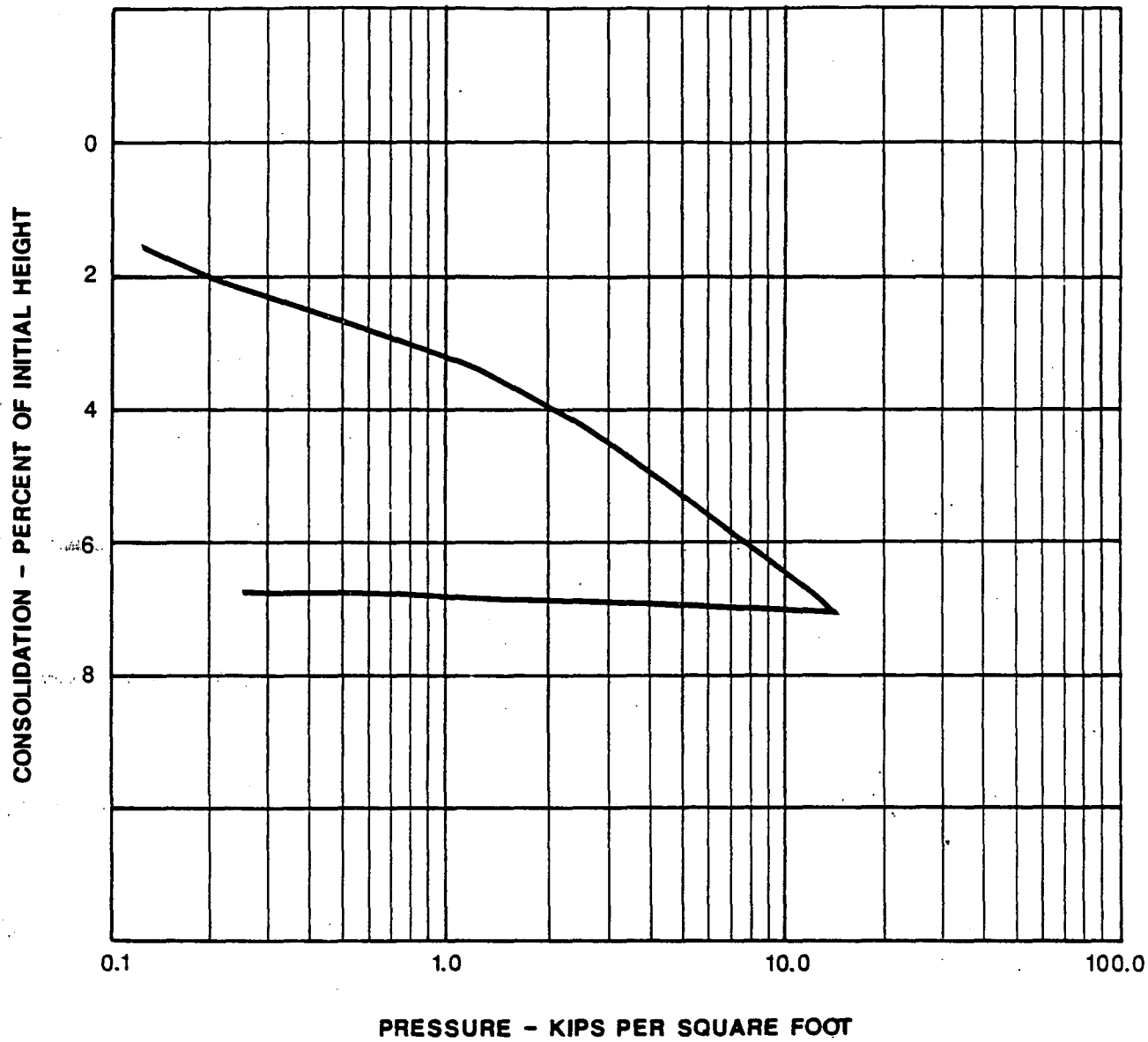


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT01-131	10.0-12.5	84.0	92.5	29.2	26.4	CL

TESTED SUBMERGED

FIGURE D.5.25

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT01-131 10.0 - 12.5 FT.

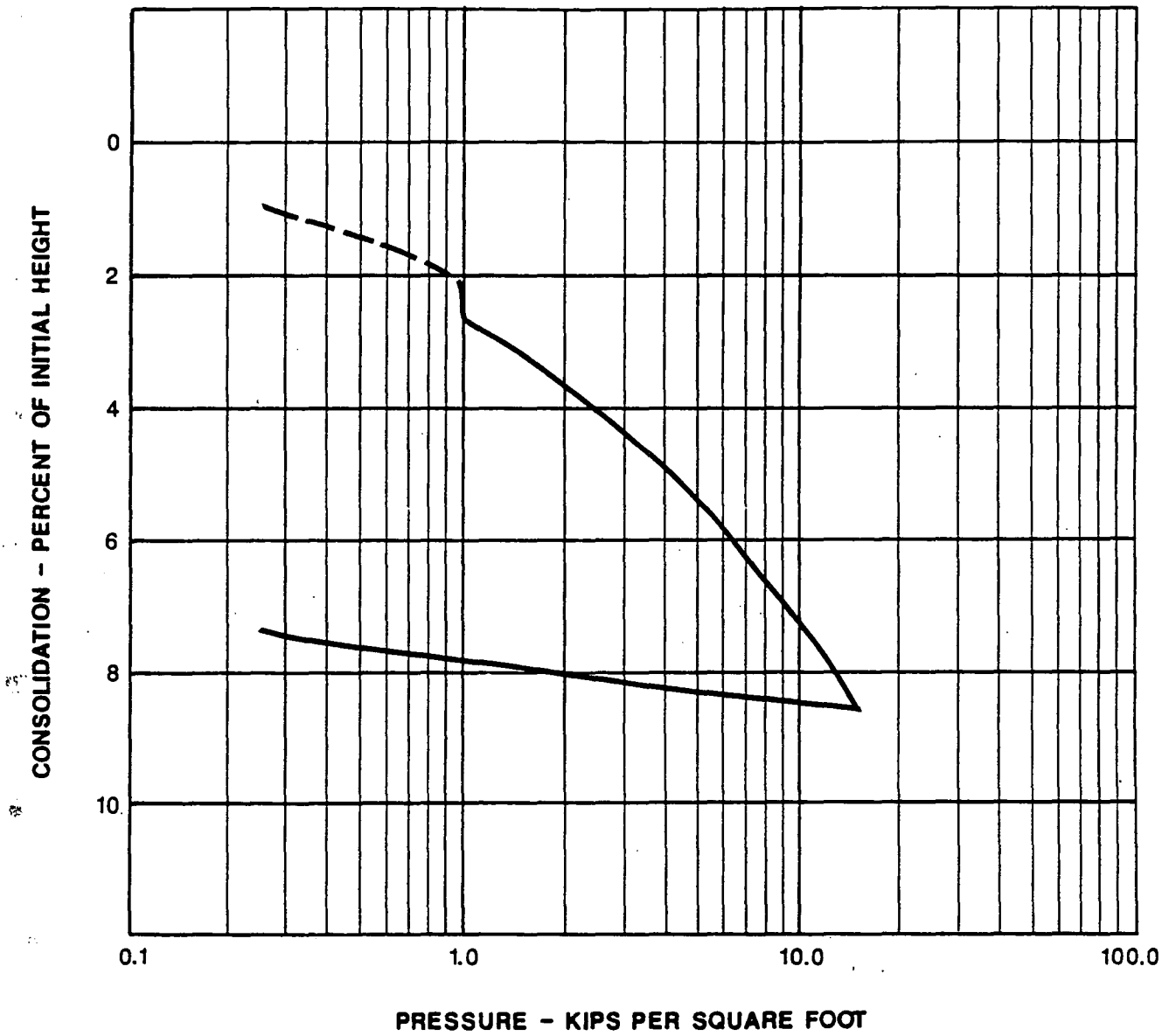


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT 01-133	8.5-11.0	86.7	92.9	8.0	31.2	(CL)

TESTED SUBMERGED

FIGURE D.5.26

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS HAT 01-133

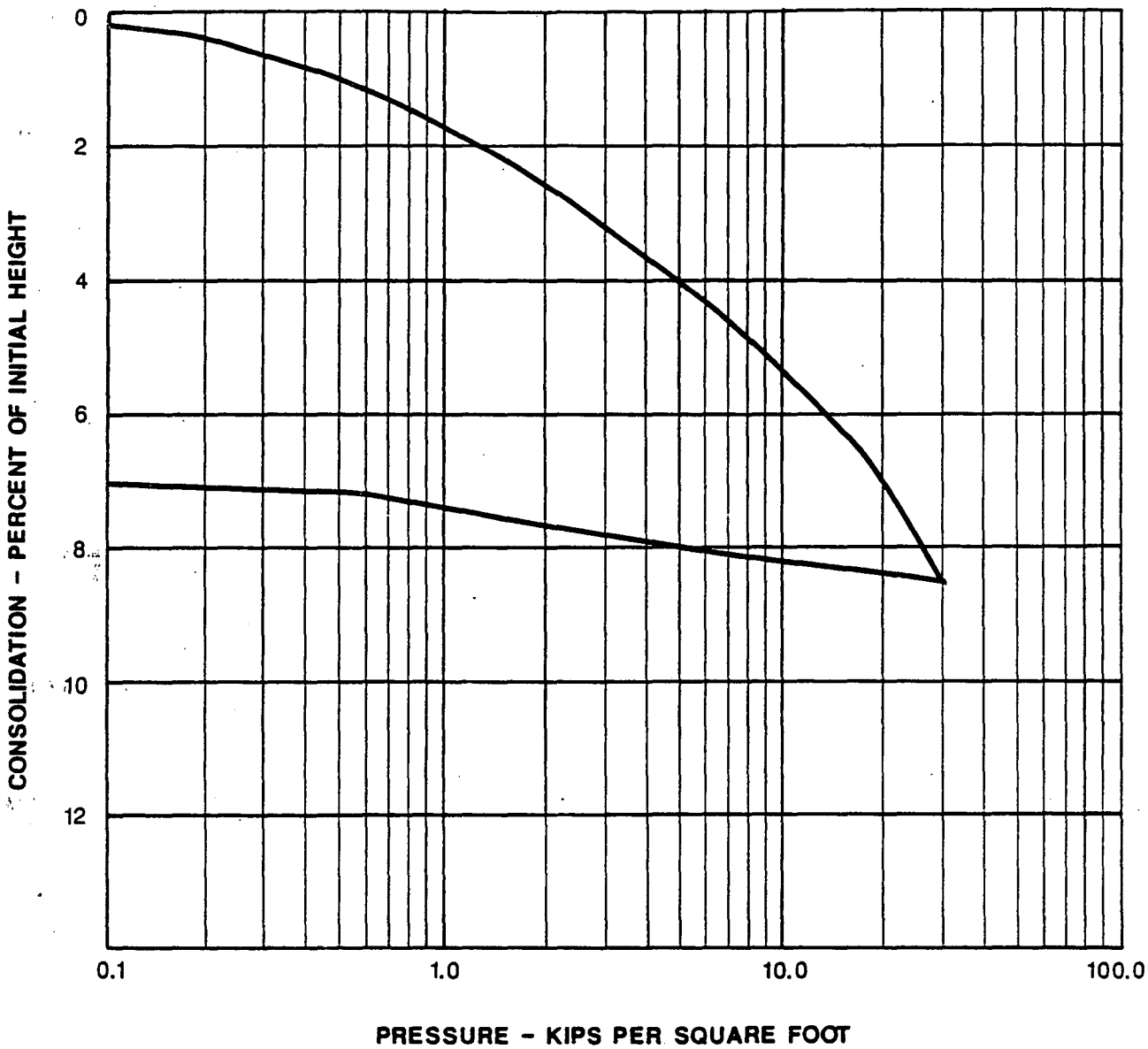


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT01-133	8.5-11.0	86.8	93.8	25.1	31.1	(ML)

TESTED AT INSITU
MOISTURE TO 1 KSF
THEN SUBMERGED

FIGURE D.5.27

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT01-133 8.5 - 11 FT.

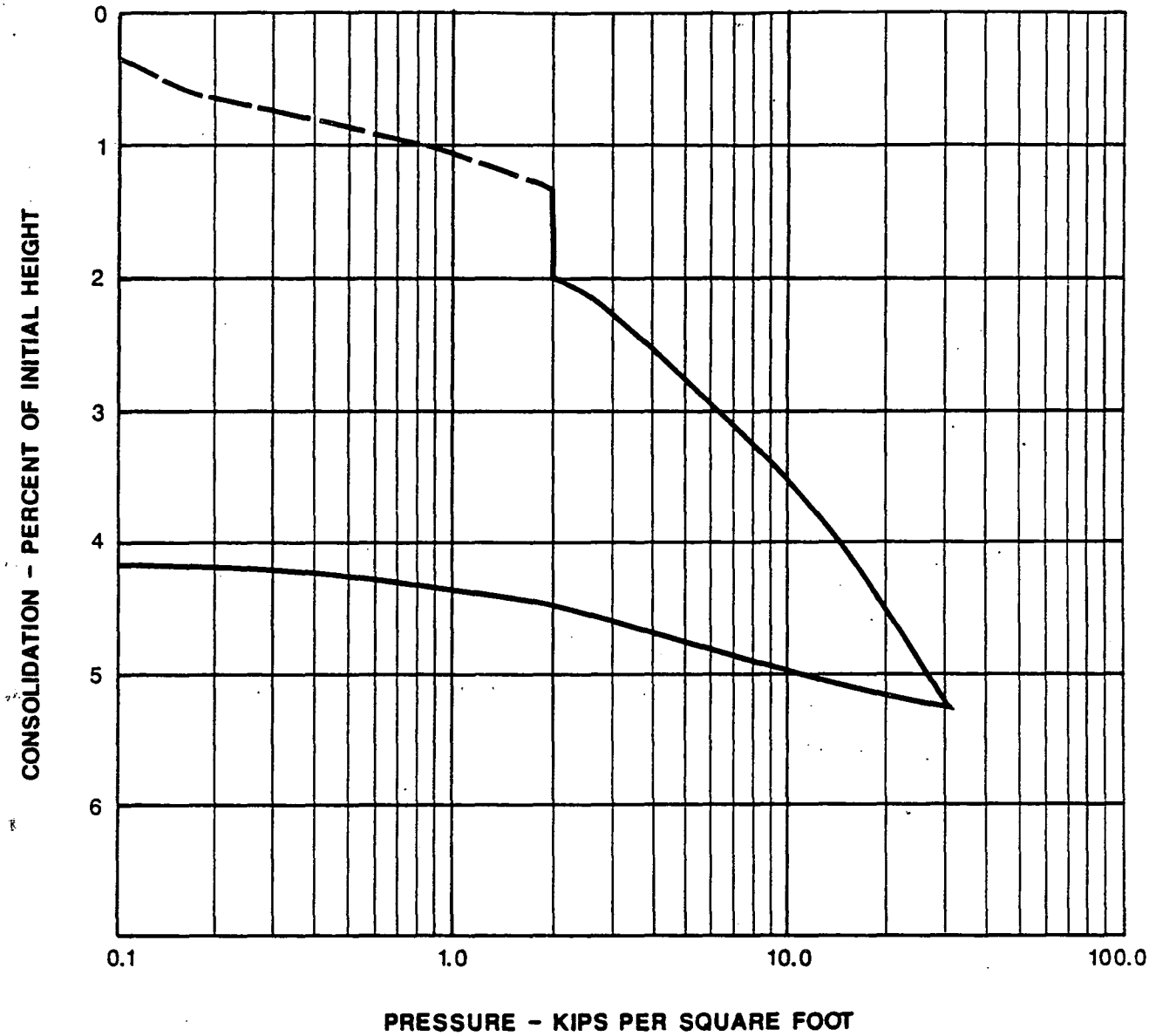


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT01-135	30.0-32.5	85.8	92.5	12.6	27.2	SM

TESTED SUBMERGED

FIGURE D.5.28

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT01-135 30 - 32.5 FT.

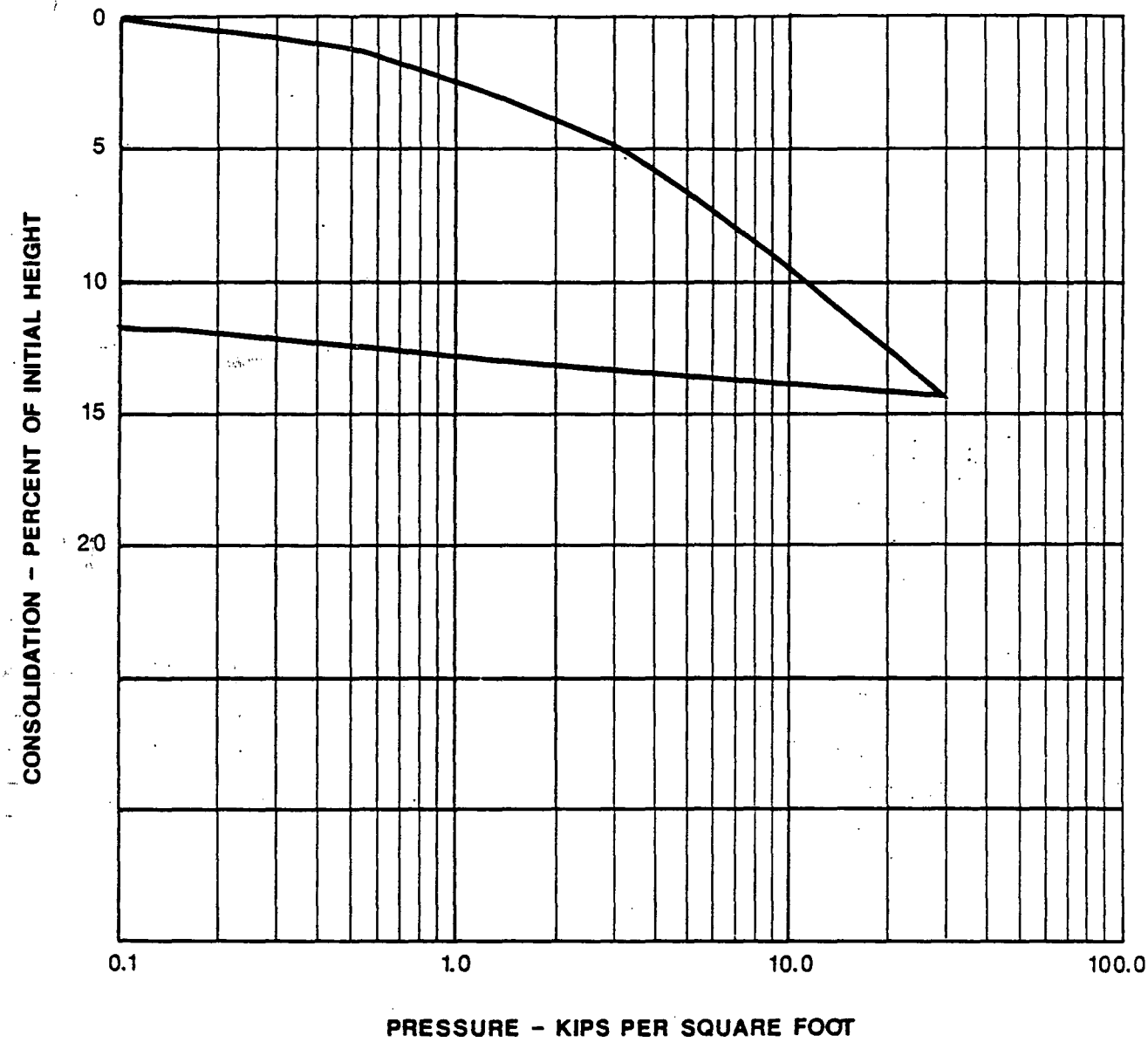


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT01-135	30.0-32.5	96.8	101.0	11.5	22.6	SM

TESTED AT INSITU MOISTURE
TO 2 KSF THEN SUBMERGED

FIGURE D.5.29

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT01-135 30 - 32.5 FT.

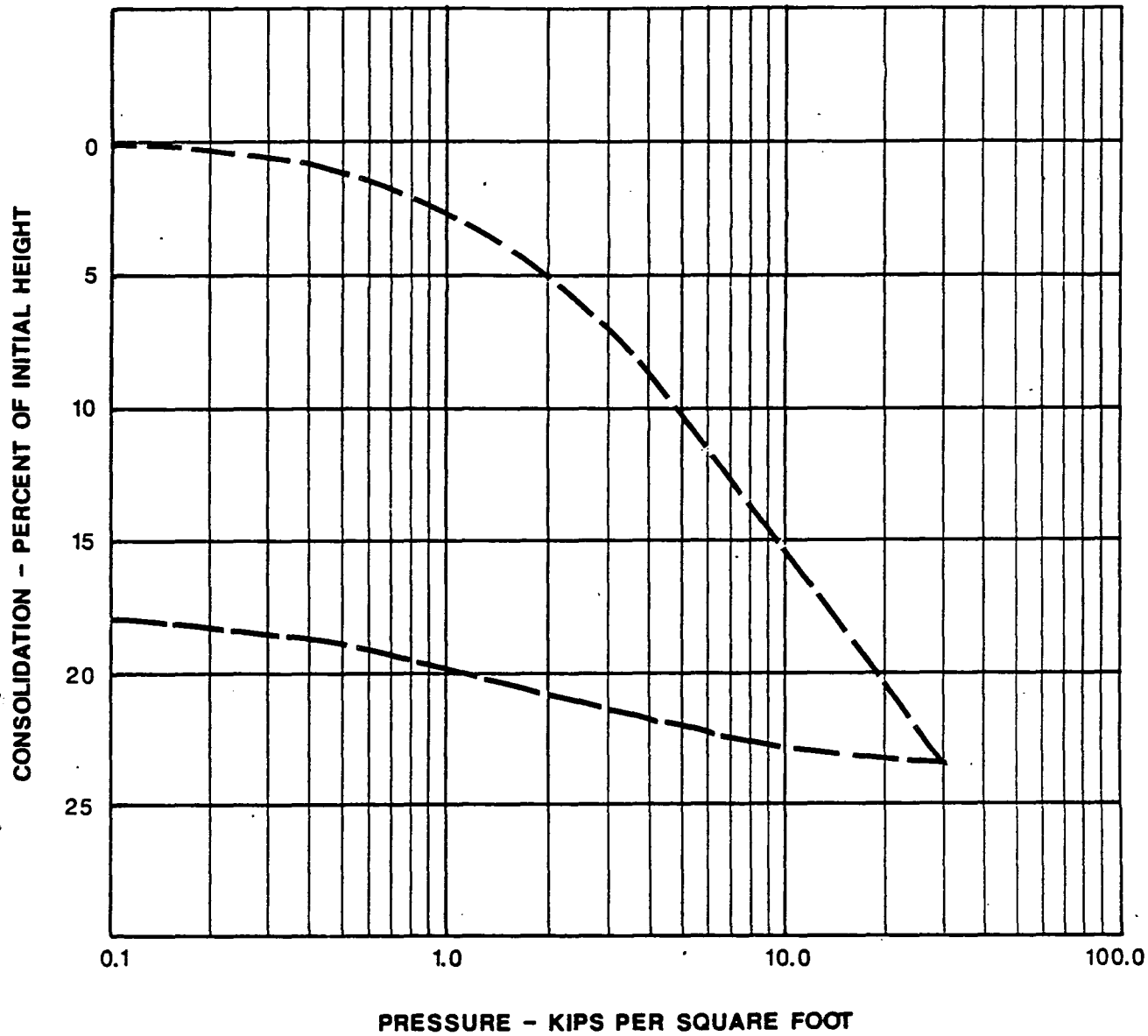


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT 01-136	3.0-5.5	77.8	88.5	35.2	32.7	CL

TESTED SUBMERGED

FIGURE D.5.30

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS
HAT 01-136 3 - 5.5 FT.

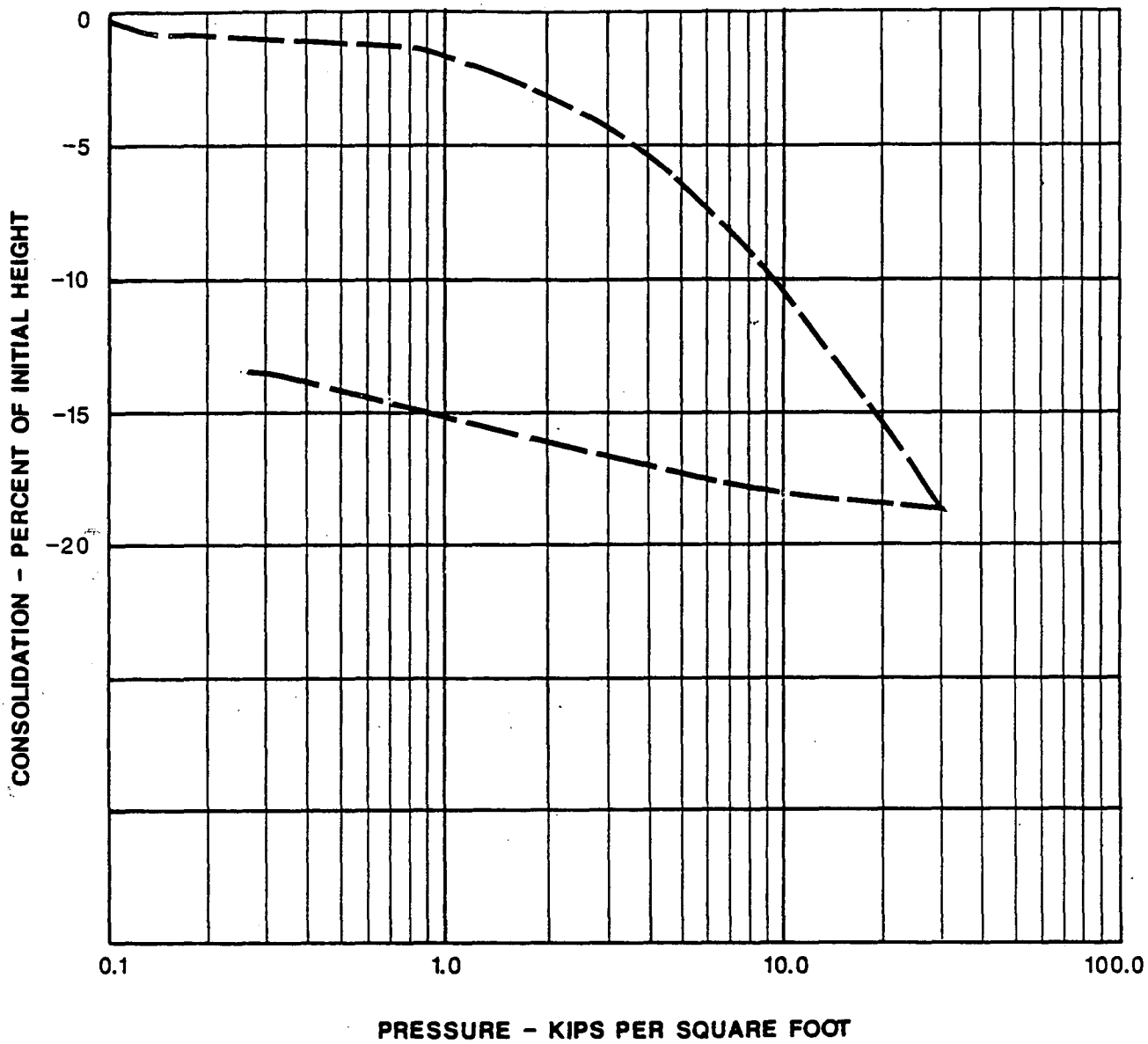


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT 01-136	13.0-15.0	74.9	91.3	48.8	30.5	CH

TESTED AT INSITU MOISTURE CONTENT

FIGURE D.5.31

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS HAT01-136 13 - 15 FT.

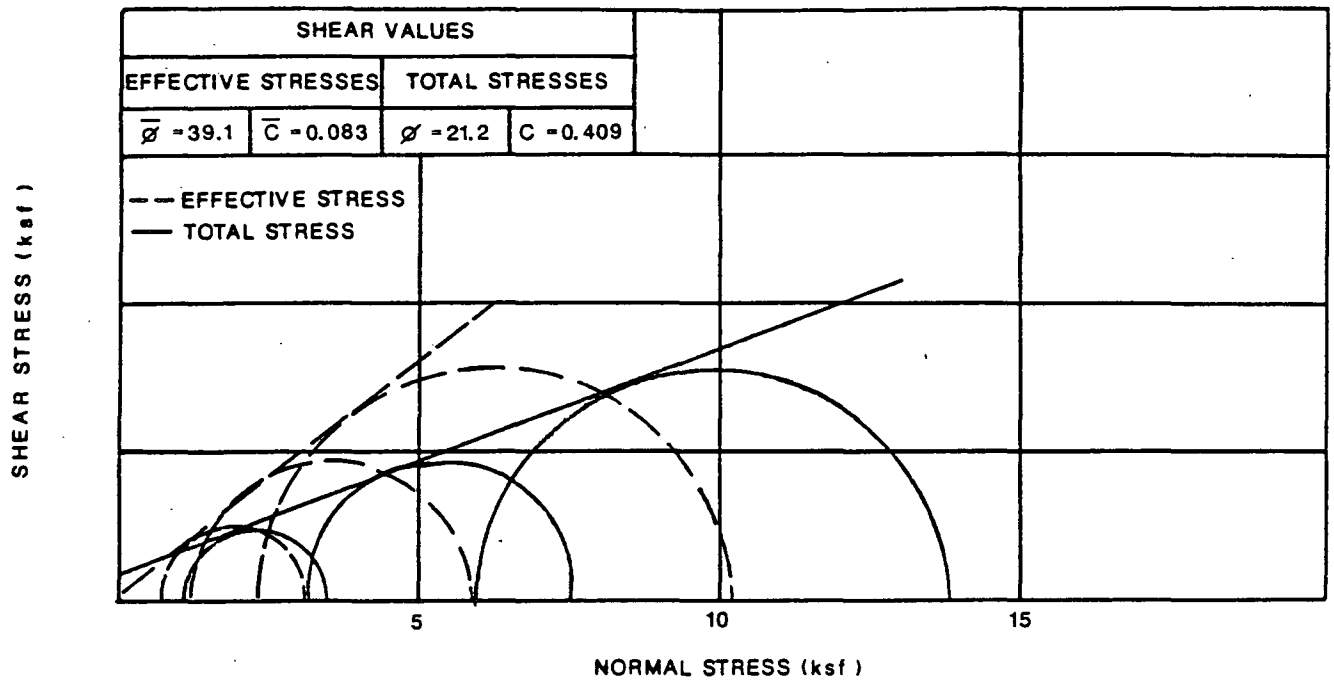


LEGEND						
SAMPLE	DEPTH INTERVAL (FT.)	DRY DENSITY PCF LBS./CU. FT.		MOISTURE CONTENT (%)		UNIFIED SOIL CLASSIFICATION
		INITIAL	FINAL	INITIAL	FINAL	
HAT 01-138	35.0-37.5	85.3	98.4	35.4	27.9	CL

TESTED AT INSITU MOISTURE CONTENT

FIGURE D.5.32

CONSOLIDATION TEST RESULTS UNDISTURBED TAILINGS HAT 01-138 35 - 37.5 FT.



STAGE NO.	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	SOIL DESCRIPTION
1	87.5	33.3	ML (SLIME)
2	88.9	34.3	
3	91.8	32.1	

SAMPLE TYPE SHELBY TUBE

FIGURE D.5.33

SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION
HAT01-126 25 FT.

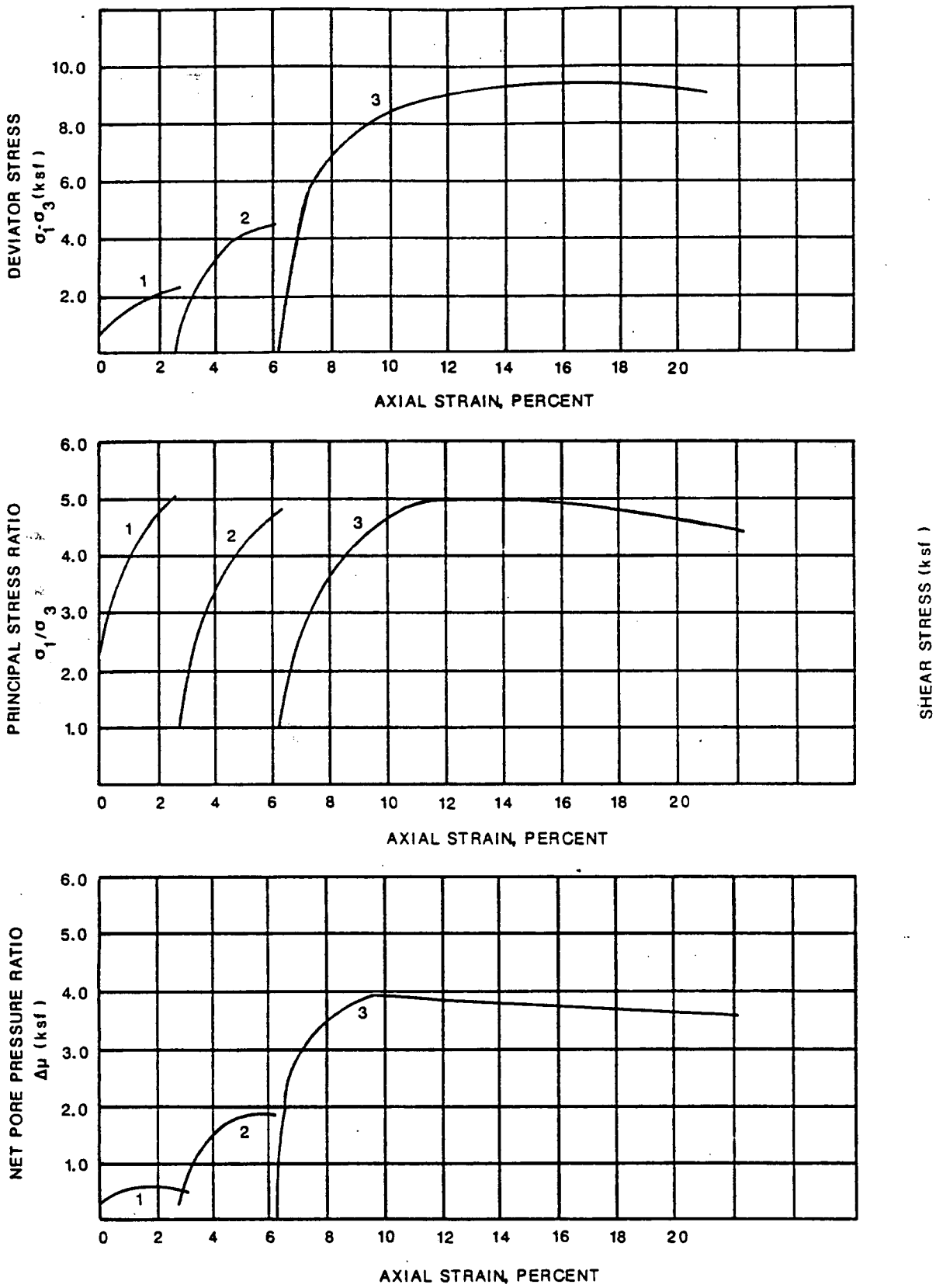
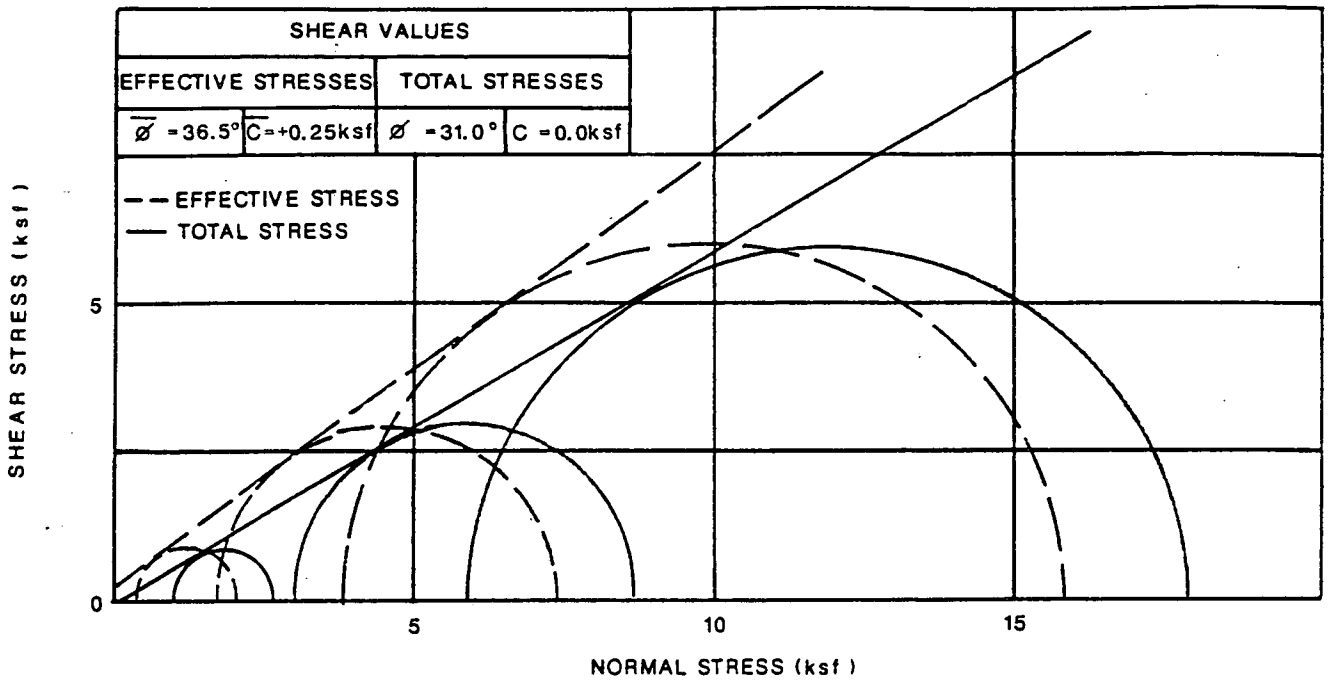


FIGURE D.5.33 (CONT.)
SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION
HAT01-126 25 FT.

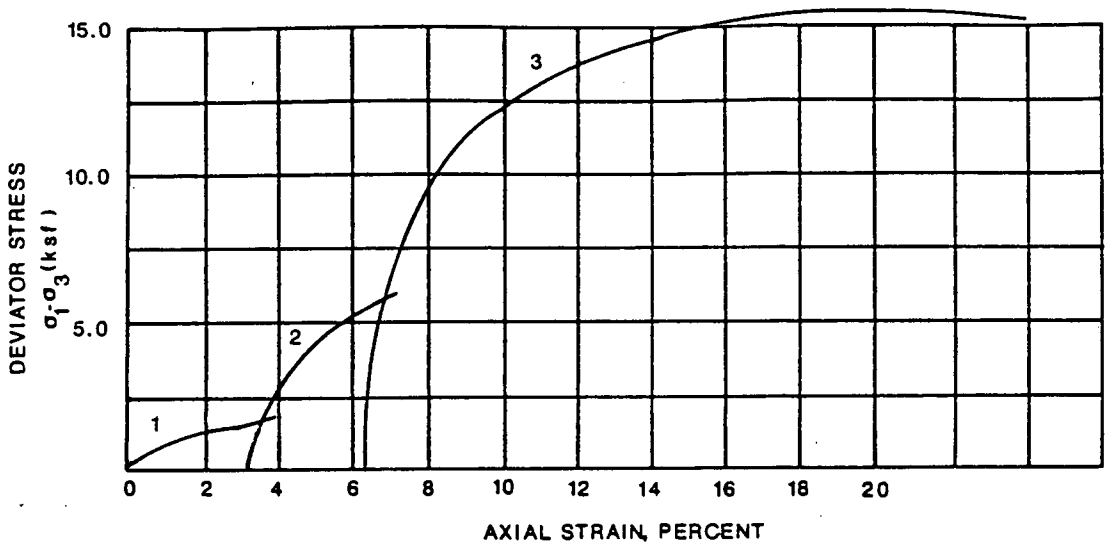


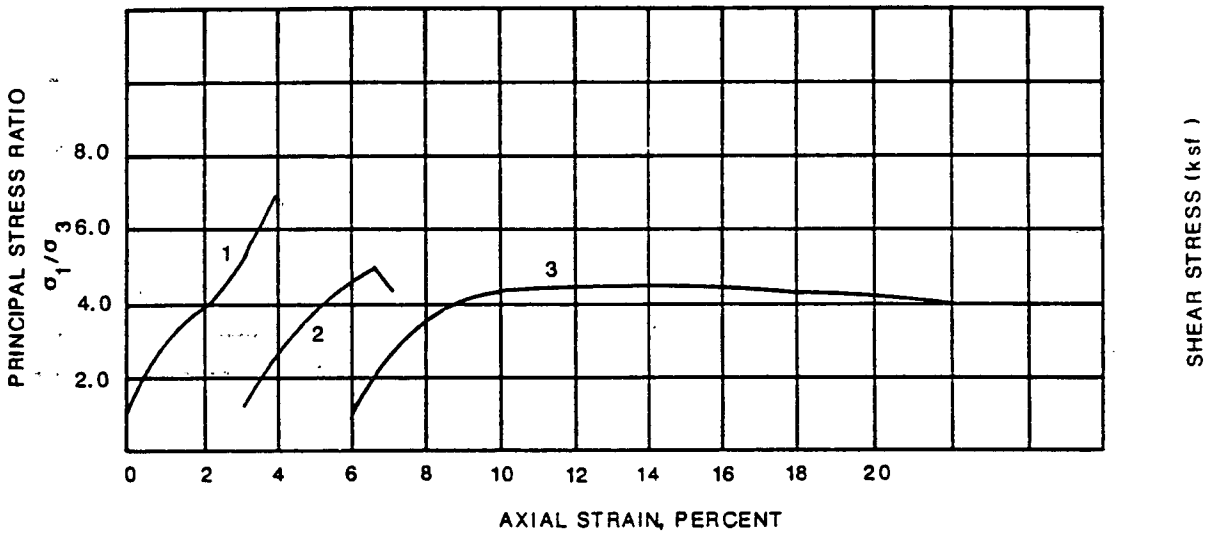
STAGE NO.	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	SOIL DESCRIPTION
1	82.0	16.9	SAND TAILS
2	85.0	34.5	SAND TAILS
3	87.2	32.7	SAND TAILS

SAMPLE TYPE UNDISTURBED
SHELBY TUBE

FIGURE D.5.34

SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION
HAT01-133 1.5 - 4 FT.





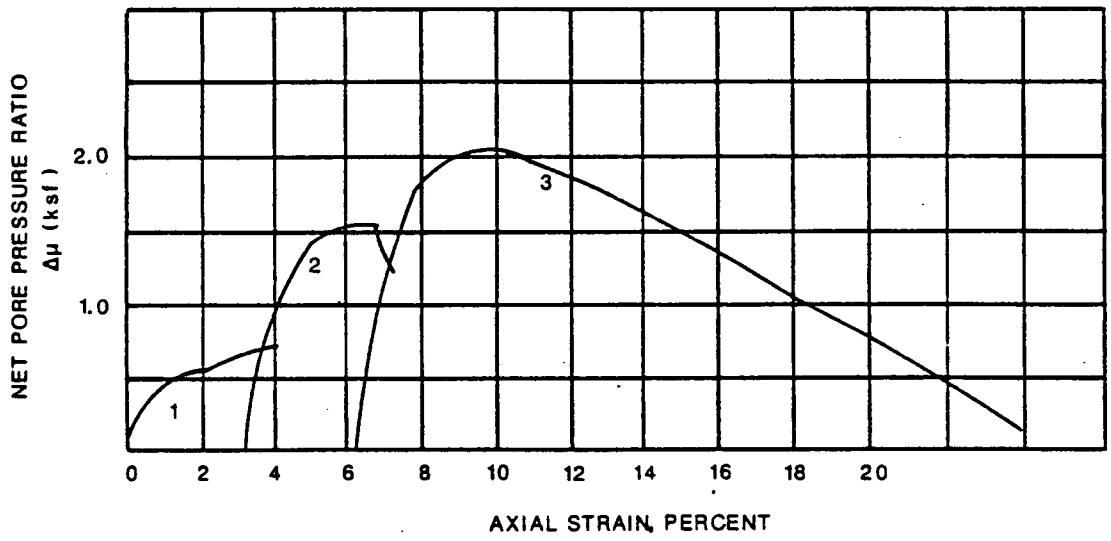
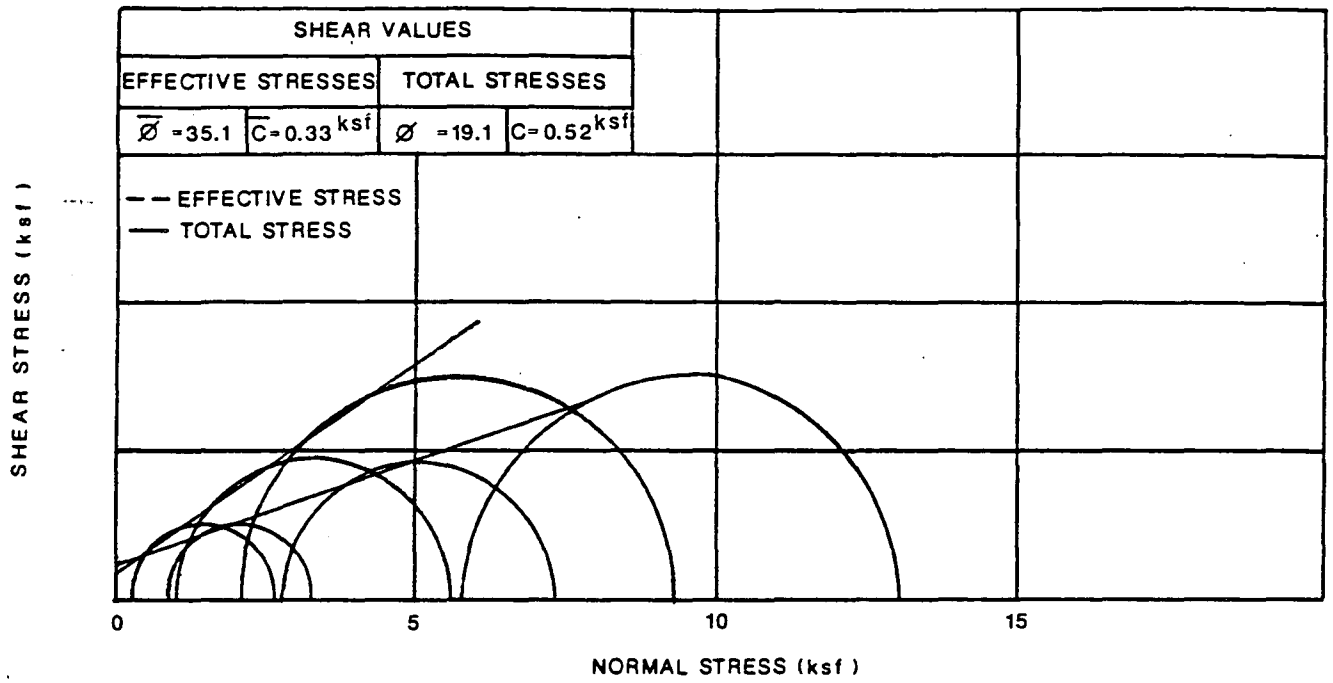


FIGURE D.5.34 (CONT.)
SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION
HAT01-133 1.5 - 4 FT.



STAGE NO.	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	SOIL DESCRIPTION
1	83.7	37.0	CL (SLIME)
2	88.1	37.1	
3	85.5	34.8	

SAMPLE TYPE UNDISTURBED SHELBY TUBE

FIGURE D.5.35

SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION HAT01-138 35 - 37.5 FT.

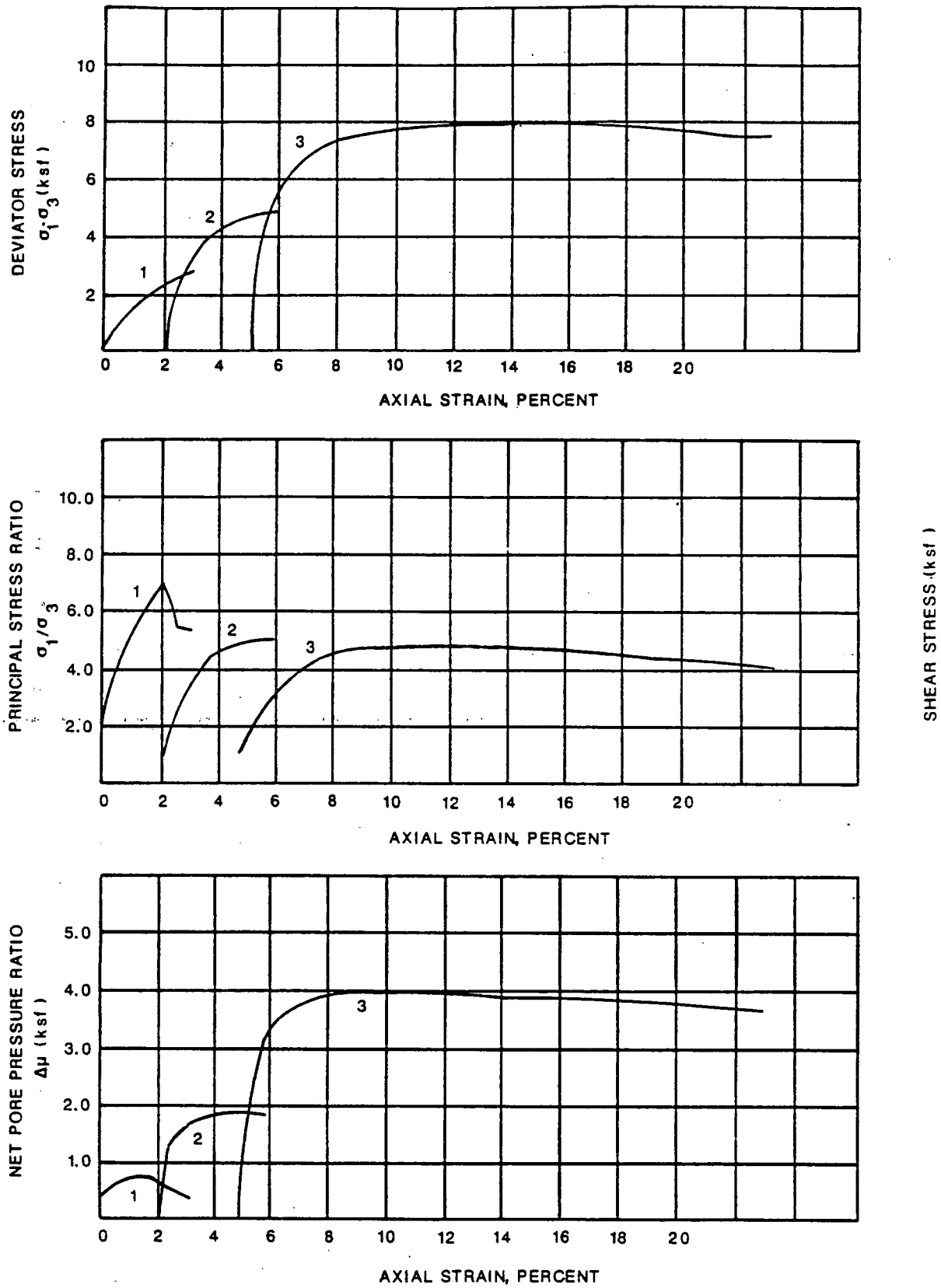


FIGURE D.5.35 (CONT.)
SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION
HAT01-138 35 - 37.5 FT.

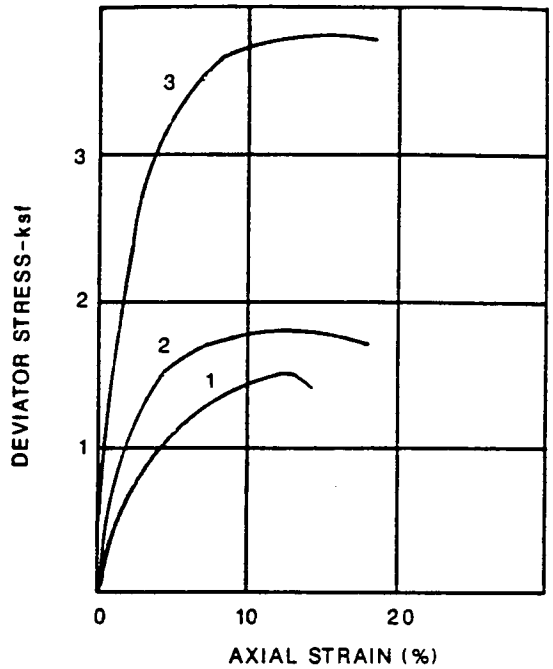
TEST NUMBER	1	2	3	4
LOCATION SAMPLE NO. DEPTH FT.	1-23 009 13-15.5			
WEIGHT-INCH	5.532	5.785	5.566	
DIAMETER-INCH	2.872	2.867	2.848	
WATER CONTENT-%	31.9	42.8	32.3	
DRY DENSITY-pcf	85.3	77.3	87.3	
σ_1 σ_3 -ksf	1.53	1.82	3.83	
σ_3 -ksf	1.01	3.02	6.05	
σ_1 -ksf	2.54	4.84	9.88	

TYPE OF SPECIMEN UNDISTURBED SHELBY TUBE

SOIL DESCRIPTION CLAY; TAILINGS

TYPE OF TEST UNCONSOLIDATED-UNDRAINED

UNSATURATED



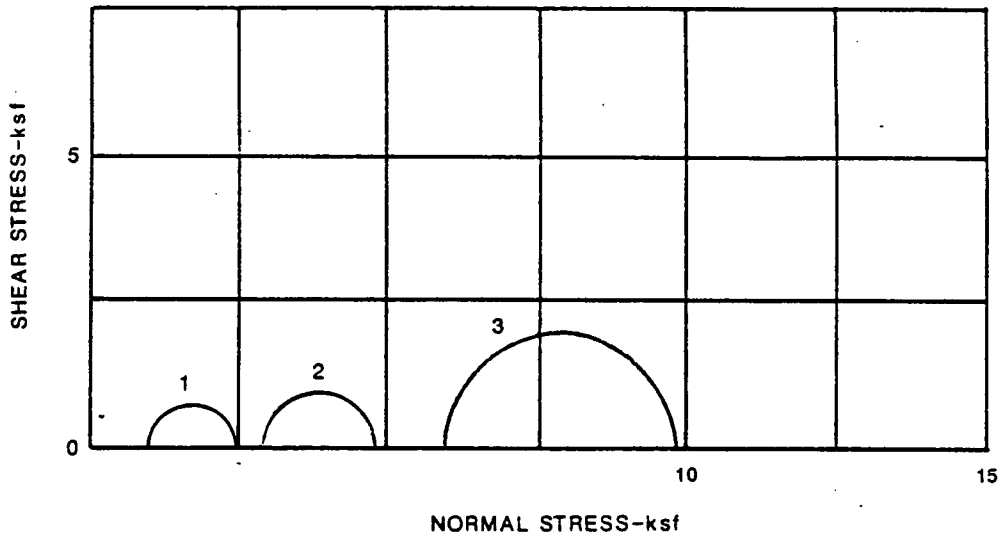


FIGURE D.5.36

TRIAXIAL SHEAR TEST RESULTS
HAT01-136 13 - 15.5 FT.

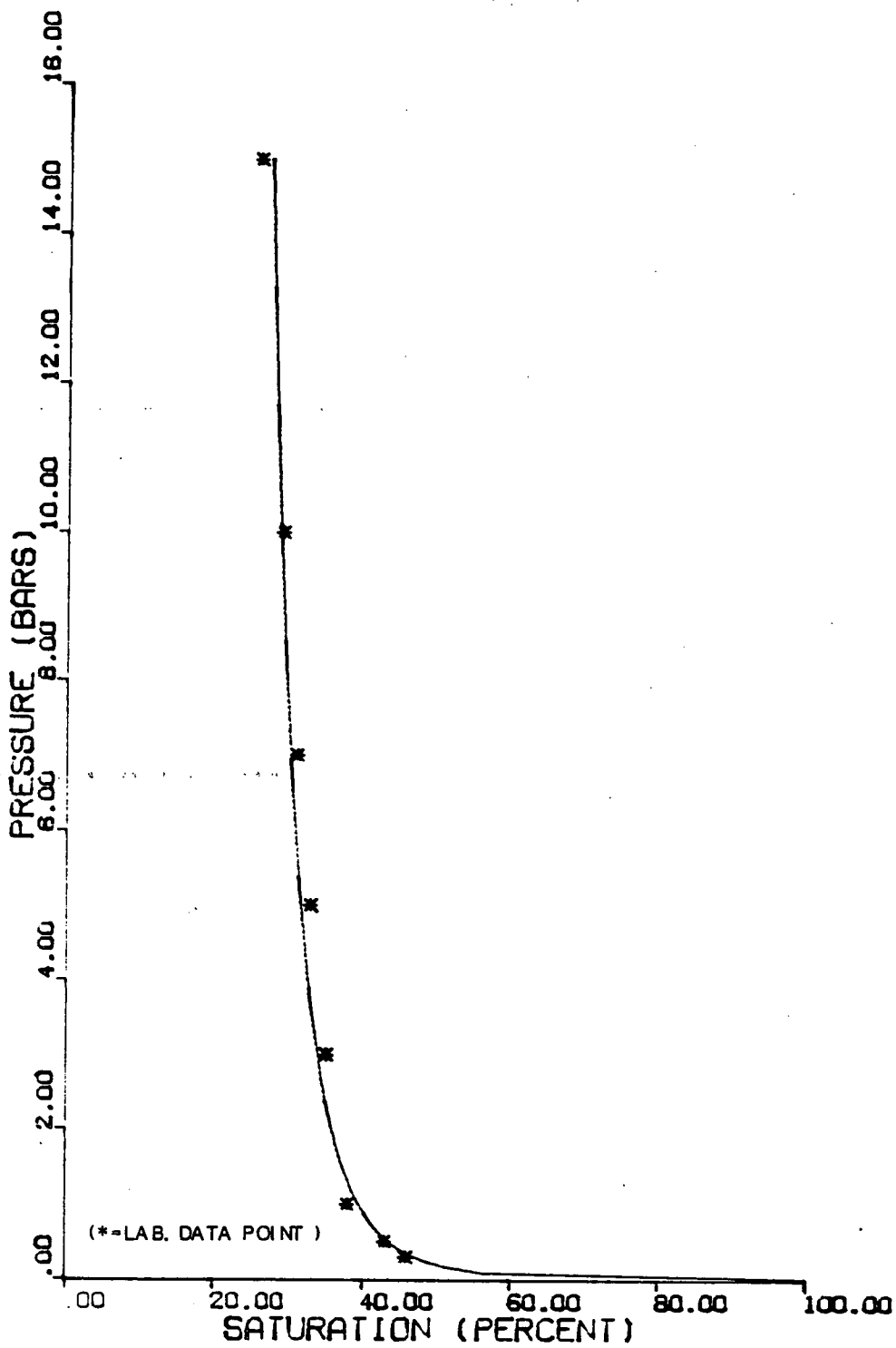


FIGURE D.5.37

CAPILLARY MOISTURE CURVE
HAT01-002 0 - 0.5 FT. (TEST PIT)

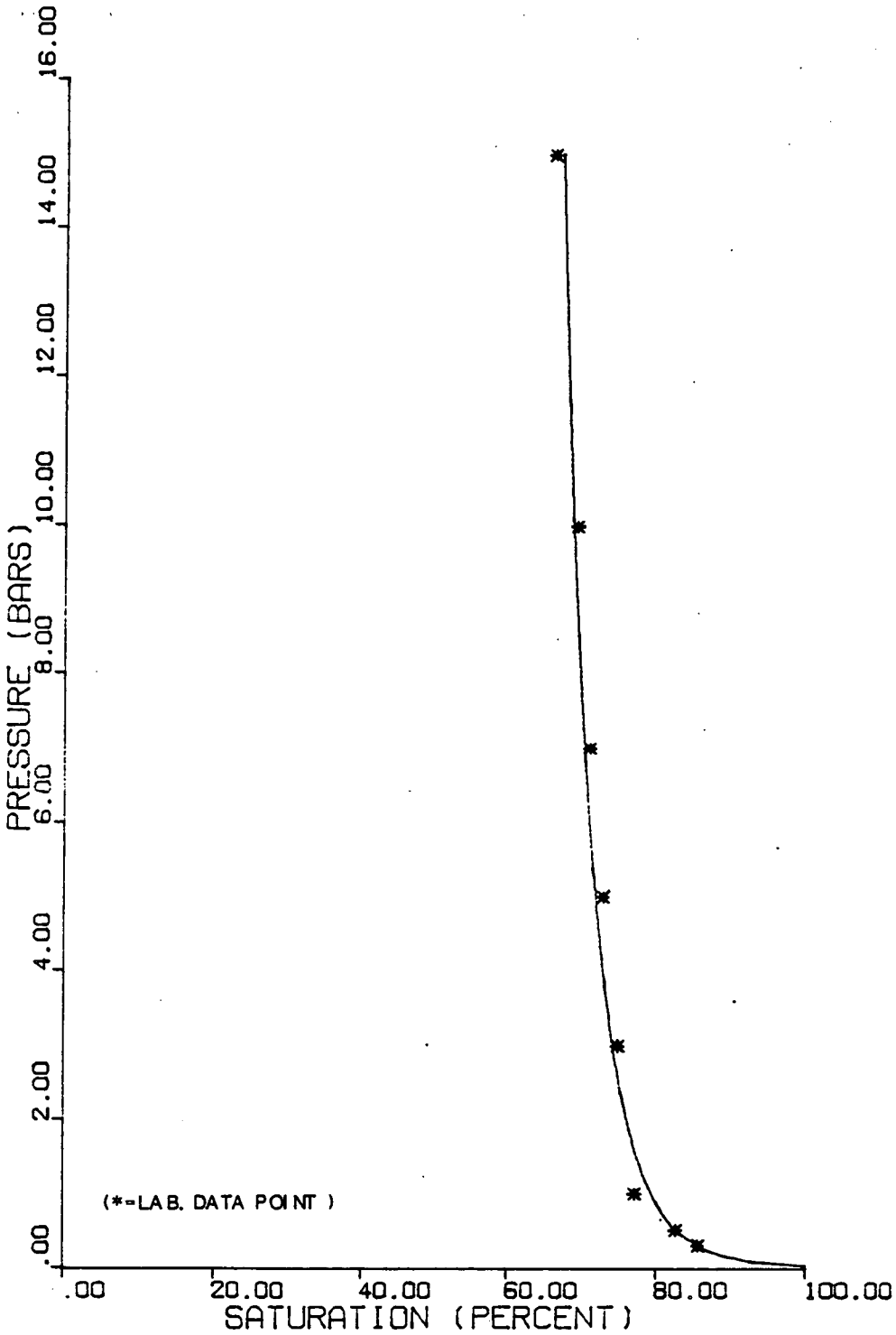


FIGURE D.5.38

CAPILLARY MOISTURE CURVE
HAT01-003 0 - 3 FT. (TEST PIT)

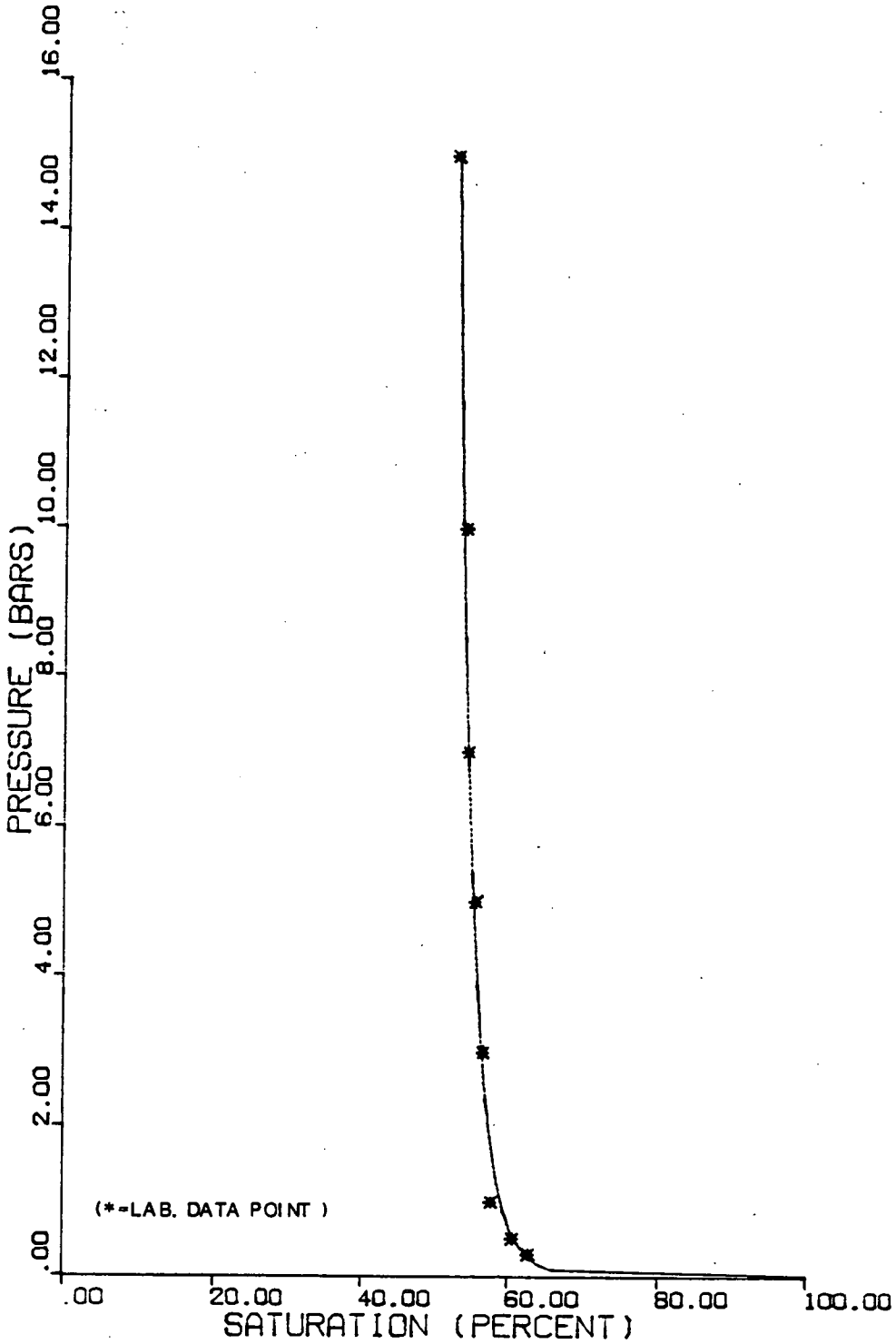


FIGURE D.5.39

CAPILLARY MOISTURE CURVE
HAT01-003 3 - 4 FT. (TEST PIT)

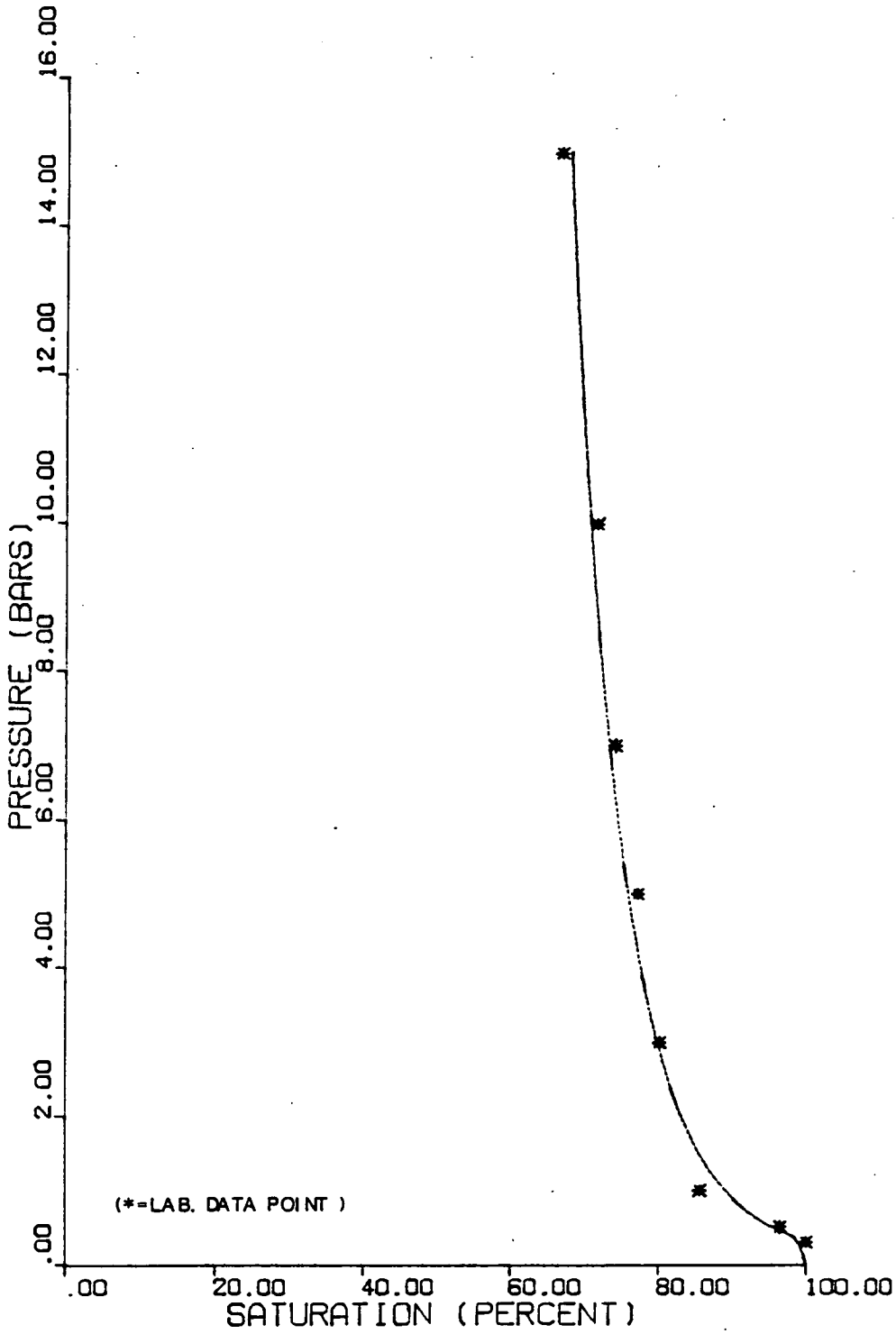


FIGURE D.5.40

CAPILLARY MOISTURE CURVE
HAT01-004 2.5-6 FT. (TEST PIT)

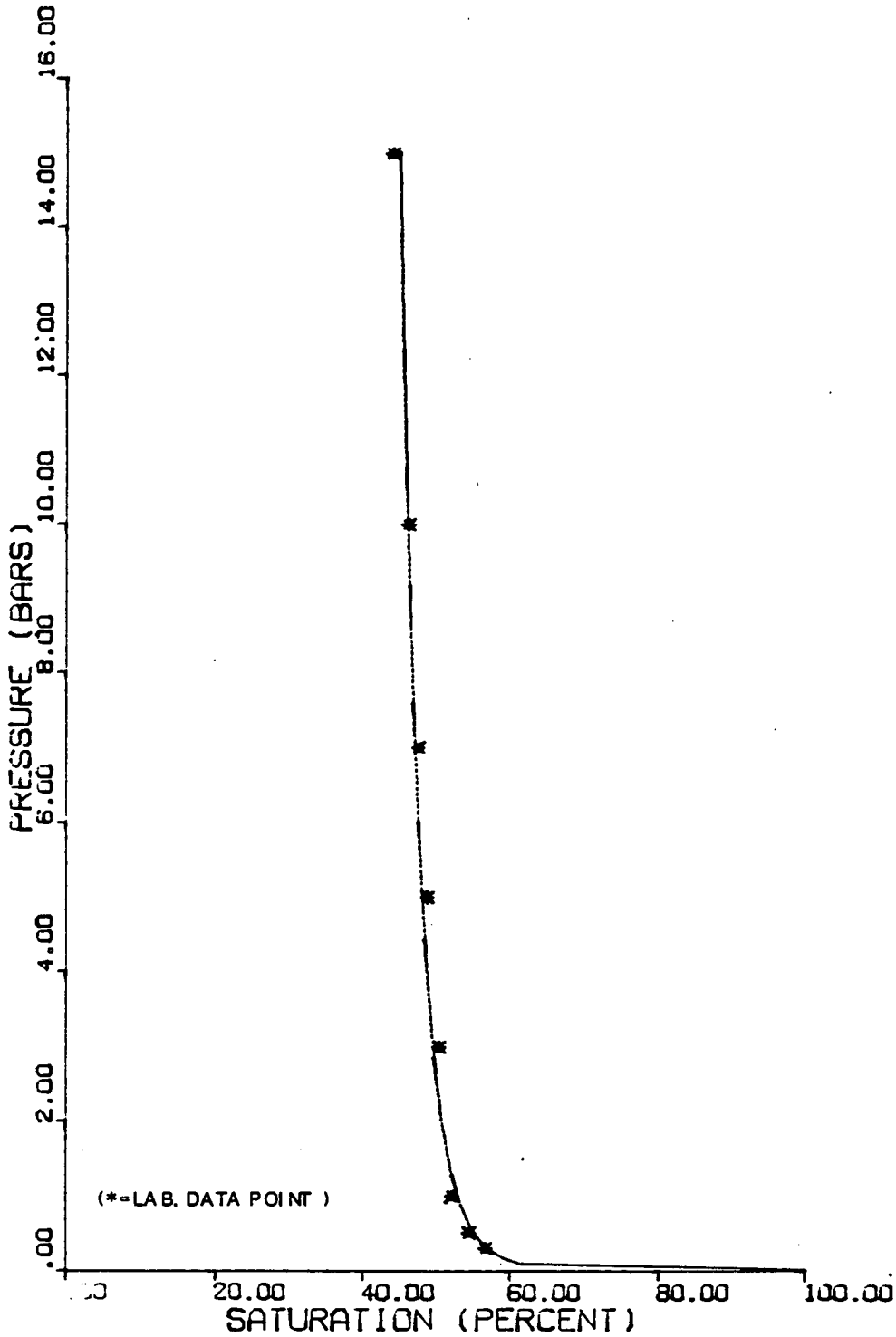
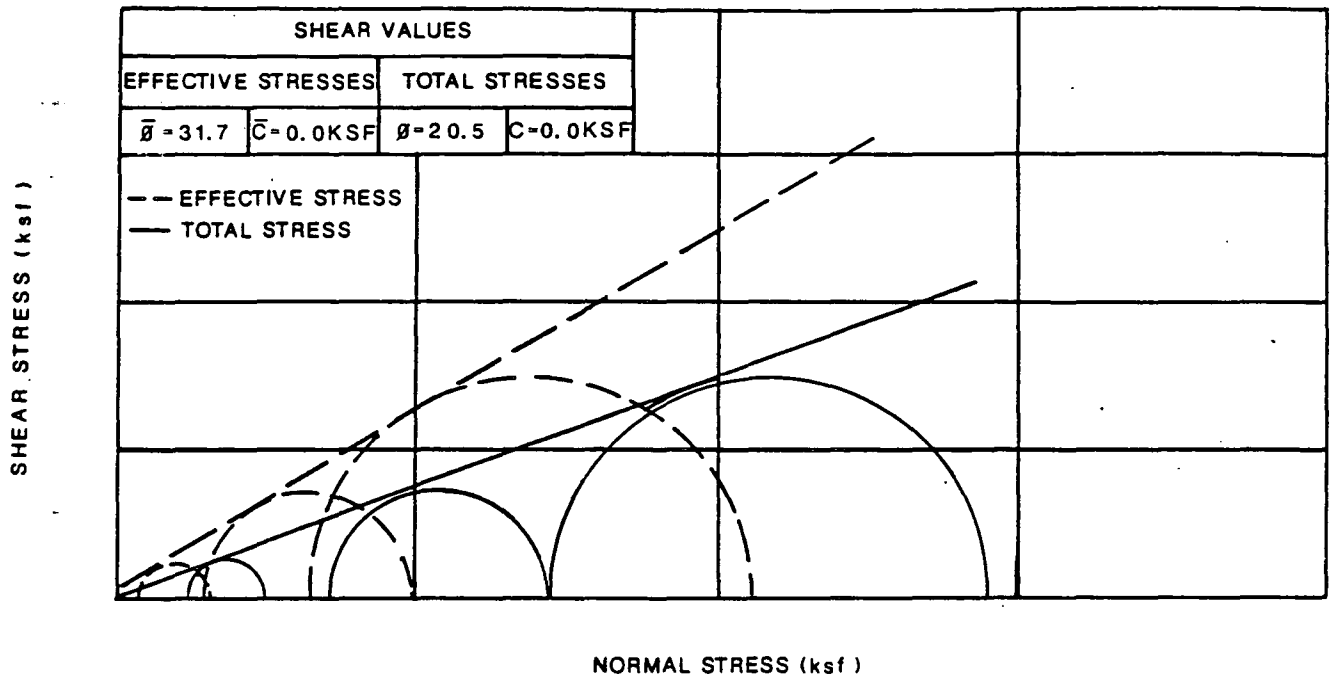


FIGURE D.5.41

CAPILLARY MOISTURE CURVE

HAT01-004 6-7.5 FT. (TEST PIT)



STAGE NO.	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	SOIL DESCRIPTION
1	90.2	16.3	TAILINGS SAND
2	95.6	27.1	" "
3	98.4	25.3	" "

LOCATION NO.	DEPTH (FT.)	SAMPLE TYPE
TP-1 & TP-5	COMBINED	REMOLD

FIGURE D.5.42

SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION

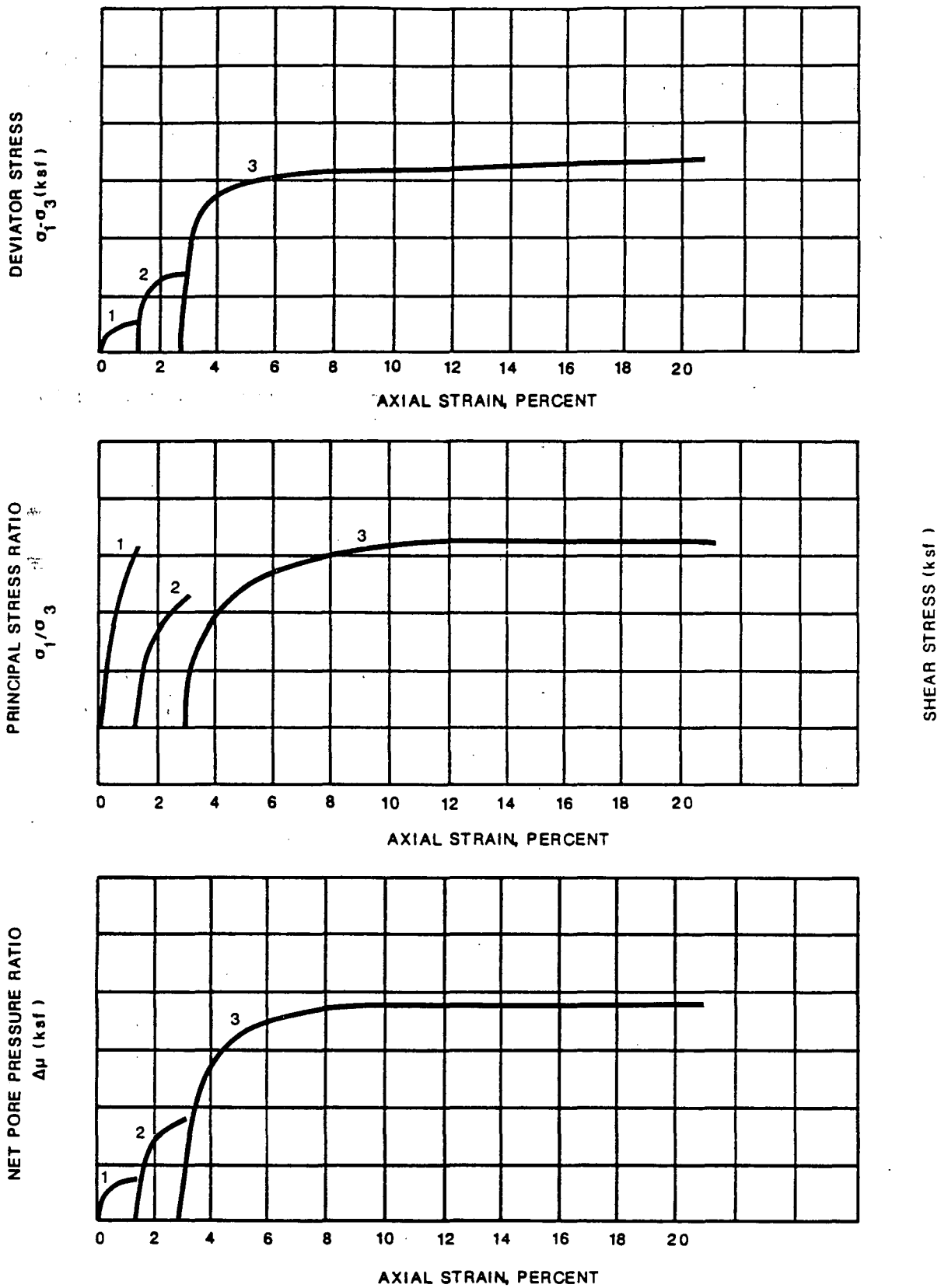


FIGURE D.5.42 (CONT.)
SHEAR STRENGTH OF SOIL IN STAGED TRIAXIAL COMPRESSION

Table D.5.1 Physical characteristics (tailings)

Boring number	Depth (ft)	Percent Passing No. 4	Percent Passing No. 200	Percent Passing 0.002 mm	Description of tailings	In situ water content	In situ saturation (%)	Liquid limit	Plastic limit	Plasticity index	USCS class	Activity	Liquidity index	Specific gravity	In situ dry unit weight (pcf)
HAT01-126	3-5.5	100	97	10	Slime	38.4	98.0	37	20	17	CL	1.70	1.08		81.7
	7-8.5					24.4									
	15-17.5	100	83	12	Slime			34	24	10	CL	0.83			52.1
	19-20.5	100	95		Slime	39.4									
	20.5-22					29.7									
	22.5-25	100	85	12	Slime	46.3	83.0	37	30	7	ML	0.58	2.33		67.4
	28-29.5					42.2									
HAT01-127	0-2.5	100	89	18	Slime	33.3	29.0				ML			3.241	43.0
	5.5-7					9.8									
	10-11.5					9.5									
	14.5-16	100	79		Slime	31.0		28	20	8	CL		1.38		
	16-18.5	100	88	12	Slime	71.7	100.0	36	24	12	CL-ML	1.00		2.819	58.5
	19-20.5	100	58		Sand-slime	19.3					ML				
	20.5-22					10.3									
	25-26.5					48.0									
HAT01-128	0-1.5	100	90	15	Slime	40.5					ML				
	3-4					67.8									50.3
	10.5-12					40.2									
HAT01-129	3-4					34.8									65.7
	7-8.5	100	87	8	Slime						ML				
	12.5-14					77.5									
HAT01-130	3-4					51.4									56.4
	4-5.5	100	61	9	Sand-slime	49.8									
	10-11.5					203.4									
	12-13.5					33.2									
HAT01-131	10-12.5	100	93	9	Slime	29.2	78.0	36	21	15	CL	1.67	0.55	2.727	84
	15.5-16.5					30.7									
HAT01-132	1.5-4	100	92	12	Slime	29.0		35	20	15	CL	1.25	0.60		
	7-8.5	100	74		Slime	22.5									
	11.5-14	100	68		Sand-slime	16.2									
	20-21.5					19.8									
	24.5-26.5	100	74	11	Slime	40.9		25	19	6	CL-ML	0.55	3.65		
HAT01-133	1.5-4	100	62	16	Sand-slime	35.6	93.0							2.682	84.2
	8.5-11	100	76	11	Slime									2.738	86.7
	14-15.5					21.3									
	15.5-17	100	60		Sand-slime	14.7									
	21.5-22.5					24.9									
	27-28.5	100	96	12	Slime	40.3		47	25	22	CL	1.83	0.70		
	35.5-37					29.3									

Table D.5.1 Physical characteristics (tailings) (Continued)

Boring number	Depth (ft)	Percent Passing No. 4	Percent Passing No. 200	Percent Passing 0.002 mm	Description of tailings	In situ water content	In situ saturation (%)	Liquid limit	Plastic limit	Plasticity index	USCS class	Activity	Liquidity index	Specific gravity	In situ dry unit weight (pcf)
HAT01-134	1.5-3	100	60		Sand-slime	13.3									
	4.5-6	100	51		Sand-slime	8.1									
	9-11.5	100	65	13	Sand-slime	12.3	36.0				ML			2.726	87.9
	14.5-16					12.4									
	22-23.5	100	58		Sand-slime										
	28-29.5					21.7									
	35-37.5	100	61		Sand-slime	10.2									88.1
	42-43.5	100	54		Sand-slime	12.5									
HAT01-135	0-1.5					43.6									
	3-5.5	100	93		Slime	27.2	63.5				ML				80.2
	8.5-10	100	38		Sand-slime	9.0									
	13-14.5					6.0									
	20-22.5	100	89	12	Slime	35.5	83.0	33	21	12	CL	1.00	1.21		80.5
	30-32.5	100	36	9	Sand-slime	12.6	36.0				SM				85.8
	35.5-37					33.0									
HAT01-136	3-5.5	100	99	12	Slime	35.2	81.0	42	23	19	CL	1.58	0.64	2.723	77.8
	7-8.5					40.2									
	10-11.5					33.7								2.728	
	13-15.5	100	96	9	Slime	48.8	100.0	51	24	27	CH	3.00	0.92	2.731	74.9
	20-22.5	100	96	12	Slime	38.8		40	23	17	CL	1.42	0.93	2.785	81.5
HAT01-137	1.5-3	100	52		Sand-slime	11.0									
	6.5-9	100	98	14	Slime			43	21	22	CL	1.57			
	10.5-12	100	62		Sand-slime	16.9									
	16.5-18	100	97	14	Slime	41.4		43	21	22	CL	1.57	0.93		
HAT01-138	5.5-7					27.0									
	10-11.5	100	91	14	Slime	39.8		38	21	17	CL	1.21	1.11	2.778	
	13-14.5					35.9									
	14.5-16					39.6									
	20.5-22	100	70		Slime	20.1		25	19	6	CL-ML		0.18		
	23.5-26					30.4									
	29-30.5					38.1									
	32-33.5					37.9									
	35-37.5	100	88	12	Slime	35.4	54.0	37	23	14	CL	1.17	0.89	2.756	85.3
HAT01-139	4.5-6	100	85		Slime	20.4		28	20	8	CL		0.05		
	7.5-9					18.5									
	10.5-12	100	65		Sand-slime	17.1					ML				
	13.5-15	100	90	13	Slime	32.1					CL				
	19.5-22	100	62	18	Sand-slime	9.7					ML				
	25-26.9					33.7									

Table D.5.1 Physical characteristics (tailings) (Concluded)

Boring number	Depth (ft)	Percent Passing No. 4	Percent Passing No. 200	Percent Passing 0.002 mm	Description of tailings	In situ water content	In situ saturation (%)	Liquid limit	Plastic limit	Plasticity index	USCS class	Activity	Liquidity index	Specific gravity	In situ dry unit weight (pcf)
HAT01-181	0-1.5	100	66		Sand-slime	14.1									
	4.5-7	100	67		Sand-slime	14.2	39.8				ML				85.8
	8.5-10	100	52		Sand-slime	12.6									
	14.5-17	100	53		Sand-slime	9.8	30.5				ML				90.2
	20-21.5	100	29		Sand	8.6					SM				
	24.5-26	100	30	10	Sand	8.5					SM			2.703	
	27.5-29					25.7									
AVERAGES:															
	Sand (N=2)	100	30	10		8.6								2.703	
	Sand-Slime (N=21)	100	58	13		16.1	47.1							2.760	87.0
	Slime (N=27)	100	89	12		37.0	77.0	37	22	15	CL	1.37	1.07	2.757	75.1

Table D.5.2 Hydraulic conductivity test results (tailings) (undisturbed samples)

Boring number	Sample internal (ft)	USCS class	Tailings type	Dry unit weight (pcf)	Water content (percent)		Saturation (percent)		Hydraulic conductivity (cm/s)	Type of test
					Initial	Final	Initial	Final		
HAT01-126	15-17.5	CL	Slime	52.1	84.7	81.4	100	100	1.8×10^{-6}	T
	22.5-25	ML	Slime	90.0	21.9	31.5	66.4	99.5	6.1×10^{-7}	T
HAT01-127	16-18.5	CL-ML	Slime	58.5	71.7	71.9	100	100	4.2×10^{-6}	C
HAT01-133	1.5-4	---	Sand	84.2	35.6	33.6	93	87.8	1.18×10^{-2}	C
HAT01-134	9-11.5	ML	Sand-slime	87.8	12.3	29.9	36	87	2.6×10^{-6}	C
HAT01-136	3-5.5	CL	Slime	75.3	49.9	42.8	100	100	1.3×10^{-7}	T

T = Triaxial permeability test.
C = Constant head test.

Table D.5.3 Consolidation test results (tailings)
(undisturbed samples)

Boring number[a]	Sample interval (ft)	USCS class	Tailings type	Preconsolidation pressure (KSF)	In situ vertical stress (KSF)	Over-consolidation ratio	Initial void ratio (e_o)	Load increment (KSF)	Coefficient of consolidation (in^2/min)	Rate of secondary compression (Ca)[b]
HAT01-126	3-5.5	CL	Slime	1.3	0.3	4.3	1.052	0.25	0.021	0.0010
								1.00	0.019	0.0013
								2.00	0.087	0.0028
								4.00	0.042	0.0040
								8.00	0.040	0.0044
								16.00	0.036	0.0060
HAT01-126	22.5-25	ML	Slime	4.8	2.3	2.1	1.531	0.25	0.002	0
								0.50	0.019	0.0004
								1.00	0.010	0.0004
								2.00	0.031	0.0016
								4.00	0.054	0.0026
								8.00	0.060	0.0055
								16.00	0.105	0.0070
HAT01-131	10-12.5	CL	Slime	4.4	1.1	4.0	1.017	0.25	0.090	0.0006
								0.50	0.058	0.0002
								1.00	0.075	0.0009
								2.00	0.039	0.0020
								4.00	0.038	0.0038
								8.00	0.037	0.0060
								16.00	0.025	0.0120
								32.00	0.032	0.0080
HAT01-133[c]	8.5-11	ML	Slime	3.3	1.0	3.3	---[d]	-------Not calculated-------		
HAT01-136	3-5.5	(SM/ ML)	(Sand-slime)	2.0	0.3	6.7	1.175	0.25	0.021	0.0015
								0.50	0.027	0.0024
								1.00	0.020	0.0044
								2.00	0.013	0.0105
								4.00	0.012	0.0056
								8.00	0.016	0.0085
								16.00	0.015	0.0085
								32.00	0.022	0.0055

Table D.5.3 Consolidation test results (tailings) (undisturbed samples) (Concluded)

Boring number[a]	Sample interval (ft)	USCS class	Tailings type	Preconsolidation pressure (KSF)	In situ vertical stress (KSF)	Over-consolidation ratio	Initial void ratio (e_o)	Load increment (KSF)	Coefficient of consolidation (in^2/min)	Rate of secondary compression (Ca)[b]
HAT01-126	3-5.5	CL	Slime	1.3	0.3	4.3	1.052	0.25	0.021	0.0010
								1.00	0.019	0.0013
HAT01-136[e]	13-15	CH	Slime	2.8	1.0	2.8	1.268	0.50	0.052	0.0011
								1.00	0.062	0.0014
								2.00	0.150	0.0052
								4.00	0.072	0.0070
								8.00	0.024	0.0090
								16.00	0.059	0.0095
								32.00	0.042	0.0100
HAT01-138[e]	35-37.5	CL	Slime	5.6	3.8	1.5	1.013	0.125	0.021	0.0009
								0.25	0.047	0.0010
								0.50	0.084	0.0011
								1.00	0.024	0.0011
								2.00	0.032	0.0011
								4.00	0.045	0.0025
								8.00	0.021	0.0075
								16.00	0.033	0.0020
								32.00	0.036	0.0100

[a]Tested submerged throughout test unless otherwise noted.
[b]The coefficient of secondary compression referenced to stress can be calculated by multiplying the values referenced to strain by $(1 + e_o)$.
[c]Tested at in situ moisture content to 1 ksf then submerged.
[d]Not available.
[e]Tested at in situ moisture content throughout test.
() Indicates that classification was determined based on micrologs (visual classifications) of Shelby tubes at time of testing.

Table D.5.4 Physical properties and mechanical behavior (remolded tailings and windblown contaminated materials)

Test pit number	Depth (ft)	Percent passing			Description of tailings	In situ water content	Liquid limit	Plastic limit	Plasticity index	USCS class	Activity	Specific gravity	Moisture-density results			Relative Density	
		No. 4	No. 200	0.002 mm									Max dry density (pcf)	Optimum moisture (%)	Sat. at opt. moist. and max. den.	Min density (pcf)	Max density (pcf)
HAT01-001	0-1.5	100	47	12	Sand-slime	6.4				SM		2.681	99.8	17.7	70.1	77.5	97.5
	0-1.5-R	100	51	22	Sand-slime	8.1						2.740	100.6	16.5	16.5		
HAT01-002	0-0.5	100	63	11	Sand-slime	7.5				ML		2.708	116.7	12.2	73.6		
					(windblown)	16.5							16.5	16.5	16.5		
HAT01-003	0-3	100	100	14	Slime		54	22	32	CH	2.29	2.794	91.9	26.4	82.1		
	1-2-R	100	100	21	Slime	46.8						2.790	95.1	25.9	23.3		
	3-4-R	100	60	18	Sand-slime	17.7						2.850	93.8	23.6	23.3		
	3-4	100	75	11	Slime	18.8				ML		2.773	96.3	23.3	81.0		
HAT01-004	2.5-6	100	96	14	Slime	19.1				ML		3.400	58.0	59.8	76.4		
	2.5-6-R	93	63	17	Sand-slime	7.6						2.780	124.6	10.0			
	6-7.5	100	61	10	Sand-slime	16.2				ML		2.749	103.5	20.1	84.0		
	6-7.5-R	100	56	15	Sand-slime	19.9						2.880	99.1	21.8			
HAT01-005	3-4.5	100	42	9	Sand-slime	12.1				SM		2.716	106.3	16.7	76.2	73.0	101.5
	3-4.5-R	100	33.5	17	Sand-slime	9.3						2.790	105.2	11.1	11.1		

R Indicates tests performed by a second laboratory on bulk samples collected from the same depths at the same pit and time.

D.6 BORROW MATERIAL CHARACTERISTICS

D.6.1 DESIGN PARAMETERS

The design parameters for both rock and radon barrier materials are presented in appropriate calculations for disposal cell design Volume III, Calculations - Geotechnical Analysis, Appendix B.

The rock material is assumed to have an infinitely high permeability and to be relatively incompressible. Thus, these properties are not given in the table.

D.6.2 EROSION BARRIER MATERIALS

The erosion barrier materials will be obtained from the Bluff and Sugarloaf quarries. The materials from Bluff quarry are round river cobbles with rock quality scores (RQS) greater than 80 (see Calculation 9-418-06-00, Appendix B, Volume II). These materials will be used as riprap types A, B, and bedding material. The materials from Sugarloaf quarry are composed of crushed limestone with RQS greater than 80 (see Calculation 9-418-04-00, Appendix B, Volume II). However, in the design calculations the RQS was conservatively assumed to be 65 (Calculation 9-418-05-0, Appendix B, Volume II). Thus, material from this source will be oversized. The Sugarloaf quarry material will be used for riprap types A, B, and C.

D.6.3 RADON BARRIER MATERIALS

Material properties for the radon barrier are described in Calculation 9-421-01-00, Appendix B, Volume II and in disclaimer 31 of Volume III of the Information for Bidders.

The material will be obtained from the RB-4 and RB-7 borrow sites. The borrowed material will be amended with 10 percent bentonite by weight.

D.7 GROUNDWATER HYDROLOGY

D.7.1 INTRODUCTION

The EPA has established health and environmental protection regulations to correct and prevent groundwater contamination from former processing activities at inactive uranium milling sites (40 CFR Part 192). According to the Uranium Mill Tailings Radiation Control Act (UMTRCA) (48 CFR 590), the DOE is responsible for assessing the processing sites. The DOE has determined this assessment for Subparts A and C of the proposed EPA groundwater standards shall include the following (DOE, 1988b):

- Characterization of the hydrogeologic environment, including hydrostratigraphy, groundwater occurrence, aquifer parameters, and areas of recharge and discharge.

- Characterization of existing groundwater quality by comparison with background water quality and the maximum concentration limits (MCL) of the proposed EPA groundwater protection standards.

- Definition of physical and chemical characteristics of the potential contaminant source, including concentration and leachability of the source in relation to migration in groundwater and hydraulically connected surface water.

- Description of local water resources, including current and future use and value, availability, and alternative supplies.

The EPA promulgated final groundwater protection standards for the disposal and cleanup of the inactive uranium processing sites under the UMTRCA on January 5, 1983. However, the groundwater provisions of the regulations (40 CFR Part 192.20(a)(2)-(3)) were remanded to the EPA by the U.S. Tenth Circuit Court of Appeals on September 3, 1985. The EPA issued revised groundwater protection standards to replace those set aside (52 CFR 36000) on September 24, 1987.

The DOE has characterized conditions at the Mexican Hat and Monument Valley uranium mill tailings sites and assessed whether the remedial actions comply with Subparts A and C of the proposed EPA groundwater protection standards. Remedial actions involving the codisposal of Monument Valley contaminated materials at the Mexican Hat disposal site would not preclude subsequent design enhancements if needed to achieve compliance. Also, they would not limit the selection of reasonable groundwater restoration methods under Subpart B, should they be found necessary when the final standards are promulgated. Evaluation of cleanup and control of existing groundwater at the Mexican Hat and Monument Valley sites will be addressed under a separate process in accordance with the National Environmental Policy Act (NEPA) following promulgation of the final EPA groundwater standards.

D.7.2 SUMMARY - MEXICAN HAT DISPOSAL SITE

- The Mexican Hat disposal site is underlain by the Halgaito Shale Formation of the Cutler Group. The Halgaito Shale Formation is composed of a varied sequence of interbedded, very fine-grained, silty sandstone and siltstone beds (O'Sullivan, 1965) and ranges from 50 to 180 feet thick in the site vicinity. It is underlain by the Honaker Trail Formation of the Hermosa Group, which consists of more than 300 feet of interbedded siltstones, limestones, shales, and sandstones (FBDU, 1981; Wengerd, 1973).

- Perched water and unconfined groundwater related to uranium milling operations occur at depths ranging from 35 to 60 feet beneath the Mexican Hat tailings in the Halgaito Shale Formation. Water-bearing fracture density within the Halgaito Shale Formation decreases with depth in the tailings pile area, so that the bottom of the formation becomes an aquitard that confines naturally recharged groundwater in the underlying Honaker Trail Formation. Recharge to the perched groundwater within the Halgaito Shale Formation occurs from tailings seepage and minor amounts of infiltration from precipitation, and flows in the arroyos within the vicinity of the tailings. Perched water and groundwater in the area of saturation within the Halgaito Shale Formation may spread laterally along layers with lower hydraulic conductivity that dip regionally to the east and southeast. It is assumed that the average hydraulic gradient is approximately equal to the dip of the formation, 0.07. The average hydraulic conductivity of the Halgaito Shale Formation is 0.20 foot per day (ft/day) (7×10^{-4} cm/s). Assuming an effective porosity range of 0.1 to 0.25, the average linear groundwater velocity is 0.09 ft/day (0.03 meters per day (m/day)).

- Naturally occurring groundwater within the Honaker Trail Formation flows under an average hydraulic gradient of 0.024 to the northeast. The Honaker Trail Formation is recharged by groundwater underflow and discharges to springs and seeps in the Gypsum Creek or as groundwater underflow from the site. The average hydraulic conductivity of the Honaker Trail Formation is 0.07 ft/day (2.5×10^{-5} cm/s). Assuming an effective porosity range of 0.1 to 0.2, the average linear groundwater velocity is 0.01 ft/day (3×10^{-3} m/day).

- The perched water and area of saturation within the Halgaito Shale Formation are present predominantly as the result of milling activities and drainage of the tailings. Consequently, there is no native groundwater and, thus, no "background" water quality data for the Halgaito Shale Formation. Fluids derived from tailings seepage sampled in monitor wells completed within the Halgaito Shale Formation have a relatively high total dissolved solids (TDS) content, with a mean TDS concentration greater than 5000 milligrams per liter (mg/l). Maximum concentrations of chromium, molybdenum, uranium, nitrate, and uranium and the activity of net gross alpha exceed the proposed EPA MCLs. After the tailings have been reconfigured into a disposal cell and covered with a low permeability radon/infiltration barrier, and

steady-state conditions are achieved, the tailings seepage to the Halgaito Shale Formation will become negligible.

- Background water quality in the Honaker Trail Formation and associated seeps is characterized by maximum observed concentrations of arsenic, chromium, selenium, and uranium, and activities of net gross alpha and radium-226 and -228 that exceed the proposed EPA MCLs. A screening of Appendix VIII inorganic constituents identified antimony, copper, fluoride, nickel, vanadium, and zinc as hazardous constituents above detection limits. The lower Honaker Trail Formation also contains naturally occurring concentrations of hazardous constituents and hydrocarbons and hydrogen sulfide gas, which make this groundwater unsuitable as a groundwater resource.

- No contamination of the Honaker Trail Formation has occurred from the Mexican Hat site because it is separated from groundwater within the Halgaito Shale Formation by a zone of low hydraulic conductivity in the basal portion of the Halgaito Shale Formation. Furthermore, an upward hydraulic gradient between the Honaker Trail Formation and the Halgaito Shale Formation prevents downward migration of tailings seepage into the Honaker Trail Formation.

- Inorganic hazardous constituents with MCLs that exceed the laboratory method detection limits in tailings pore water include arsenic, barium, cadmium, chromium, lead (total only), mercury, molybdenum, net gross alpha, nitrate, silver, and uranium. For characterization purposes, mean or median tailings pore water quality data were compared to MCLs. Mean or median observed concentrations or activities of arsenic, cadmium, net gross alpha, and uranium in tailings pore water exceeded the MCLs.

- Water discharges from seeps in the North Arroyo exhibit maximum observed concentrations or activities of molybdenum, net gross alpha, nitrate, and uranium above MCLs. Discharges from these seeps are from milling operations-related water. Discharges from Gypsum Creek seep GS-3 (254) may also be derived from milling operations-related water based on major cation/anion chemistry, elevated nitrate concentrations, and elevated uranium concentrations.

- Discharges from seeps in Gypsum Creek are primarily from the upward movement of naturally occurring groundwater from either the Honaker Trail Formation or the Halgaito Shale Formation, based on major cation/anion geochemistry. However, five Gypsum Creek seeps exhibit concentrations of uranium elevated generally an order of magnitude above background. Therefore, these seeps may have a component of discharge derived from milling operations-related water.

- Groundwater in the Halgaito Shale Formation and the Honaker Trail Formation in the vicinity of the Mexican Hat site is not used as a source of drinking water or for other domestic or beneficial purposes. Groundwater has not been developed in the Halgaito Shale Formation because of the limited areal extent of saturation in the site vicinity and the low-hydraulic conductivity of the member, which results in low

yields to wells. Groundwater within the Honaker Trail Formation has not been developed because of poor water quality (hydrocarbons and hydrogen sulfide gas). Alternative supplies of good quality water are readily available from the San Juan River, which supplies the total water needs in the area.

D.7.3 PREVIOUS INVESTIGATIONS AT THE MEXICAN HAT SITE

Several investigators have reported on the hydrogeologic environment of the Mexican Hat tailings site. These studies include stratigraphic and geomorphic reconnaissance-level surveys, surface and subsurface radioactivity surveys, and preliminary water quality analyses.

A radiation survey of the Mexican Hat area was completed in 1968 (Snelling, 1971). The study identified locations contaminated by wind-blown tailings and uranium ore scattered during storage at the Mexican Hat mill. Radium-226 and -228 activities and natural uranium concentrations were measured in four surface water samples collected within the area of the tailings site.

The EPA has reported on radiological sampling for the radium-226 and -228 activities of the San Juan River water (EPA, 1973). Samples were collected over a 12-year period at locations both upstream and downstream of the Mexican Hat site.

A very general survey of hydrologic and geologic characteristics of the Mexican Hat tailings site was conducted by Fuhriman and Hintze (1976). Climatological data for the region were also reported.

Water quality sampling for metals and radionuclides was conducted by Ford, Bacon & Davis, Utah Inc. (FBDU, 1981). Five surface water locations were sampled, as were several locations from which sediment samples were collected and analyzed for radium-226 and -228 and selected heavy metals.

Geochemistry and Environmental Chemistry Research, Inc. (GECR, 1982) conducted a fairly comprehensive sampling program in the area of the tailings site. Analytical results were reported for several surface water samples from the San Juan River both upstream and downstream of the Mexican Hat tailings site, for several surface water samples in the area of the tailings, and for water and acid extracts from solid samples taken within and adjacent to the tailings pile.

Chemical analyses of solid samples taken from within the tailings pile and below the tailings-bedrock interface were reported from a survey conducted by Colorado State University (CSU, 1983a).

D.7.4 DOE INVESTIGATIONS AT THE MEXICAN HAT SITE

Hydrogeologic data including borehole logs, well completion records, groundwater levels, aquifer test data, and water quality analyses were

collected at the Mexican Hat tailings site by the DOE from the fall of 1984 to the present. All field and laboratory procedures and calculations were performed according to the DOE's standard operating procedures, which follows EPA guidance to the maximum extent possible (DOE, 1985).

Twenty boreholes were drilled to depths between three and 235 feet below land surface (bls) in the area of the Mexican Hat tailings site. Seven 2.0-inch diameter and three 4.0-inch diameter polyvinyl chloride (PVC) monitor wells were installed in the boreholes. These monitor wells range in depth from 12 to 200 feet bls. One well (907) was constructed using inflatable packers set at depths of 107 and 110 feet bls, with a 0.75-inch steel riser pipe. Lithologic samples were obtained from all of the boreholes and geophysical logs were obtained from five of the boreholes prior to abandonment. Each borehole was cemented from the total depth to slightly above the land surface during abandonment. The locations of DOE monitor wells and abandoned boreholes described in the DOE investigation are shown on Figure D.7.1. Seep locations and remaining monitor wells are shown in Figure D.7.2.

Following installation and development of the monitor wells, slug withdrawal and packer injection tests were performed to estimate the hydraulic characteristics of the saturated strata at the completed intervals of the wells. The completed wells were surveyed and groundwater levels measured to determine hydraulic gradients and groundwater flow directions. Information concerning DOE monitor well and borehole data is presented in Table D.7.1, and typical DOE monitor well construction is shown on Figure D.7.3.

Seeps in the vicinity of the Mexican Hat disposal cell have been reported or observed prior to the start of the remedial action. Seeps in Gypsum Creek were evaluated for both surface water and groundwater impacts during initial site characterization and were discussed in the remedial action plan for Mexican Hat (DOE, 1988c). They also were the focus of an on-site evaluation conducted by representatives of the DOE, TAC, NRC, and Navajo Nation in April 1989.

The TAC and the RAC personnel have performed additional seep characterization. Water samples from the seeps and other surface water bodies have been sampled and analyzed. Flow rates have been monitored at four of the seeps. References to and previous observations of the seeps in the disposal site area were evaluated. The amount of water used during the remedial action was estimated and compared to the amount of water used during milling. The results of this characterization program were presented in a comprehensive report (DOE, 1990).

D.7.5 GEOLOGY AND HYDROSTRATIGRAPHY

The Mexican Hat tailings site is on outcrops of the Halgaito Shale Formation of the Cutler Group. The Halgaito Shale Formation is underlain by the Honaker Trail Formation (Figure D.7.4). At the site, these strata

dip three to four degrees eastward, toward the axis of the Mexican Hat Syncline (Figure D.7.5).

The Halgaito Shale Formation is of Permian age and is comprised of an erratic sequence of thinly to thickly bedded, dark, reddish-brown siltstones, silty sandstones, and silty shales with thin, discontinuous beds of gray, silty limestone. A few thin, discontinuous clay layers were observed in several of the boreholes. Prominent fracture sets are generally closely spaced, strike east, and have nearly vertical dips (Figure D.7.5).

The Halgaito Shale Formation crops out in areas of the site where soil or alluvial deposits do not occur. The Halgaito Shale Formation is reported to be up to 400 feet thick in the region (Witkind and Thaden, 1963) and 50 to 100 feet thick in the area of the site (FBDU, 1981). The contact between the Halgaito Shale Formation and the underlying Honaker Trail Formation is gradational and indistinct. However, in some areas the top of the Honaker Trail Formation is marked by a thin fossiliferous limestone bed.

The Honaker Trail Formation of the Hermosa Group is of Pennsylvanian age and underlies the Halgaito Shale Formation. It is visible in outcrops approximately one mile west of the site and in Halgaito Wash approximately one mile southwest of Halchita. The Honaker Trail Formation is reported as a varied sequence of gray to white, fossiliferous limestone interbedded with gray, massive sandstone, thinly-bedded red sandstone, minor red shale, and mudstone (Witkind and Thaden, 1963). It is reported to be not less than 300 feet thick in the area of the site (FBDU, 1981).

On the basis of the reported stratigraphy in the area of the site, the shallow monitor wells are interpreted as being completed within the Halgaito Shale Formation. The deeper monitor wells, which encountered hydrocarbons, are interpreted as being completed within the upper Honaker Trail Formation. The deepest boreholes, which encountered hydrocarbons and hydrogen sulfide gas, are interpreted as intercepting the lower portion of the Honaker Trail Formation. The locations of hydrogeologic cross sections are shown on Figure D.7.6; the cross sections are presented on Figures D.7.7, D.7.8, and D.7.9. The surface topography shown on the cross sections was developed from the U.S. Geological Survey (USGS) 15-minute topographic map of the Mexican Hat Quadrangle. Subsurface lithologies were drawn from borehole logs and visual inspection of recovered core samples.

D.7.6 PRESENCE AND MOVEMENT OF GROUNDWATER

Halgaito Shale Formation

Perched water and groundwater in an area of saturation downdip and down hydraulic gradient of the tailings occur under unconfined conditions within the Halgaito Shale Formation. This groundwater system occurs over a limited area and has formed as a result of seepage from the tailings piles during uranium milling operations. Most groundwater flow occurs in

the shale in joints, bedding planes, and fractures that are near the surface. These secondary permeability features diminish with depth. Because the Halgaito Shale Formation has a relatively low primary permeability related to its interstitial porosity, it behaves as an aquitard at depths below 100 feet where the fracture density is very low.

Relatively shallow perched water underlies at least a part of the area of the tailings site within the Halgaito Shale Formation. Deeper groundwater occurs within the Halgaito Shale Formation in an area of saturation downgradient of the site. Several borings both upgradient and off gradient of the site in the Halgaito Shale Formation were dry, suggesting that the area of saturation within the Halgaito Shale Formation is related to milling operations resulting from tailings drainage. Perched water, which is related to tailings drainage, occurs on top of a clay layer that is approximately 75 feet bls in wells 911 and 912. This clay layer was evident in the boring logs of wells 911 and 912 and does not extend to the northeast or southwest of the piles (Figure D.7.9).

The hydraulic gradient for unconfined groundwater surface in the Halgaito Shale could not be determined by creating a water table map, since the monitor wells completed in this formation were screened across several different intervals. In an unconfined system, the depth of screened intervals should be fairly uniform to ensure an accurate depiction of the water table surface. Since a water table map could not be created, it was assumed that the direction of groundwater flow is down dip and the gradient is approximate to the dip magnitude. The resultant gradient is 0.07, with a flow direction toward the east (Calculation HAT 01-09-91-14-06-00, Appendix F). This assumption is reasonable since the groundwater flows above a zone of very low hydraulic conductivity within the basal section of the Halgaito Shale (Calculation HAT01-07-91-14-03-00, Appendix F) and this zone most likely is oriented parallel to the dip of the entire formation. This is consistent with both the topography and the regional dip.

There is no source of recharge to the Halgaito Shale Formation in the site vicinity other than tailings drainage related to milling operations. Precipitation on outcrop areas of the Halgaito Shale Formation and flows in the arroyo in which the tailings are located are probably insufficient to sustain saturation. For this reason, the Halgaito Shale is generally unsaturated regionally; however, some perched water and groundwater do exist within the Halgaito Shale Formation immediately below and downgradient of the existing tailings piles.

Honaker Trail Formation

Groundwater in the Honaker Trail Formation occurs under confined conditions beneath the Mexican Hat tailings site. The Honaker Trail Formation aquifer is regionally extensive and is confined within the site vicinity by approximately 40 feet of low-hydraulic conductivity, unfractured, well-consolidated siltstones, and shales of the Halgaito Shale Formation. There is a gradational and indistinct contact between the Halgaito Shale Formation and the Honaker Trail Formation. Inspection of

stratigraphic and structural relationships presented by Cooley et al. (1969), Baars (1973), and FBDU (1981) were used to define the contact. The Honaker Trail Formation is considered to be the uppermost aquifer at the Mexican Hat site.

The potentiometric surface of the Honaker Trail Formation is shown on Figure D.7.10. The Honaker Trail Formation in the site vicinity is recharged by groundwater underflow. Groundwater within the Honaker Trail Formation flows toward the northeast, under an average hydraulic gradient of 0.024 (Calculation HAT-09-91-14-06-00). The Honaker Trail potentiometric surface rises above the floor of Gypsum Creek (Figure D.7.10), which indicates that groundwater from this formation may contribute to Gypsum Creek seep discharges.

The presence of hydrogen sulfide gas within the lower Honaker Trail Formation prevented the completion of monitor wells deeper within the formation and the measurement of hydraulic gradients with depth.

Vertical hydraulic gradients

In the vicinity of monitor well 907, the Honaker Trail Formation is confined to the extent that there is artesian pressure (Figure D.7.9). The vertical gradient between the Honaker Trail Formation and the Halgaito Shale Formation was determined with data from the monitor well pair 907 and 906 (Figure D.7.1) (Calculation HAT-01-09-91-14-06-00, Appendix F). Monitor well 907 is screened in the Honaker Trail Formation and monitor well 906 is screened in the Halgaito Shale Formation. The vertical gradient between the Honaker Trail Formation and the Halgaito Shale Formation is approximately 0.09 upward. This upward gradient in the area of the Mexican Hat tailings piles would preclude the migration of contaminants into the underlying, confined Honaker Trail Formation beneath the disposal cell.

The vertical gradient within the Halgaito Shale Formation in the tailings pile area was determined in a similar fashion with the monitor well pair 911 and 912 (Calculation HAT-01-09-91-14-06-00, Appendix F). The vertical gradient within the Halgaito Shale Formation ranges from 0.7 to 1.0 downward in the area of the Mexican Hat tailings.

D.7.7 HYDRAULIC CHARACTERISTICS

A summary of the hydraulic characteristics of Halgaito Shale Formation and Honaker Trail Formation is presented in Table D.7.2. Falling head slug-withdrawal tests were conducted in monitor wells and a packer test was performed in a borehole to measure hydraulic conductivities. All calculations are included in Appendix F.

Halgaito Shale Formation

No previously published quantitative data are available for the Halgaito Shale Formation. Cooley et al. (1969) stated that "the rock outcrops in the area have low permeability and carry little or no water." The Halgaito Shale Formation and the Honaker Trail Formation are not considered potentially potable aquifers with significant water-yielding capabilities in the area of the tailings site. This is evident from hydrogeologic exploration by previous investigators and the absence of producing water wells in the area of the tailings site (Denny, 1985; Little, 1985; May, 1985).

The results of a slug test performed within monitor well 912 and a series of packer tests within monitor well 911 indicate relatively low hydraulic conductivities within a shallow, perched groundwater zone at a depth of about 70 feet bls within the Halgaito Shale Formation (Table D.7.2). Computed values of saturated hydraulic conductivity for the packer intervals over a 51-foot vertical section are presented in Table D.7.2. A decrease in hydraulic conductivity over an order of magnitude with depth is apparent in monitor well 911 (Calculation HAT-07-91-14-03-00). The lowest hydraulic conductivity, 0.014 ft/day (5×10^{-6} cm/s), occurs in the interval from 94.5 to 104.5 feet. This decrease in hydraulic conductivity is interpreted as representing the transition into a zone of low fracture density or into a zone of decreased fracture aperture.

The average hydraulic conductivity of the upper unit, as calculated from slug and packer tests conducted within wells 911 and 912, is 0.20 ft/day (7×10^{-5} cm/s) (Calculations HAT-07-91-14-02-00 and HAT-07-91-14-03-00) (Table D.7.2). Assuming an average hydraulic gradient of 0.07, a range of effective porosities from 0.10 to 0.25 for the upper unit, and an average hydraulic conductivity of 0.20 ft/day (7×10^{-5} cm/s), the average linear groundwater velocity is 0.09 ft/day (0.03 m/day) (Calculation HAT-09-91-14-06-00). The fracture flow velocity may be orders of magnitude greater than this average velocity, depending on fracture aperture and fracture wall roughness (Freeze and Cherry, 1979).

Honaker Trail Formation

Very limited previously published quantitative data are available concerning hydraulic characteristics for the Honaker Trail Formation (and the Halgaito Shale Formation) in the vicinity of the Mexican Hat tailings site. Groundwater was presumed absent beneath the site by Snelling (1971), Fuhriman and Hintze (1976), and FBDU (1981). A regional hydrogeologic study of the Navajo and Hopi Reservations (Cooley et al., 1969) reported no quantitative data on conditions within the Mexican Hat area due to a lack of producing water wells in the area. Woodward-Clyde Consultants (WCC, 1982) prepared a comprehensive report on the hydrogeologic characteristics for an area north of the Mexican Hat tailings site. Included in this report are analyses of drill stem tests conducted within the upper Honaker Trail Formation. An extremely low saturated hydraulic

conductivity of 2.1 x 10^{-6} ft/day (7.4 x 10^{-10} cm/s) was calculated for an interval within the upper Honaker Trail Formation (WCC, 1982).

Slug tests were conducted in monitor wells 908, 909, 930, 934 and 935 in the Honaker Trail Formation and analyzed by the Skibitske, Ferris-Knowles, and Cooper-Bredehoeft-Papadopolus methods (Bentall, 1963) that are applicable to confined groundwater systems. The average saturated hydraulic conductivity of the Honaker Trail Formation, as determined from slug tests conducted within wells 908, 909, 930, 934, and 935, is 0.07 ft/day (2.5 x 10^{-5} cm/s) (Calculation HAT-07-91-14-02-00) (Table D.7.2). Assuming an average effective porosity range of 0.10 to 0.20, and an average hydraulic conductivity of 0.07 ft/day, the average linear groundwater velocity in the Honaker Trail Formation is 0.01 ft/day (3 x 10^{-3} m/day) (Calculation HAT-09-91-14-06-00).

The lower Honaker Trail Formation contains groundwater and naturally occurring hydrocarbon compounds under confined conditions and is an oil-producing horizon in the Mexican Hat oil field immediately north of the tailings site (Wengerd, 1973). At the Mexican Hat site, the lower Honaker Trail Formation was penetrated by boreholes 908, 909, and 910. Inspection of the recovered core samples from these boreholes revealed sulfur and traces of oil coating fractures and vugs at depths between 125 and 185 feet bls. Hydrogen sulfide gas was encountered at a depth of approximately 215 feet bls in borehole 910. Due to health and safety considerations involved in drilling through strata charged with hydrogen sulfide gas and the concomitant natural degradation of groundwater quality in this hydrocarbon-bearing zone, boreholes 908 and 909 were cemented to a level substantially above the lower hydrostratigraphic unit. The lowermost portion of each borehole was sealed with bentonite before being completed as monitor wells within the upper Honaker Trail Formation. Borehole 910 was grouted through the total depth of the borehole and abandoned. Subsequently, a new borehole was located approximately 100 feet south of the abandoned borehole and completed as well 910.

As a result of the hazardous nature of this lowermost, deep, confined groundwater system, limited data were gathered, and only a qualitative assessment of the hydrologic regime was made. The presence of oil indicated that the overlying rocks are sufficiently low in permeability to trap the oil, indicating minimal hydraulic communication between this zone and the overlying hydrostratigraphy. The lower Honaker Trail Formation gives rise to occasional oil seeps where it outcrops along the banks of the San Juan River. Thus, the river is incised to an elevation at least equivalent to this zone, and any overlying hydrostratigraphic units cannot be hydraulically connected across the river because of topographic incision of the units by the river.

D.7.8 BACKGROUND GROUNDWATER QUALITY

This section discusses the existing groundwater quality characteristics of the Halgaito Shale Formation and the upper Honaker Trail Formation at the Mexican Hat tailings site. Because the lower Honaker Trail Formation was found to contain naturally occurring, potentially

hazardous accumulations of hydrogen sulfide gas, it was omitted from further data collection and discussion.

Halgaito Shale Formation

Background water quality was characterized by analyzing constituents listed in Table 8.1 of the Technical Approach Document (TAD) (DOE, 1989) in Halgaito Shale monitor wells 910, 911, and 912. A statistical analysis of background water quality in the monitor wells could not be performed due to an insufficient number of samples collected prior to abandonment of these monitor wells because of construction activity.

Exploratory drilling and installation of monitor wells has defined the occurrence of groundwater within the Halgaito Shale Formation at the Mexican Hat site. The occurrence of groundwater within the Halgaito Shale is erratic. Because exploratory drilling into the Halgaito Shale upgradient from the tailings site encountered no groundwater and no wells are developed in the Halgaito Shale Formation for any purpose, there was probably no saturation in the Halgaito Shale Formation prior to processing of uranium at the Mexican Hat site.

Therefore, the DOE proposes that the background (baseline) water quality of the Halgaito Shale Formation be defined as the existing groundwater quality found within this unit immediately underlying the tailings site. Groundwater derived from tailings seepage was sampled in monitor wells 911 and 912, which were completed within the perched water zone in the Halgaito Shale Formation directly below the disposal cell (Table D.7.3). These waters have a relatively high TDS content, with maximum TDS concentrations of 1960 mg/l and 6670 mg/l in monitor wells 911 and 912, respectively. The pH ranges from 6.2 to 7.7 (Table D.7.3) A trilinear diagram of chemical composition of water samples collected in the vicinity of the Mexican Hat site is shown on Figure D.7.11. Groundwater from the Halgaito Shale Formation is classified as a calcium magnesium sulfate type. The sulfate (SO_4^{2-}) is derived from the acid leach process. The dominant cations, calcium (Ca^{2+}) and magnesium (Mg^{2+}), were released to the groundwater by neutralization of acidic leachates by carbonates. This mechanism is supported by the higher concentrations of bicarbonate in this unit than are found in the native groundwaters of the Honaker Trail Formation. Stiff diagrams created for groundwater samples from the Halgaito Shale monitor well 912 show that Mg^{2+} is the dominant cation, followed by Ca^{2+}, then Na^{+} plus K^{+} (Figure D.7.12). The dominant anion is SO_4^{2-}.

Analyses of groundwater samples from the Halgaito Shale indicate that maximum concentrations or activities of chromium, molybdenum, net gross alpha, nitrate, and uranium have exceeded the proposed EPA MCLs (Table D.7.3). The mean uranium concentration for downgradient monitor wells 911 and 912 is 0.53 mg/l. Nitrate concentrations in monitor wells 911 and 912 averaged 8.0 mg/l in 1985. In 1988, the mean nitrate concentration in monitor well 912 had risen to 258 mg/l. The mean ammonium concentration in 1988 was 50 mg/l (Table D.7.3). A screening of Appendix IX inorganic constituents identified aluminum, ammonium, antimony,

copper, fluoride, nickel, vanadium, and zinc as hazardous constituents above detection limits.

A screening of Appendix IX constituents in monitor well 912 found lindane at a concentration of 0.18 μg/l, which is three times the detection limit. This organic compound is an insecticide and is unrelated to the milling process. It has not been detected in raffinate at active uranium processing sites (Smith, 1987). Methyl iodide also appears to be present in concentrations approximately equal to the detection limit (5 μg/l). Generally, methyl iodide is not used in the uranium process and also has not been detected in raffinate at Title II uranium processing sites.

A different type of water quality that may be less influenced by perched tailings fluids in the Halgaito Shale is defined by samples from monitor well 934, approximately 800 feet east of the tailings pile (Table D.7.4). This monitor well is screened in the Honaker Trail/Halgaito Shale contact zone. Water quality analyses suggest that groundwater from this low-yield monitor well is not milling-related, but is native groundwater in an isolated area in the Halgaito Shale or confined groundwater leaking upward from the deeper Honaker Trail Formation. TDS concentrations in monitor well 934 average approximately 26,000 mg/l, which is an order of magnitude higher than the TDS concentrations in monitor wells 911 and 912 (Table D.7.3). The pH in monitor well 934 ranges from 7.7 to 11.2. Groundwater from monitor well 934 does not plot with any other group on the trilinear diagram because of the high proportion of sodium and chloride ions to other ions (Figures D.7.11 and D.7.13). Monitor well 934 is the only well at the site with such high proportions of sodium and chloride ions. The water quality of this monitor well could be influenced by highly soluble salts in brines from deeper zones in the Honaker Trail Formation. Concentrations of nitrate are detected at levels below the EPA MCL for nitrate. Ammonium is observed in concentrations less than 1.0 mg/l. Uranium concentrations are relatively low, with a maximum observed concentration of 0.048 mg/l. This is considerably less than concentrations observed in the tailings pore fluids, seeps SP-1 and SP-2, and Gypsum Creek seeps 922 and 924.

Upper Honaker Trail Formation

Background water quality was characterized by analyzing constituents listed in Table 8.1 of the TAD (DOE, 1989). For characterization purposes, background water quality of the Honaker Trail Formation can be characterized by describing an average concentration and a statistical maximum. The procedures for calculating average and statistical maximum concentrations are discussed in "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities-Interim Final Guidance" (EPA, 1989) and are described in the TAD. Average concentrations of hazardous constituents are represented statistically by a mean or median, depending on the proportion of nondetects and whether the distribution is normal or nonparametric. The statistical maximum may be represented as the 98 percent confidence maximum for normal or lognormal distributions or a nonparametric confidence interval if the distribution is neither normal

nor log normal. In some cases, it is not appropriate to use statistics and the maximum observed concentration is chosen as a "statistical maximum." In other cases, the statistical maximum may be the detection limit.

Background groundwater quality was established for the upper Honaker Trail Formation using water quality analyses for samples collected from wells 907, 908, 909, and 930. Samples from these wells are representative of background water quality in the Honaker Trail Formation because the monitor wells are properly completed, are separated from tailings seepage in the Halgaito Shale Formation by the interval of very low hydraulic conductivity at the base of the Halgaito Shale, and are hydraulically isolated by an upward hydraulic gradient between the Honaker Trail Formation and the Halgaito Shale Formation. A statistical analysis of background water quality in the Honaker Trail Formation that includes the minimum, mean, median, maximum, percentage of nondetects, the 99 percent confidence interval, and other important statistical parameters is provided in Table D.7.5.

Hazardous constituents with MCLs that exceeded the laboratory method detection limits in the Honaker Trail monitor wells include arsenic, cadmium, chromium, molybdenum, net gross alpha, nitrate, radium-226 and -228, selenium, silver, and uranium. Concentrations of elements included individually or as compounds that are listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that exceeded the laboratory method detection limits include aluminum, fluoride, nickel, strontium, vanadium, and zinc.

Maximum observed concentrations of six hazardous constituents equaled or exceeded proposed EPA MCLs in the Honaker Trail Formation groundwater. These constituents include arsenic, chromium, net gross alpha, radium-226 and -228, selenium, and uranium (Table D.7.5). The lower end of the 98 percent confidence interval for these constituents by monitor well was compared with the MCL. According to "Statistical Analyses of Groundwater Monitoring Data at RCRA Facilities - Interim Final Guidance" (EPA, 1989), if the lower end of the confidence interval exceeds the MCLs, there is statistical evidence of an exceedance of the MCLs. The lower end of the 98 percent confidence interval concentrations of these constituents do not exceed MCLs in the Honaker Trail Formation.

Major cation and anion chemical compositions of samples from monitor wells in the Honaker Trail Formation are plotted on a trilinear diagram on Figure D.7.11 and the Stiff diagrams in Figure D.7.14. The groundwater is classified as a sodium calcium sulfate type. Comparison of the Stiff diagrams indicates that the major element patterns are different for the groundwater from the two different formations. The dominant cations in the tailings pore water are calcium and magnesium. The calcium is from the San Juan feed water used in the milling process. The magnesium is from magnesium hydroxide, which was used to precipitate yellow cake from solution. The dominant cation in the Honaker Trail groundwater samples is Na^{+}, followed by Ca^{2+}, then lesser concentrations of Mg^{2+} (Figure D.7.14). This differs from Halgaito Shale groundwater, which is primarily tailings pore water, where Mg^{2+} is the dominant cation

and the Na^+ concentration is generally less than the Ca^{2+} concentration (Figure D.7.12). These major ion patterns prove very important in placing limits on the source waters for the Gypsum Creek seeps. The mean values of concentrations for both sulfate (2136 mg/l) and total dissolved solids (3467 mg/l) are naturally elevated. Groundwater within the Honaker Trail Formation is classified as brackish and unsuitable for domestic drinking water.

D.7.9 TAILINGS CHARACTERIZATION

Approximately 2.2 million tons of ore processed from 1957 to 1965 at the Mexican Hat site produced 5,700 tons of concentrate for an AEC contract. Much of the ore processed at the Mexican Hat mill contained large quantities of sulfides, some of which were consumed in a sulfuric acid plant at the site. Two separate piles occupied most of the site. The upper pile occupied approximately 25 acres and contained about 833,000 cy of tailings in thicknesses up to 40 feet. The lower pile contained about 1,623,000 cy of tailings on 43 acres with a maximum thickness of 55 feet. The surface of the upper pile was approximately 30 feet higher than that of the lower pile. As part of the remedial action undertaken, the upper and lower piles have been consolidated into one pile.

The physical properties of the existing tailings have been investigated by a number of geotechnical techniques, including grain-size distribution (sieve and hydrometer analysis), determination of Atterberg limits, natural moisture content, specific gravity, unit weight, hydraulic conductivity, and capillary moisture relationships (see Section D.5, Tailings Characteristics). In summary, the existing Mexican Hat tailings are composed of a mixture of sand, sand-slime, and slimes. The average saturated hydraulic conductivities of samples of these three materials were calculated from laboratory test data as 1.2×10^{-2} cm/s, 3.0×10^{-6} cm/s, and 1.7×10^{-6} cm/s, respectively.

The chemical characteristics of the Mexican Hat tailings were evaluated by pore water sampling with suction lysimeters. Four suction lysimeters were installed in the tailings piles by the DOE in 1990 and sampled in 1990 and 1991. Some lysimeters produced water too turbid to be field filtered. In these cases, unfiltered samples were analyzed and the results were reported as total concentrations. Stiff diagrams of cations and anions in lysimeter samples are shown in Figure D.7.15.

Tailings pore water quality statistics by parameter for these lysimeters are presented in Table D.7.6. Inorganic hazardous constituents with MCLs that exceed the laboratory method detection limits in tailings pore water are listed in this table. They include arsenic, barium, cadmium, chromium, lead, mercury, molybdenum, net gross alpha, nitrate, silver, and uranium. Radium-226 and -228 were not analyzed in tailings pore water. Based on analysis of tailings pore water from other UMTRA sites, radium-226 and -228 most likely exceeds the laboratory method detection limit in the Mexican Hat tailings pore water also. For characterization purposes, mean or median tailings pore water quality

data were compared to MCLs. Mean or median observed concentrations or activities of arsenic, cadmium, net gross alpha, and uranium in tailings pore water exceeded the MCLs, as shown in Table D.7.6.

Concentrations of elements listed individually or included in compounds that are listed in Appendix I of 40 CFR 192 or in Appendix IX of 40 CFR 264 that exceed the laboratory method detection limit include aluminum, ammonium, antimony, beryllium, cobalt, copper, fluoride, nickel, strontium, tin, vanadium, and zinc. The TDS concentrations range from 3540 to 6500 mg/l (Table D.7.6). The pH of tailings fluids ranges from 3.0 to 6.6. Tailings pore fluids are a magnesium and calcium sulfate type water, as shown on Figures D.7.11 and D.7.15. Nitrogen species and uranium are general indicators of tailings pore fluids. The mean ammonium concentration is 18.47 mg/l (range 7 to 94 mg/l). The median nitrate concentration is 1.3 mg/l (range 0.22 to 6.5 mg/l). The mean concentration of uranium from the four lysimeters is 0.53 mg/l (range 0.0005 to 1.53 mg/l) (Table D.7.6).

D.7.10 EXTENT OF EXISTING CONTAMINATION

Tailings seepage related to milling operations created a condition of saturation within the Halgaito Shale Formation. As described in Section D.7.8, the existing water quality is defined as baseline water quality for the Halgaito Shale Formation. Therefore, no contamination of native groundwater has occurred within the Halgaito Shale Formation. However, water in the Halgaito Shale Formation exceeds the EPA MCLs for several constituents, including chromium, molybdenum, net gross alpha, nitrate, and uranium.

Contamination due to tailings seepage has not been detected within the Honaker Trail Formation or the San Juan River. Contamination due to tailings seepage has only been found in the Halgaito Shale Formation in the vicinity of the existing Mexican Hat tailings piles.

D.7.11 GEOCHEMICAL CONDITIONS

At the Mexican Hat site, potential evaporation exceeds 80 inches per year, while the annual rainfall is only six inches. Therefore, it is expected that there is little ongoing recharge to the piles, and the current seepage rate from the piles is very low. The majority of the contamination present in the soil and groundwater is due to drainage from the piles during active milling (1957 to 1965), when large amounts of water were used to pump the slurried tailings onto the piles.

The Mexican Hat tailings are situated on outcrops of the Halgaito Shale Formation of the Cutler Group, which overlies the Honaker Trail Formation. These units are up to 180 feet thick in this area and the Halgaito Shale Formation is generally unsaturated (FBDU, 1981). The primary geochemical process affecting contaminants in seepage from mill tailings piles is neutralization of the acidic solution by reaction with carbonate minerals in the underlying sediment. This neutralization

causes precipitation of some contaminants. The concentrations of these contaminants in groundwater decrease as they precipitate or are adsorbed onto the surface of aquifer matrix minerals. These geochemical processes remove most radionuclides (radium and thorium) and metals (aluminum, iron, manganese, chromium, zinc, cadmium, and copper). In general, arsenic, uranium, selenium, and molybdenum remain in solution because they form relatively mobile anionic species in the oxidizing, alkaline environments characteristic of the sediment. As a result of the adsorption and precipitation processes, the rate of movement of these elements through the aquifer or soil may be retarded compared to that of the average linear velocity of groundwater.

The concentrations of major cations (calcium, magnesium, sodium, and potassium) moving through the subpile sediments will be affected by ion exchange between the water and mineral surfaces. Because one ion in solution is exchanged for another, the TDS level may not be significantly affected by ion exchange.

Two contaminated wells (911 and 912 completed directly beneath the tailings pile) provide a good indication of which contaminants are carried by the seepage from the piles. The water chemistry data for samples collected from below the tailings piles show that chromium, molybdenum, nitrate, uranium, and radionuclides that result in net gross alpha activity are moving through the Halgaito Shale Formation. The driving force moving fluids through the Halgaito Shale Formation is gravity drainage, and the source of water has been limited. There is no reason to believe that flow will continue indefinitely. Once the tailings seepage has dispersed to the point where surface tension dominates, flow will cease and vapor diffusion will allow the Halgaito Shale Formation to dry to natural conditions. There is no way to estimate the time required for this drying, but when this process is complete, the dissolved components will be left in the intergranular void spaces within the Halgaito Shale Formation.

Chemical analyses of soil samples taken beneath the tailings piles define the distribution of the contaminants beneath the pile (Shepard and Brown, 1983). Soil pH values show that the acid front extends no further than 4.5 feet beneath the pile into the underlying sediment. In this chemically affected zone, iron, aluminum, calcium, magnesium, and sulfate concentrations are higher than in sediment below this zone. Iron and aluminum have probably been precipitated as oxyhydroxides or hydroxysulfate minerals, and gypsum precipitates from calcium and sulfate. The relatively high solubility of gypsum allows the large amount of sulfate in the water samples from the wells beneath the piles. Magnesium may coprecipitate as a component within the newly formed minerals. The radium-226 concentration was shown to decrease with migration into bedrock from approximately 300 picocuries per gram (pCi/g) to less than 5 pCi/g within a three-foot interval beneath the tailings-bedrock interface (FBDU, 1981; ORNL, 1980). Radium is probably incorporated into the gypsum formed in this neutralization zone. In summary, it appears (from soil chemical analyses at the Mexican Hat site) that some of the potential groundwater contaminants are immobilized in the neutralization zone beneath the tailings piles.

D.7.12 CHARACTERIZATION AND ORIGIN OF SEEP WATER

During initial site characterization, surface water was not reported in an arroyo just to the north of the Mexican Hat tailings piles (North Arroyo). However, in December 1989, after the start of remedial activities, seeps were observed in the North Arroyo. The RAC set up a program to characterize and monitor the seeps (MK-ES, 1990). In March 1990, two other seeps previously unreported were observed, one in a tributary to the North Arroyo and one in Gypsum Creek. A program was developed to characterize and monitor these seeps as well as all seeps in the site vicinity, and to determine their sources, if possible.

D.7.12.1 Seep locations

The Mexican Hat site is drained by several well-entrenched arroyos. The largest of these, Gypsum Creek, is approximately one-half mile east of the tailings pile. This wash drains north into the San Juan River. Another arroyo, north of the tailings pile, drains the Mexican Hat site. This arroyo, identified as the North Arroyo, generally courses to the northeast and joins Gypsum Creek about 4000 feet northeast of the lower tailings pile. The locations of the major arroyos around the Mexican Hat site are shown in Figure D.7.2.

Several seeps have been identified in the vicinity of the Mexican Hat site. These seeps are located either along the North Arroyo and Gypsum Creek or in minor tributaries to these drainages. Seep locations are also shown on Figure D.7.2.

North Arroyo seeps

Three seeps are located along the North Arroyo or its tributary, Gully No. 2. A brief description of the seeps follows.

Seep SP-1 (water quality ID 251), which at this time has stopped flowing, is on the south bank of the North Arroyo. It is approximately 400 to 500 feet north of the lower tailings pile, subparallel to the geologic strike of the bedding. Individual seeps occurred along a 200-foot length, and several test pits were excavated to characterize the seeps (MK-ES, 1990). This seep (also identified as the French Drain Seep) is emanating from above a soft marl layer in the Halgaito Shale Formation just above the arroyo bottom.

Seep SP-2 (water quality ID 249) is at the base of the southeast bank of Gully No. 2, approximately 800 feet northeast of the toe of the lower tailings pile and on

strike of the bedding. It is approximately 100 feet upslope from its confluence with the North Arroyo and the retention dam containing contaminated surface runoff (Figure D.7.2). Water is emanating from small fractures in a thin rock layer in the Halgaito Shale Formation just above the gully bottom. The face of this seep is about 15 feet long.

Seep SP-3 (water quality ID 255) is in the North Arroyo downslope from the retention basin embankment, approximately 1300 feet north of the lower tailings pile. Water is ponding from the seep from the Halgaito Shale Formation in the bottom of the arroyo and from surface runoff, which is retained by the embankment.

Gypsum Creek seeps

Along Gypsum Creek, six seeps have been identified. A brief description of these seeps follows.

Seep 922 is in the floor of Gypsum Creek, about 2000 feet upslope from the confluence with the North Arroyo. The seep is approximately 2200 feet east of the disposal cell. During spring months, discharging water has been observed jetting up from the sandy floor of Gypsum Creek through fractures in the bedrock (DOE, 1989).

Seep 923 is in the floor of Gypsum Creek, approximately 3100 feet upslope from the confluence with the North Arroyo. The seep is approximately 2400 feet east by southeast of the lower tailings pile. Discharging water has also been observed jetting up from the floor of Gypsum Creek during the spring.

Seep 924 is in the floor of Gypsum Creek, just below the confluence with the North Arroyo. The seep is about 500 feet upstream from the confluence of Gypsum Creek and the San Juan River, and approximately 3500 feet north and downslope of the lower tailings pile. The seep is located subparallel (north 45 degrees east) to the bedding strike.

Seep GS-1 (water quality ID 248) is on the west wall of Gypsum Creek, approximately 2200 feet northeast of the toe of the lower tailings pile. The seep emanates from a soft marl layer 15 to 20 feet above the floor of Gypsum Creek and extends for about 200 feet along the west wall of the wash. The direction of the seep from the disposal cell is subparallel to the geologic dip of the bedding. Sets of high-angle (nearly vertical) fractures with general strikes of north 85 degrees west occur at two- to three-foot spacings within the vicinity of the seep

and the site. The apparent dip of the bedding in this direction is approximately the same as the true dip (four degrees).

Seep GS-2 (water quality ID 261) is on the east wall of Gypsum Creek, approximately 3000 feet east by southeast from the tailings pile. The seep is emanating from a soft rock layer just above the creek floor and is approximately 100 feet long.

Seep GS-3 (water quality ID 254) is in an arroyo that drains into Gypsum Creek from the south. The gully forms south of the tailings pile (Figure D.7.2). The seep originates between two rock strata and is about 10 inches in length. However, the efflorescence indicates that the seep previously occurred over 100 feet in length.

In addition to the observed seeps, there are numerous surface expressions in the form of heavy vegetation or evaporites along distinct rock strata on both sides of the Gypsum Creek. Groundwater also discharges to a spring in Halgaito Wash, as noted on the U.S. Geological Survey map (Bluff 3 SW, 7.5 Minute Quad.) (USGS, 1963). The USGS has mapped the spring in the Halgaito Shale Formation close to the contact between the Halgaito Shale and the Honaker Trail. The DOE and TAC located an outcrop of Honaker Trail fossiliferous limestone approximately 1000 feet down wash from the spring. However, it is not known whether this water is derived from the Halgaito Shale Formation or discharges upward through fractures connected to the Honaker Trail Formation, which has an artesian head.

D.7.12.2 Seep identification and monitoring

The seeps that have been identified in the vicinity of the Mexican Hat disposal cell have been reported and sampled by various researchers (DOE, 1990). Surface expressions of near-surface water (heavy vegetation) can also be identified in aerial photographs that have been taken at various times in the past. In response to seepage observed during remedial activities in December 1989, a more thorough investigation of the occurrence of surface water in the site vicinity was initiated. This has been a combined effort by the TAC and the RAC. The following is a description of the reporting and monitoring of the seeps that have been performed to date.

North Arroyo seeps

Seep SP-1 (251). This seep was first noticed in December 1989; a French drain was installed in February 1990 to collect water samples and measure flow rates (MK-ES,

1990). Earlier evidence of the occurrence of near-surface water in this location is the presence of vegetation, noted in aerial photographs taken as early as 1974. The flow rate of the seep was first measured at 0.07 gpm; the flow subsequently decreased and stopped flowing in May 1990 (DOE, 1990). The seep resumed flow in 1991 at about the same time of year as first noticed, but subsequently stopped in June 1991.

Seep SP-2 (249). A spring in the area of this seep was documented and sampled by Snelling in 1968 (Snelling, 1971). No other observations were recorded prior to remedial activities. During the remedial action, this area was covered by the water ponded by the retention dam. In October 1987 when the retention basin was pumped dry, seepage water was noticed at the present location. Flow rates were measured in 1990 and 1991; initially, they were approximately 0.5 gpm and by mid-July 1990 had decreased to about 0.35 gpm (DOE, 1990). By August 1991, flow had decreased to 0.1 gpm. Currently, the seep is under water from the retention basin.

Seep SP-3 (255). Two different researchers sampled water from a pond at this location as early as March 1976. A seep at this location has been observed from 1988 through August 1990 (DOE, 1990). Heavy vegetation in this area also appears in aerial photographs taken in 1976 and 1980. No flow rates have been taken.

The seasonal variations in flow rates indicate that the seeps are naturally occurring.

Gypsum Creek seeps

Seeps 922 and 923. These seeps were first documented and sampled in 1980; they were subsequently sampled and included in the site characterization efforts performed by the TAC starting in 1985 (DOE, 1990). No flow rates have been measured.

Seep 924. Seepage in Gypsum Creek in the vicinity of seep 924 was first documented and sampled in 1971. A seep in this location was sampled in 1976 and 1980 and was included in the TAC characterization efforts starting in 1985 (DOE, 1990). No flow rates have been measured.

Seep GS-1 (248). This seep was first reported in February 1990. However, an eyewitness has stated that this seep, the GS-2 seep, and three other seeps in Gypsum Creek (presumably seeps 922, 923, and 924) have existed since the 1930s (DOE, 1990). Flow rates have been

measured since June 1990 and appear to be stable at approximately 0.2 gpm.

Seep GS-2 (261). This seep was first reported in April 1989; however, as stated above, the existence of this seep on the opposite side of the wash from the disposal site has been reported since the 1930s (DOE, 1990). No flow rate measurements have been made.

Seep GS-3 (254). This seep was first observed during a field investigation conducted in July 1990. An initial flow rate measurement was 0.004 gpm.

D.7.12.3 Seep water quality characterization

Since the identification of the seeps in the vicinity of the Mexican Hat site during December 1989, several series of samples have been collected for geochemical analyses. In addition, lysimeters and monitor wells were installed in the disposal cell. These have provided both individual and composite samples of the tailings pore fluids. In April 1990, the redox couples of iron and nitrogen were measured along with dissolved oxygen and the redox potential. At this time, samples of the water from the tailings embankment and all of the seeps were collected for hydrogen/deuterium (H/D) and oxygen-18/oxygen-16 (O-18/O-16) analyses. Samples of the solid sulfate mineral efflorescence and sulfate that precipitated from the seeps and tailings pore fluids were collected for sulfur-34/sulfur-32 (S-34/S-32) and oxygen-18/oxygen-16 (O-18/O-16) analyses. During the summer of 1988, several of the seeps in Gypsum Creek and monitor wells in the vicinity of the site were sampled for water quality and H/D, O-18/O-16, and S-34/S-32 analyses.

General chemistry

Five basic water quality groups have been defined by analysis of water samples at the Mexican Hat site. On a trilinear diagram (Figure D.7.11) and on Stiff diagrams (Figures D.7.12 through D.7.17), the analyses plot as discernible groups:

- San Juan River samples 938 and 939 are mixed sulfate type.
- Lysimeter samples 241, 242, 243, and 244 are a calcium sulfate type.
- Monitor wells 911, 912, North Arroyo seeps SP-1, SP-2, and SP-3, and Gypsum Creek seep 254 are a mixed sulfate type with magnesium as the dominant cation.

- Honaker Trail Formation background wells 907, 908, 908, and 930, and Gypsum Creek seeps 922, 923, 924, and 248 are a mixed sulfate type with a higher proportion of sodium and potassium.

- Analyses of samples from monitor well 934 plot as a sodium chloride type water that is distinct from all other samples.

Based on water quality type, it appears that perched groundwater beneath the tailings (Figure D.7.12) is similar in water quality type to that which discharges from the North Arroyo seeps (Figure D.7.16).

A comparison of the TDS of the different water quality type groups (Tables D.7.3 through D.7.8) indicates that the tailings lysimeter water, North Arroyo seep water, Halgaito Shale groundwater downgradient of the tailings, and Gypsum Creek water are similar in TDS. The Honaker Trail groundwater, however, has an average TDS of approximately 1500 mg/l lower than the above groups.

The water quality type of the Gypsum Creek seeps is similar to the background water quality type in the Honaker Trail Formation based on cation trends in Stiff diagrams (Figure D.7.14 and D.7.17). One exception to this relationship is seen in the Stiff diagrams of water from seep 254. The cation proportions in this seep resemble those seen in the Halgaito Shale monitor wells and in the North Arroyo seeps, indicating that a significant component of tailings pore water contributes to seep 254 discharge.

Hazardous constituents

Constituents that appear to be indicators of water contamination resulting from uranium processing activities at the Mexican Hat site are uranium and species of nitrogen including ammonium and nitrate. Although background groundwaters also contain these constituents, the concentrations are significantly higher in contaminated waters.

All the seeps in the site area except 923 and 261 have uranium concentrations that exceed the MCL. Seeps in the bottom of Gypsum Creek and seep 251 in the North Arroyo all exceed the MCL by about an order of magnitude. Seeps on the west side of Gypsum Creek (GS-1 and GS-3; 248 and 254, respectively) and seeps SP-2 (249) and SP-3 (255) in the North Arroyo have uranium concentrations that are 10 to 20 times the MCL (Tables D.7.7 and D.7.8).

Three of the site vicinity seeps that have uranium concentrations similar to background groundwater in the Honaker Trail Formation are GS-2 (261) and 923 in Gypsum Creek and the Halgaito Wash spring (256). Concentrations of uranium

in GS-2 (261) ranged from 0.014 to 0.046 mg/l (Table D.7.8). Recent sampling of Halgaito Wash spring, approximately two miles southwest of the site, showed uranium concentrations of 0.017 mg/l. Concentrations in Gypsum Creek seep 923 were detected at 0.021 and 0.020 mg/l in two sampling rounds. All three of these seeps discharge water with uranium concentrations below the EPA MCL.

Waters contaminated by uranium milling processes at the Mexican Hat site generally have high nitrate and/or ammonium concentrations. The ammonium concentrations in tailings pore fluids (7 to 94 mg/l) are generally higher than the nitrate concentrations (0.22 to 6.5 mg/l). Once these fluids leave the pile they become more oxidized, leading to higher nitrate concentrations. Waters sampled below the pile in well 912 have nitrate/ammonium ratios of 5:6 by weight. The seep directly downgradient from the toe ditch of the disposal cell has similar nitrate/ammonium ratios. Seeps that are farther from the cell have very little ammonium but significant concentrations of nitrate. The highest nitrate concentrations occur in seep GS-3 (254) in the South Side Arroyo, with concentrations up to 1000 mg/l (Table D.7.7). Seeps in the North Arroyo show nitrate concentrations in the range of 100 to 400 mg/l. The seeps in the bottom of Gypsum Creek generally have nitrate concentrations below the MCL except for one-time exceedances in seep 922 (338 mg/l) and 253 (36.7 mg/l) (Table D.7.8). Overall, these data lead to the conclusion that the seeps in the North and South Arroyos clearly show nitrate contamination from the site, while the Gypsum Creek seeps only occasionally show evidence of nitrate contamination.

Of the other hazardous constituents with MCLs, silver, arsenic, cadmium, mercury, and lead show concentrations that are below the respective MCLs in all seeps. There was only one exceedance for chromium (in seep 922). Molybdenum shows concentrations above the MCL in three seeps (SP-1, 924, and 253). All of these seeps are on the northern boundary of the site area. The concentrations in SP-1 (251) range up to 0.45 mg/l, but they are less than 0.20 mg/l in the other seeps. The MCL for selenium is exceeded in most of the seep waters, including those that represent background waters. However, in only one seep are the exceedances outside the range observed in background groundwaters (e.g., well 909). In this seep (GS-1; 248), exceedances are up to 32 times the MCL. Whether these exceedances are due to natural variations in the background concentrations or due to milling operations is uncertain. The MCL for radium-226 and -228 was exceeded only once in seeps GS-3 (254), GS-2 (261), and 923. The measured activities exceeded the MCL by less than a factor of two. The MCL for net gross alpha is exceeded in most of the seeps, except 923 and 261 in Gypsum Creek in the southeastern portion of the site area.

Stable isotopes

Sulfur and oxygen isotope data for sulfate minerals and dissolved sulfate in seeps, selected monitor wells and tailings pore fluids are presented in Table D.7.9. The bedded gypsum within the Halgaito Shale and dissolved sulfate in monitor well 930, completed in the Honaker Trail Formation, are significantly heavier in isotopic ratios than the other samples. A sample of efflorescence on the canyon wall was collected from below the bedded gypsum. This sample is isotopically lighter (3 per mil) than the bedded material about four feet higher in the section. The isotopically lightest gypsum came from fracture fillings in a very short-lived Gypsum Creek dry seep (262) in the west wall of Gypsum Creek. The dry seep appears to be in alignment with the disposal cell along the major fracture set. The solid sample collected from seep GS-1 (248) lies between the relatively light isotopic ratios of dissolved sulfate and the heavier isotopic ratios of bedded gypsum in the wall of Gypsum Creek.

The dissolved sulfate in tailings pore fluids collected from the lysimeters have oxygen isotopic ratios that are lighter than the isotopic ratios obtained from analyses of gypsum salts and efflorescence along Gypsum Creek and dissolved sulfates in monitor well 930. The lysimeter samples and samples from monitor well 912 (completed in the Halgaito Shale beneath the tailings) show sulfur isotope ratios in relatively wide range (five to eight per mil). The San Juan River water is the isotopically lightest in sulfur of all of the samples. It is quite possible that bacterial activity has preferentially removed some of the light isotopic sulfur from the tailings pore fluids. Bacteria prefer to consume S-32 over the heavier S-34. As stated previously, the isotopically heaviest dissolved sulfate sulfur (15.1 per mil) came from monitor well 930, which is considered background for the Honaker Trail Formation.

In summary, the samples from the lysimeters, monitor well 912, and the nearby north arroyo seeps are isotopically lighter than samples from the Gypsum Creek seeps. This provides evidence that the Halgaito Shale Formation groundwater beneath the tailings and the North Arroyo seep discharges are contaminated with tailings pore water. The Gypsum Creek seeps form a sample population (9.9 per mil < $S^{34}S$ < 10.5 per mil) that lies between the Honaker Trail groundwater ($S^{34}S$ = 15.1 per mil) and the tailings pore water ($S^{34}S$ in the range of 5.5 to 8.1 per mil). This provides evidence of mixing of the two waters.

Hydrogen and oxygen isotope data for selected water samples in the vicinity of the Mexican Hat tailings are presented in Table D.7.10. All of the samples collected, including San Juan River water, lysimeter pore fluids, and seep water, plot very close to the meteoric water line on a

delta deuterium (D) versus delta 0-18 graph. This confirms that the isotopes have not been influenced by geochemical processes that would cause an enrichment of the isotopic ratios of hydrogen relative to oxygen.

D.7.12.4 Potential sources of seep water

Water emanating from the seeps in the vicinity of the Mexican Hat disposal cell could potentially be: 1) from naturally occurring discharge; 2) from the milling operations; 3) construction-related from the remedial action; or 4) a combination of the above. Because of the widespread occurrence of the identified seeps in the area, there is probably not just one source for all seeps.

Seeps and springs in arid environments, especially where the land surface is incised by canyons or washes, are natural responses to the local geologic, climatic, and hydrologic conditions. Examples are provided by the spring in Halgaito Wash, the GS-2 seep, and the long-term existence of seeps in Gypsum Creek, as reported by area residents. These seeps may be ephemeral or perennial, depending on the specific conditions. Detailed characterization and long-term monitoring would be required to determine the controlling conditions.

As described in Section D.7.12.3, the seeps in Gypsum Creek have similar major cation and anion proportions to those observed in background Honaker Trail Formation monitor wells. Also, the potentiometric surface of the Honaker Trail is higher in elevation than the floor of Gypsum Creek (see Section D.7.7). Because of the upward gradient of the confined groundwater in the Honaker Trail Formation, there is the potential for discharge where fractures occur in the overlying confining layers and the land surface has been incised. However, native Halgaito Shale background groundwater (if it exists) has not been sampled, and comparisons between this water and Gypsum Creek seep water have not been made. Therefore, groundwater from the Honaker Trail Formation or background groundwater from the Halgaito Shale Formation most likely provides the greatest contribution to seep discharges in Gypsum Creek. Seep GS-3 (254) is an exception, however. Water from this seep resembles North Arroyo seep water in major cation and anion proportions, nitrate concentrations, and uranium concentrations. Therefore, milling operations-related water most likely provides the greatest contribution to discharges from this seep.

A considerable amount of water was used at the processing site during the milling operations from 1957 to 1965. To slurry the 2.2 million tons of tailings materials and form the two piles, approximately 14 million cubic yards (8,640 acre-feet) of water were used (DOE, 1990). After the milling

operations stopped, both the upper and lower piles continued to pond water periodically from precipitation and surface runoff; this would add to the amount of water that could infiltrate into the bedrock. As stated previously, perched groundwater was found in the Halgaito Shale beneath the site, which was the result of the milling operations.

During the second phase of the remedial action, an estimated 154 acre-feet of water was pumped from the San Juan River for use in construction. Most of this water was used for dust control or haul road construction. The pan evaporation for the Mexican Hat area is estimated to be about 85 inches per year (DOE, 1990). Because of this high evaporation rate, very little water used for dust control at the site should have contributed to deep infiltration. However, the estimated annual infiltration rate over contaminated areas is 10 acre-feet per year (DOE, 1990).

The most significant contribution of water to deep infiltration from remedial action activities at the site would be from consolidation of the disposal cell and pond leakage. Based on the settlement contours of consolidation (DOE, 1990), it is estimated that approximately five acre-feet of water have infiltrated into the underlying bedrock. Water loss due to pond leakage was estimated to be 24 acre-feet (DOE, 1990). Not all leakage water contributed to deep infiltration. A component of this pond leakage water exits the Halgaito Shale via the North Arroyo seeps (DOE, 1990).

In summary, the total potential contribution of water to the Halgaito Shale from remedial action is approximately two percent of that estimated potential contribution from milling operations. Therefore, the majority of the discharge observed from the North Arroyo seeps is most likely related to milling operations.

D.7.12.5 Interpretations and conclusions

Remedial action construction activities at the Mexican Hat site have contributed a maximum of two percent of the water to deep percolation as compared to the milling operations (approximately 150 acre-feet versus about 8,500 acre-feet used as slurry water during milling).

Significant amounts of water drained from the tailings piles during and after milling operations. This created a limited body of perched groundwater in the Halgaito Shale beneath the site. Potential movement of this groundwater would be downdip (east-southeast direction) and/or along fractures (east-northeast direction).

The elevated concentrations of uranium in Gypsum Creek seeps GS-1 (248), GS-3 (254), 922, SN-2 (253), and 924 are most likely related to uranium milling operations at the Mexican Hat site. Water derived from uranium milling has probably moved downdip or along fractures and mixed with native groundwater to produce the chemical composition of water observed in these seeps. Seep GS-2 (261) and 923 do not have discharges related to uranium milling operations. The water chemistry of the perched groundwater in the Halgaito Shale is similar to the water chemistry of the North Arroyo seeps, although the seeps are slightly lower in TDS.

The component of flow to the seeps in the North Arroyo and to seep GS-3 (254) in Gypsum Creek that has been caused by remedial activities at the site should continue to decrease. The site has been regraded to promote surface runoff, the construction ponds were relined, and approximately 90 percent of the estimated settlement of the disposal cell has occurred. Excess pore pressures that were generated in the saturated tailings in the lower pile when the relocated contaminated materials were placed during construction will dissipate as the tailings consolidate. Placement of Monument Valley materials on the disposal cell will generate approximately one-half the amount of consolidation water as previous construction.

D.7.13 GROUNDWATER USE, VALUE, AND ALTERNATIVE WATER SUPPLIES

A well inventory was conducted within a two-mile radius of the Mexican Hat site. It was determined there is no recorded use of groundwater in the Mexican Hat area. Process water for milling operations was obtained from the San Juan River. A search of the Navajo Tribal Utility Authority (NTUA) records produced no evidence of any producing water wells in the area (Little, 1985). A long-time local resident of the community of Halchita reported that the area had been drilled in attempts to develop groundwater resources, but "potable water was not found" (Denny, 1985).

Domestic water for the community of Halchita is supplied by a treatment facility located on the south bank of the San Juan River near the crossing of U.S. Highway 163. This facility treats approximately 59,000 gallons of water per day for Halchita domestic use. Prior to construction of the present water supply system, the local residents obtained their water from windmills or wells located in Monument Valley, Arizona, or Bluff, Utah, or directly out of the San Juan River (Denny, 1985).

Domestic water for the community of Mexican Hat is supplied by a converted oil exploration well beneath the community and the San Juan River. The water is not treated (Ball, 1985; May, 1985). No other information is available for this water supply; however, it is believed that the water is withdrawn from strata recharged directly by the San Juan River.

The value of groundwater in the vicinity of the tailings site may be approximated by the value of alternate water supplies in the area, although the actual value is probably less because of the poor quality and limited amount of groundwater in the area. A rate schedule for the delivery of water to Halchita is shown in Table D.7.11.

The tailings have not affected any groundwater that is currently being used. Should the affected groundwater be considered unfit for use, there are potential alternate water supplies. Alternate water supplies in the potentially affected hydrogeologic setting would include:

- San Juan River water as currently supplied by the NTUA. The current Utah water right potentially provides Halchita, in perpetuity, with water from the San Juan River.

- Commercial water supply (i.e., delivery by tanker).

D.7.14 SUMMARY - MONUMENT VALLEY TAILINGS SITE

- The major hydrostratigraphic units underlying the Monument Valley tailings site, in descending order, are alluvium and dune sand, the Shinarump Member of the Chinle Formation, the Moenkopi Formation, and the DeChelly Sandstone. The alluvium and dune sand are fine-grained, unconsolidated deposits more than 80 feet thick in the center of Cane Valley, which feather out at the valley edges. The Shinarump Member outcrops west of the tailings site, dips to the east, and underlies the dune sand and alluvium below the lower tailings pile. The Shinarump Member consists of lenticular, cross-bedded units of sandstone, conglomerate, and mudstone, and ranges from 25 to 90 feet thick in the site vicinity. The Moenkopi Formation underlies the Shinarump Member and consists of shaley siltstone and sandstone. The Moenkopi Formation is 50 to 60 feet thick in most of the site area; however, only about 20 feet of the Moenkopi Formation occurs beneath the upper tailings pile. The DeChelly Sandstone is a cross-bedded, fine-grained sandstone and is approximately 550 feet thick below the site (Witkind and Thaden, 1963).

- Groundwater within the alluvial aquifer is unconfined. Depths to groundwater range from a few feet near Cane Valley Wash to slightly more than 10 feet below the lower tailings pile. This unconfined groundwater is recharged by the spring-fed pond northeast of the site and by occasional flows in Cane Valley Wash. Alluvial groundwater in the site vicinity flows to the north under an average hydraulic gradient of 0.01, and discharges as underflow or to seeps in northern Cane Valley. Using the observed range of hydraulic conductivities and an assumed effective porosity of 0.25, the average linear groundwater velocity ranges from five to 300 ft/year.

- Groundwater within the Shinarump Member is confined, probably by the mudstones found within this unit. This confined groundwater flows northward from recharge areas in the south, under an average hydraulic gradient of 0.01, and probably discharges to the alluvium

in northern Cane Valley. Using the observed range of hydraulic conductivities and an assumed effective porosity of 0.10, the linear groundwater velocity ranges from 15 to 290 ft/year.

- Groundwater within the DeChelly Sandstone is confined by the overlying Moenkopi Formation. This confined groundwater flows northward from recharge areas in the south, under an average hydraulic gradient of 0.01, and discharges to areas north of Cane Valley. Using the observed range of hydraulic conductivities and an assumed effective porosity of 0.10, the linear groundwater velocity ranges from 0.8 to 120 ft/year.

- An upward vertical hydraulic gradient exists between the Shinarump Member and the overlying alluvium and dune sand, and between the DeChelly Sandstone and the overlying units. Some wells completed within the DeChelly Sandstone flow at the surface in the area of the Monument Valley tailings site.

- The maximum observed concentration of molybdenum exceeded the EPA MCL in the background alluvium groundwater. However, there is no statistical evidence of an MCL exceedance for any hazardous constituent in the alluvium background groundwater. In the Shinarump background groundwater, maximum observed concentrations or activities of molybdenum, net gross alpha, and radium-226 and -228 exceeded EPA MCLs. However, there is no statistical evidence of an MCL exceedance for any hazardous constituent in the Shinarump Member background groundwater. In the DeChelly background groundwater, the maximum observed concentration of molybdenum exceeded EPA MCLs. However, there is no statistical evidence of an MCL exceedance for any hazardous constituent in the DeChelly background groundwater.

- The tailings at the Monument Valley site are much more sandy and contain fewer slimes than those at Mexican Hat. There are approximately 1,900,000 cy of contaminated material at the Monument Valley site that produces an acidic, oxidizing leachate. Concentrations or activities of barium, chromium, molybdenum, nitrate, radium-226, and uranium exceeded laboratory method detection limits in tailings pore water. It is assumed that activities of net gross alpha and radium-228 also exceed laboratory method detection limits. Mean or geometric mean observed concentrations of molybdenum, nitrate, and radium-226 exceeded their MCLs in the tailings pore water. The mean or median concentrations of aluminum, ammonium, cobalt, copper, fluoride, nickel, strontium, and zinc exceeded the statistical maximum of background groundwater in the alluvium, and are therefore potential groundwater contaminants also.

- Maximum observed concentrations or activities of cadmium, chromium, molybdenum, net gross alpha, nitrate, radium-226 and -228, and selenium equaled or exceeded MCLs in the alluvial groundwater downgradient of the tailings area. The lower end of the statistical confidence interval does not exceed the MCLs for any of these constituents except nitrate in any alluvial monitor well; therefore, there is no statistically significant evidence that they are

groundwater contaminants at the site. However, because the lower end of the 98 percent confidence interval exceeds the MCL of nitrate in downgradient monitor wells 606 and 655, there is statistical evidence that groundwater from these monitor wells exceeds the MCL. Nitrate in the alluvium, related to the milling process, forms a plume that extends to approximately 3000 feet north of the mill site. Within the plume, nitrate concentrations range from a high of over 1000 mg/l in the central portion to below the MCL for nitrate on the fringe. Even though the plume has moved a distance downgradient, there has been no substantial plume migration laterally to the east due to recharge to the alluvium from a spring-fed pond northeast of the site.

- In the Shinarump downgradient groundwater, maximum observed concentrations or activities of molybdenum, net gross alpha, and radium-226 and -228 exceeded the MCLs. However, the lower end of the confidence interval does not exceed the MCLs for these constituents in any Shinarump Conglomerate monitor well; therefore, there is no statistically significant evidence that they are groundwater contaminants that exceed the MCLs.

- In the DeChelly downgradient groundwater, maximum observed concentrations or activities of chromium, molybdenum, net gross alpha, and uranium exceeded the MCLs. However, the lower end of the confidence interval does not exceed the MCLs for these constituents in any DeChelly monitor well; therefore, there is no statistically significant evidence that they are groundwater contaminants that exceed the MCLs.

- The surface remediation of the Monument Valley tailings site will result in the removal of the source of groundwater contamination and will not create additional groundwater contamination. No residences or domestic wells are located downgradient of the nitrate plume. Therefore, remediation of the nitrate groundwater contamination will be addressed under a separate process under the UMTRA Phase II groundwater program.

D.7.15 PREVIOUS INVESTIGATIONS AT THE MONUMENT VALLEY SITE

Several investigations have been conducted on the geology and hydrogeology of the Monument Valley tailings site area for the DOE (Fuhriman and Hintze, 1976; FBDU, 1983; GECR, 1983). These studies include stratigraphic and geomorphic reconnaissance-level surveys, surface and subsurface radioactivity surveys, and preliminary surface-water and groundwater quality investigations.

Hydrogeologic field data, including lithologic, groundwater level, aquifer property, and water-quality data, were collected by the TAC in 1985 and 1986. During this period, 15 two-inch PVC monitor wells and 17 four-inch PVC monitor wells were installed in the site vicinity. Monitor well locations are shown in Figure D.7.18. Monitor well completion information is listed in Table D.7.12.

Following completion of the monitor wells, well locations and elevations were surveyed and groundwater levels were measured to determine hydraulic gradients and groundwater flow directions. Groundwater quality data have been collected by the DOE annually or semi-annually since 1985 (except 1987) from selected monitor wells. Slug withdrawal tests and one aquifer test were performed to estimate hydraulic conductivity values near the site. Tensiometer and lysimeter nests were installed in the tailings area to obtain seepage rate and tailings pore water quality data. The results of these investigations were summarized in the Monument Valley Environmental Assessment (DOE, 1988a).

D.7.16 GEOLOGY AND HYDROSTRATIGRAPHY

The Monument Valley tailings site is in the northern part of the Navajo Section of the Colorado Plateau, approximately 15 miles south of the Mexican Hat site (Figure D.7.19). The tailings site is located in Cane Valley, a northward draining strike valley eroded into the Chinle Formation bordered by Comb Ridge to the east. The bedrock formations dip eastward about 400 feet per mile.

The geologic rock units are composed of the following units, from youngest to oldest: 1) surficial deposits of alluvium; 2) Shinarump Conglomerate Member of the Chinle Formation; 3) Moenkopi Formation; and 4) DeChelly Sandstone Member of the Cutler Formation.

The two tailings piles at the site are either on Shinarump Conglomerate or alluvium, as shown on the west-to-east cross section (Figures D.7.18 and D.7.20). The alluvium is primarily sand, with a minor amount of gravel. Fine-grained silty sands derived locally from sandstone bedrock occur in erosional channels. The thickness is about 55 feet. The Shinarump Member consists of a heterogeneous combination of conglomerate, sandstone, and mudstone beds, but locally conglomerate predominates. The thickness of the Shinarump is about 85 feet. The upper part of the Moenkopi Formation consists of a shaley siltstone and sandstone unit that behaves as an aquitard between the Shinarump Conglomerate and the DeChelly Sandstone Member. The basal member of the Moenkopi Formation consists of massive sandstone underlain by siltstone and sandstone beds.

The DeChelly Sandstone Member unconformably underlies the Moenkopi Formation. It consists of massive, fine-grained sandstone. It ranges in thickness from 300 to 500 feet, but thins to the north. It is the lowest aquifer beneath the Monument Valley tailings site.

D.7.17 PRESENCE AND MOVEMENT OF GROUNDWATER

Alluvial aquifer

Groundwater within the alluvial aquifer is unconfined. Depths to groundwater range from over three feet near Cane Valley Wash to slightly more than 10 feet below the lower tailings pile. This unconfined

groundwater is recharged by upgradient underflow and by precipitation. Locally, east of the tailings area, a spring-fed pond in Cane Valley Wash provides recharge to the alluvium groundwater (Figure D.7.21). Minor amounts of recharge are also provided by intermittent or continuous ground surface discharges of artesian groundwater from monitor wells 611, 613, and 615 and former production well 625 completed in the DeChelly Sandstone (Figure D.7.21), and from occasional flows in Cane Valley Wash. A water table map for the alluvial aquifer is also shown in Figure D.7.21. Alluvial groundwater in the site vicinity flows to the north under an average hydraulic gradient of 0.011 (Calculation MON-11-92-14-06/07-00), and discharges as underflow or seeps in northern Cane Valley.

Shinarump Conglomerate

Groundwater within the Shinarump Conglomerate is confined by the mudstones within this rock unit. This confined groundwater flows northward from recharge areas in the south under an average hydraulic gradient of 0.010 (Calculation MON-01-08-92-14-06/07-00). An upward vertical hydraulic gradient exists between the Shinarump Conglomerate and the overlying alluvium (Calculation MON-11-92-14-06/07-00). A potentiometric surface map for the Shinarump Conglomerate is shown in Figure D.7.22.

DeChelly Sandstone

Groundwater within the DeChelly Sandstone is confined by the overlying Moenkopi Formation. This confined groundwater flows northward from recharge areas in the south and discharges to areas north of Cane Valley. Groundwater flows under an average hydraulic gradient of 0.011 (Calculation MON-11-92-14-006/07-00). A map of the potentiometric surface map for the DeChelly sandstone is presented in Figure D.7.23. An upward, vertical hydraulic gradient exists between the Shinarump Conglomerate and the overlying alluvium, and between the DeChelly Sandstone and the overlying units (Calculation MON-11-92-14-06/07-00). Two former production wells (612 and 613) completed within the DeChelly Sandstone flow onto the ground surface under artesian conditions. It is not known if this upward gradient existed at the site during milling operations when groundwater was withdrawn from the DeChelly aquifer.

D.7.18 HYDRAULIC CHARACTERISTICS

The hydraulic conductivities in the alluvium, Shinarump Sandstone and DeChelly Sandstone were obtained from analysis of slug test data collected by the TAC (Calculation No. MON-08-92-14-02-00). An aquifer pumping test was also performed in monitor well 651 screened in the alluvium (Calculation No. MON-08-92-14-03-00). The hydraulic conductivities determined from the slug tests and the aquifer test are summarized in Table D.7.13. All calculations are included in Appendix F.

Alluvial aquifer

Hydraulic conductivities computed from slug test data showed a variation in values ranging from 0.28 to 3.9 ft/day. The hydraulic conductivity computed from the aquifer test data resulted in a value of 19 ft/day. The range of average linear groundwater velocities in the alluvium was calculated using this range of hydraulic conductivities, a hydraulic gradient of 0.011 to the north (Figure D.7.21), and an assumed effective porosity of 0.25. Using Darcy's Law, the range of average linear velocities for groundwater flow in the alluvium is from five to 300 ft/year (Calculation MON-08-92-14-06/07-00).

Shinarump Conglomerate

Hydraulic conductivities computed from slug test data showed a variation in values ranging from 0.39 to 8.1 ft/day for the Shinarump Conglomerate. The range of average linear groundwater velocities was calculated using this range of hydraulic conductivities, a hydraulic gradient of 0.010 to the north (Figure D.7.22), and an assumed effective porosity of 0.10. Using Darcy's Law, the range of average linear velocities for groundwater flow in the alluvium is from 15 to 290 ft/year (Calculation MON-08-92-14-06/07-00).

DeChelly Sandstone

Hydraulic conductivities computed from slug test data showed a variation in values ranging from 0.02 to 2.8 ft/day for the DeChelly Sandstone. The range of average linear groundwater velocities was calculated using this range of hydraulic conductivities, a hydraulic gradient of 0.011 to the north (Figure D.7.23), and an assumed effective porosity of 0.10. Using Darcy's Law, the range of average linear velocities for groundwater flow in the alluvium is from 0.8 to 120 ft/year (Calculation MON-08-92-14-06/07-00).

D.7.19 BACKGROUND GROUNDWATER QUALITY

This section discusses the background groundwater quality characteristics of the alluvium, Shinarump Member, and DeChelly Member in the area upgradient of the Monument Valley tailings site. For all three hydrostratigraphic units, upgradient is to the south of the site.

Background groundwater quality was characterized by analyzing constituents listed in Table 8.1 of the TAD (DOE, 1989). For characterization purposes, background groundwater quality of each hydrostratigraphic unit can be described by an average concentration and a statistical maximum. The procedures for calculating average and statistical maximum concentrations are discussed in "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Interim Final Guidance" (EPA, 1989) and are described in the TAD. Average

concentrations of hazardous constituents are represented statistically by a mean or median, depending on the proportion of nondetects and whether the distribution is normal or nonparametric. The statistical minimum may be represented as the 98 percent confidence minimum for normal or lognormal distributions or a nonparametric confidence interval if the distribution is neither normal nor log normal.

Alluvium

Background groundwater quality in the alluvium has been determined by the analyses of water samples collected from upgradient monitor well 602 (Figure D.7.21). A statistical analysis of background water quality in the alluvium that includes the minimum, mean, median, maximum, percentage of nondetects, the 98 percent confidence interval, and other information is provided in Table D.7.14.

Hazardous constituents with MCLs that exceeded the laboratory method detection limits in the alluvium background groundwater include barium, cadmium, chromium, molybdenum, net gross alpha, nitrate, radium-226 and -228, selenium, and uranium. Concentrations of elements included individually or listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that have exceeded the laboratory method detection limits include aluminum, antimony, fluoride, nickel, strontium, vanadium, and zinc.

The maximum observed concentration of molybdenum exceeded the EPA MCL in the background alluvium groundwater (Table D.7.14). The lower end of the 98 percent confidence interval (statistical minimum) of molybdenum was compared with the MCL. According to the EPA (1989), if the lower end of the confidence interval exceeds the MCLs, there is statistical evidence of an exceedance of the MCL. The lower end of the 98 percent confidence interval concentrations of molybdenum does not exceed the MCL in background alluvium groundwater. Therefore, there is no evidence of MCL exceedance for any hazardous constituent in the alluvium background groundwater.

Shinarump Member

Background groundwater quality in the Shinarump Member has been determined by the analyses of water samples collected from upgradient monitor wells 601, 610, and 658 (Figure D.7.22). A statistical analysis of background water quality in the Shinarump Member that includes the minimum, mean, median, maximum, percentage of nondetects, the 98 percent confidence interval, and other information is provided in Table D.7.15.

Hazardous constituents with MCLs that exceeded the laboratory method detection limits in the Shinarump background groundwater include barium, chromium, molybdenum, net gross alpha, nitrate, radium-226 and -228, selenium, and uranium. Concentrations of elements included individually or listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that have exceeded the laboratory

method detection limits include aluminum, antimony, cobalt, fluoride, nickel, strontium, vanadium, and zinc.

Maximum observed concentrations or activities of molybdenum, net gross alpha, and radium-226 and -228 exceeded EPA MCLs in the background Shinarump groundwater (Table D.7.15). The lower end of the 98 percent confidence interval (statistical minimum) of these constituents were compared with their MCLs. According to the EPA (1989), if the lower end of the confidence interval exceeds the MCLs, there is statistical evidence of an exceedance of the MCLs. The lower end of the 98 percent confidence interval concentrations of molybdenum, net gross alpha, and radium-226 and -228 do not exceed the MCLs in background Shinarump groundwater. Therefore, there is no evidence of MCL exceedance for any hazardous constituent in the Shinarump Member background groundwater.

DeChelly Sandstone

Background groundwater quality in the DeChelly Sandstone has been determined by the analyses of water samples collected from upgradient monitor wells 612, 613, and 661 (Figure D.7.23). A statistical analysis of background water quality in the Dechelly Sandstone that includes the minimum, mean, median, maximum, percentage of nondetects, the 98 percent confidence interval, and other information is provided in Table D.7.16.

Hazardous constituents with MCLs that exceeded the laboratory method detection limits in the DeChelly Sandstone upgradient groundwater include arsenic, barium, cadmium, chromium, molybdenum, net gross alpha, nitrate, radium-226 and -228, selenium, and uranium. Concentrations of elements included individually or listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that have exceeded the laboratory method detection limits include aluminum, antimony, cobalt, fluoride, nickel, strontium, vanadium, and zinc.

Maximum observed concentrations of molybdenum exceeded EPA MCLs in the background DeChelly Sandstone groundwater (Table D.7.16). The lower end of the 98 percent confidence interval (statistical minimum) of molybdenum was compared with its MCL. According to the EPA (1989), if the lower end of the confidence interval exceeds the MCL, there is statistical evidence of an exceedance of the MCL. The lower end of the 98 percent confidence interval concentrations of molybdenum did not exceed the MCL in background alluvium groundwater. Therefore, there is no evidence of MCL exceedance for any hazardous constituent in the DeChelly background groundwater.

D.7.20 TAILINGS CHARACTERIZATION

The mill at the Monument Valley site was operated from 1955 to 1968 by Vanadium Corporation of America and its successor, Foote Mineral Company. The Monument No. 2 Mine, just west of the site on Yazzie Mesa, was the sole source of ore for the Monument Valley mill. During the early years of operation, this site was used to physically concentrate

the slime fraction, which contained the majority of the uranium. This fine-grained fraction was then shipped to other mills for refining. In later years, low-grade ores and the stockpiled sand fraction were heap leached. This process produces an acidic, oxidizing leachate from tailings.

The waste solids from the processing and leaching of the uranium ore were transferred to the tailings piles. The Monument Valley tailings are a coarse-grained, sand-like material. Two tailings piles, concrete building foundations, and debris remain at the site. The two tailings piles occupy approximately 28 acres and contain approximately 842,600 cy of tailings. The total amount of contaminated materials, including the tailings, soils beneath and around the tailings, and other contaminated materials, is estimated to be 1,100,000 cy. All mill buildings and milling equipment have been removed from the site.

The chemical characteristics of the Monument Valley tailings were evaluated by pore water sampling with suction lysimeters. Six lysimeters were sampled in 1985 and 1986. A list of the lysimeters and sampling results is shown in Table D.7.17. The TDS concentration ranges from 703 to 6850 mg/l. The pH of the tailings pore water ranges from 4.3 to 7.63. Inorganic hazardous constituents that exceed laboratory method detection limits in the tailings pore water include barium, chromium, molybdenum, nitrate, radium-226, and uranium. Radium-228 and net gross alpha activities were not determined, but it is assumed that their activities exceed laboratory method detection limits based on data from tailings piles at other uranium processing sites. For characterization purposes, mean or geometric mean tailings pore water quality data were compared to MCLs. Mean or geometric mean observed concentrations of molybdenum, nitrate, and radium-226 exceeded their MCLs (Table D.7.17), and are therefore potential groundwater contaminants at the Monument Valley site.

Concentrations of elements included individually or listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that have exceeded the laboratory method detection limits include aluminum, ammonium, cobalt, copper, fluoride, nickel, strontium, vanadium, and zinc (Table D.7.17). Cyanide, sulfide, and thallium were not determined. Concentrations of these potential hazardous constituents with no MCLs were compared to the statistical maximum concentrations in alluvium background groundwater to determine their potential to be groundwater contaminants at the Monument Valley site. The mean or median concentrations of aluminum, ammonium, cobalt, copper, fluoride, nickel, strontium, and zinc exceeded the statistical maximum of background groundwater in the alluvium, and are therefore potential groundwater contaminants.

D.7.21 EXTENT OF EXISTING CONTAMINATION

To assess the extent of groundwater contamination at the Monument Valley processing site caused by seepage of leachate from the tailings piles and previous processing activities, groundwater quality data have

been collected by the DOE annually or semi-annually since 1985 (except 1987) from selected upgradient, on-site, and downgradient monitoring wells in the alluvium, the Shinarump Conglomerate, and the DeChelly Sandstone.

Alluvium

A statistical analysis of alluvial groundwater quality from 1985 to 1992 is presented in Table D.7.18. Hazardous constituents with MCLs and with concentrations or activities that exceeded the laboratory method detection limits in monitor wells at the Monument Valley site are shown in this table. These include arsenic, barium, cadmium, chromium, lead, molybdenum, nitrate, net gross alpha, radium-226 and -228, selenium, and uranium. Concentrations of elements included individually or listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that have exceeded the laboratory method detection limits include aluminum, ammonium, antimony, cobalt, copper, fluoride, nickel, strontium, sulfide, thallium, tin, vanadium, and zinc.

Maximum observed concentrations or activities of seven hazardous constituents equaled or exceeded MCLs in the alluvial groundwater downgradient of the tailings area. These constituents are cadmium, chromium, molybdenum, net gross alpha, nitrate, radium-226 and -228, and selenium. Concentrations of chromium, molybdenum, and nitrate exceed laboratory method detection limits in the tailings pore water (Table D.7.17). Therefore, the presence of these hazardous constituents in the groundwater may be related to uranium processing activities. Concentrations of cadmium and selenium did not exceed laboratory method detection limits in the tailings pore water (Table D.7.17), so their presence in groundwater may not be related to uranium processing activities. Activities of net gross alpha and radium-226 and -228 have not been analyzed in tailings pore water, but it is assumed that they exceed laboratory method detection limits based on pore water analyses from other uranium mill tailings piles. Therefore, the presence of these hazardous constituents in the alluvium groundwater may be related to uranium processing activities.

To confirm whether the presence of these hazardous constituents represents groundwater contamination, the lower end of the 98 percent confidence interval (statistical minimum) for these constituents by monitor well was compared with the MCL. According to the EPA (1989), if the lower end of the confidence interval exceeds the MCL, there is statistical evidence of an exceedance of the MCL. Because the lower end of the confidence interval does not exceed the MCLs for cadmium, chromium, molybdenum, net gross alpha, radium-226 and -228, and selenium in any alluvial monitor well, there is no statistical evidence that they are groundwater contaminants that exceed the MCLs. However, because the lower end of the 98 percent confidence interval exceeds the MCL of nitrate in downgradient monitor wells 606 and 655, there is statistical evidence that groundwater from these monitor wells exceeds the MCL. A detailed discussion of the nitrate contamination in the alluvium groundwater is in Section D.7.22.

As stated in Section D.7.20, eight hazardous constituents without MCLs are considered to be potential groundwater contaminants. These are aluminum, ammonium, cobalt, copper, fluoride, nickel, strontium, and zinc. To determine if these potential hazardous constituents are groundwater contaminants at the Monument Valley site, the maximum observed concentration in downgradient groundwater was compared to the statistical maximum for background groundwater. The statistical maximum for background groundwater was exceeded for ammonium, cobalt, copper, fluoride, strontium, and zinc in downgradient alluvium groundwater.

Ammonium most likely oxidizes to nitrate within a shallow water table aquifer. Therefore, ammonium is probably a major contributor to the nitrate plume at the Monument Valley site. This is discussed in detail in Section D.7.22. Fluoride is considered a hazardous constituent because it is an element of a hazardous constituent compound, carbon oxyfluoride, listed in Appendix IX of 40 CFR 264. Carbon oxyfluoride does not exist in water. Therefore, in groundwater, fluoride will not be considered a hazardous constituent. Strontium is listed as an element of the hazardous constituent compound strontium sulfide, which is unlikely to exist in a shallow aquifer environment. Therefore, strontium will not be considered a hazardous constituent.

Cobalt, copper, and zinc remain to be considered as potential hazardous constituents in downgradient groundwater. Neither cobalt nor copper was detected in background alluvium groundwater. Therefore, the presence of these constituents in downgradient groundwater is most likely related to the uranium mill tailings, and no further statistical tests are necessary.

Zinc was detected in background groundwater; however, there are not enough data above the detection limit to perform a statistical comparison test. Zinc concentrations in downgradient groundwater (locations 606, 655, and 662) have exceeded background concentrations. Therefore, the presence of zinc in downgradient groundwater is most likely related to uranium mill tailings.

Screening of Appendix IX organic constituents in the alluvium groundwater from several monitor wells in 1985 and 1986 identified no organic constituents related to uranium processing that exceeding their laboratory method detection limits. In 1988, bis(2-ethylhexl)pthalate was identified in groundwater from monitor well 606. This organic compound is a laboratory reagent and is used in the production of other organic compounds. It is not used in uranium processing. Except in cases where laboratory cross-contamination of samples may have occurred, it has not been detected in raffinate at Title II uranium processing sites (Smith, 1987).

Shinarump Conglomerate

A statistical analysis of Shinarump Conglomerate downgradient and cross gradient groundwater quality from 1985 to 1992 is presented in Table D.7.19. Hazardous constituents with MCLs and with concentrations

or activities that exceeded the laboratory method detection limits in monitor wells completed in the Shinarump Conglomerate are shown in this table. These include arsenic, barium, cadmium, chromium, lead, molybdenum, nitrate, net gross alpha, radium-226 and -228, selenium, and uranium. Concentrations of elements included individually or listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that have exceeded the laboratory method detection limits include aluminum, ammonium, antimony, cobalt, fluoride, nickel, strontium, vanadium, and zinc.

Maximum observed concentrations or activities of three hazardous constituents equaled or exceeded MCLs in the Shinarump groundwater downgradient of the tailings area. These constituents are molybdenum, net gross alpha, and radium-226 and -228. Concentrations of molybdenum exceed laboratory method detection limits in the tailings pore water (Table D.7.17). Therefore, the presence of molybdenum in the groundwater may be related to uranium processing activities. Activities of net gross alpha and radium-226 and -228 were not analyzed in tailings pore water, but it is assumed that they exceed laboratory method detection limits based on pore-water analyses from other uranium mill tailings piles. Therefore, the presence of these hazardous constituents in the Shinarump Conglomerate groundwater may be related to uranium processing activities.

To confirm whether the presence of molybdenum, net gross alpha, and radium-226 and -228 represents groundwater contamination, the lower end of the 98 percent confidence interval of the mean for these constituents by monitor well was compared with the MCL. According to the EPA (1989) (Section 6.2.1), if the lower end of this confidence interval exceeds the MCL, there is statistical evidence of an exceedance of the MCL. The lower ends of the confidence intervals do not exceed the MCLs for molybdenum, net gross alpha, and radium-226 and -228 in any Shinarump Conglomerate monitor well. Therefore, there is no statistically significant evidence for groundwater contamination above the MCLs. The upward hydraulic gradient between the Shinarump Conglomerate and the overlying alluvium served to prevent significant downward movement of contaminated groundwater from the alluvium.

DeChelly Sandstone

A statistical analysis of DeChelly Sandstone groundwater quality from 1985 to 1992 is presented in Table D.7.20. Hazardous constituents with MCLs and with concentrations or activities that exceeded the laboratory method detection limits in monitor wells completed in the DeChelly Sandstone are shown in this table. These include arsenic, barium, cadmium, chromium, molybdenum, nitrate, net gross alpha, radium-226 and -228, and uranium. Concentrations of elements included individually or listed as hazardous constituents in Appendix I of 40 CFR 192 and Appendix IX of 40 CFR 264 that have exceeded the laboratory method detection limits include aluminum, ammonium, antimony, cobalt, fluoride, nickel, strontium, tin, vanadium, and zinc.

Maximum observed concentrations or activities of four hazardous constituents equaled or exceeded MCLs in the DeChelly Sandstone groundwater downgradient of the tailings area. These constituents are chromium, molybdenum, net gross alpha, and uranium. Concentrations of chromium, molybdenum, and uranium exceed laboratory method detection limits in the tailings pore water (Table D.7.17). Therefore, the presence of these hazardous constituents in the groundwater may be related to uranium processing activities. The activities of net gross alpha were not analyzed in tailings pore water, but it is assumed that they exceed laboratory method detection limits based on pore water analyses from other uranium mill tailings piles. Therefore, the presence of net gross alpha in the DeChelly Sandstone groundwater may be related to uranium processing activities.

To confirm whether the presence of these hazardous constituents represents groundwater contamination, the lower end of the 98 percent confidence interval (statistical minimum) for these constituents by monitor well was compared with the MCL, as was done for the alluvium and Shinarump Conglomerate. If a statistical minimum could not be calculated due to lack of data, median concentrations were compared with MCLs. Because the lower end of the confidence interval or median does not exceed the MCLs for chromium, net gross alpha, and uranium in any DeChelly monitor well, there is no statistical evidence that they are groundwater contaminants that exceed the MCLs.

The statistical minimum did not exceed the MCL for molybdenum in the two monitor wells for which it could be calculated (657 and 663 in Table D.7.20). However, the median concentrations observed in former production well 625 and in monitor wells 664 and 668 did exceed the MCL for molybdenum (Table D.7.20). Therefore, contamination from uranium mill tailings is possible in these wells. However, more recent sampling rounds showed molybdenum less than detection in monitor wells 625 and 668 (Table D.7.21).

The upward hydraulic gradient between the DeChelly Sandstone and the overlying formations served to prevent significant downward movement of contaminated groundwater from the alluvium. However, during the period of milling operations when groundwater was produced from the DeChelly, the upward hydraulic gradient could have been reversed locally in the areas of maximum withdrawal. This temporary downward gradient from the alluvium to the DeChelly could have caused contaminated groundwater to flow to the DeChelly, which would account for the elevated molybdenum concentrations in some wells in the past.

D.7.22 NITRATE PLUME MOVEMENT IN THE ALLUVIUM

An isopleth map of nitrate concentrations in alluvium groundwater is shown in Figure D.7.24. This figure shows a nitrate plume of concentrations greater than the MCL extending downgradient to the northeast approximately 3000 feet from the Monument Valley tailings site. Within the plume, nitrate concentrations range from a high of over 1000 mg/l in the central portion to below the MCL for nitrate on the fringe.

Downgradient nitrate plume movement over time is described with nitrate concentration versus time plots from alluvium monitor wells 606, 655, 656, and 653. Monitor well 606 is located close to the tailings approximately 500 feet to the north, monitor wells 655 and 656 are of intermediate distance, and monitor well 653 is located approximately 3000 feet north of the tailings (Figure D.7.24). The nitrate concentration versus time plots for monitor wells 606, 655, and 656 (Figures D.7.25 and D.7.26) show a peak nitrate concentration in early 1988 and a gradual decrease since then. The nitrate concentration versus time plot for monitor well 653 (Figure D.7.27) shows a general increase in nitrate concentrations. These figures indicate that the plume is moving northeastward, and that the central portion of the plume with the highest nitrate concentrations has passed by monitor well 606, might have passed by monitor wells 655 and 656, but has not reached monitor well 653.

Even though the plume has moved a distance downgradient, there has been no substantial plume migration laterally to the east, as demonstrated by nitrate concentrations in alluvium monitor wells 603, 604, and 605 (Figure D.7.24). Plots of nitrate concentrations versus time for these crossgradient monitor wells and upgradient monitor well 602 are shown in Figure D.7.28. This figure shows nitrate concentrations consistently below 12 mg/l since 1985 in these monitor wells and below the background concentration most of the time. As described in Section D.7.17, the area east of the pile is a zone of alluvium recharge. This alluvium recharge is contributed by a spring-fed pond and flowing wells discharging water from the DeChelly Sandstone onto the ground surface in this area. This recharge has most likely created a higher water table locally which deflects plume movement away from the area northeast of the tailings piles. Surface remediation will not affect the alluvium recharge in this area. Therefore, the nitrate plume is not expected to move to the east in the future.

D.7.23 POTENTIAL IMPACTS OF SURFACE REMEDIATION ON GROUNDWATER QUALITY

The surface remediation of the Monument Valley tailings site will consist of relocating the tailings and residual radioactive material to the Mexican Hat disposal site. This activity will result in removal of the source of groundwater contamination and will not create additional groundwater contamination. In addition, it is unlikely that the remedial activities will substantially affect the existing water table configuration in the alluvium. If there is a steeper water table gradient locally beneath the tailings, the remediation will serve to level the topography which, in turn, will level the gradient. Therefore, if any change in the water table is effected, the result would be a reduction in groundwater velocity from the tailings area.

As described above, surface remediation will have little if any effect on plume movement. The nitrate plume will continue in its present course and velocity.

As part of a preliminary risk assessment for the Monument Valley site, a domestic well survey of the area was conducted by the TAC in 1992. This survey did not locate residences or domestic wells in the path of the plume (Figure D.7.29). One domestic well was located northwest of the plume (Figure D.7.29). However, this well is completed in the DeChelly Sandstone (Flowers, 1993).

There is potential for a local resident to hand dig a water well within the plume area or downgradient of the plume and encounter water that exceeds the MCLs. The high nitrate concentrations, in particular, would present an immediate health risk to infants if this water were ingested (Flowers, 1993). This risk will be avoided during remedial action by informing the residents not to dig water wells in the area of the plume or downgradient of the plume. This information will be transferred to the residents individually by TAC toxicologists and public relations personnel, and a permanent solution will be implemented as part of the UMTRA groundwater restoration program at Monument Valley.

For these reasons, remediation of the nitrate plume at the Monument Valley site will be addressed under a separate process in accordance with the NEPA and the UMTRA Phase II groundwater program. This deferral of the groundwater remediation will not affect future public health and safety.

D.7.24 WATER USE, VALUE, AND ALTERNATIVE SUPPLIES

Two families have domestic supply wells upgradient of the site (Figure D.7.29). Both wells are shallow hand-pump wells completed in the alluvium. Well 616, which supplies water for several families, is approximately eight feet deep and periodically dries up (DOE, 1988a). The depth of well 617 is unknown. A former production well (625) is also used as a domestic supply well for one nearby residence (DOE, 1988a). Three seeps in Cane Valley Wash (Figure D.7.29) within the area of the Monument Valley tailings site are used for stock water. Seeps 621 and 622 supply water to the pond ("frog pond") east of the site. The groundwater quality of domestic supply wells 616 and 617 is presented in Table D.7.22. Groundwater quality data for 625 are shown in Table D.7.20. No hazardous constituents with MCLs show concentrations above the MCLs in these wells, except for unfiltered (total) radium-226 and -228. Radium-226 and -228 (total) exceeded the MCL (5 pCi/l) by 2.8 pCi/l in 1991 in domestic well 616. This activity was derived mainly from radium-228 (total) with an uncertainty of 2.3 pCi/l (Table D.7.22). Given this uncertainty, it is questionable whether this value indicates an MCL exceedance. A subsequent sampling round for domestic well 616 showed 0.0 pCi/l of radium-226 and -228 (total) (Table D.7.22).

There are no rates charged for the use of private water wells. It is relatively inexpensive to install the shallow hand-pump wells, but due to the aridity of the region, any reliable groundwater resource is considered to be extremely valuable (DOE, 1988a).

Groundwater contamination from the tailings has not affected any groundwater currently being used. Should alternative water supplies be needed, possible sources include the installation of shallow hand-pump wells further upgradient or closer to the pond east of the site or installation of a production well(s) in the DeChelly Sandstone.

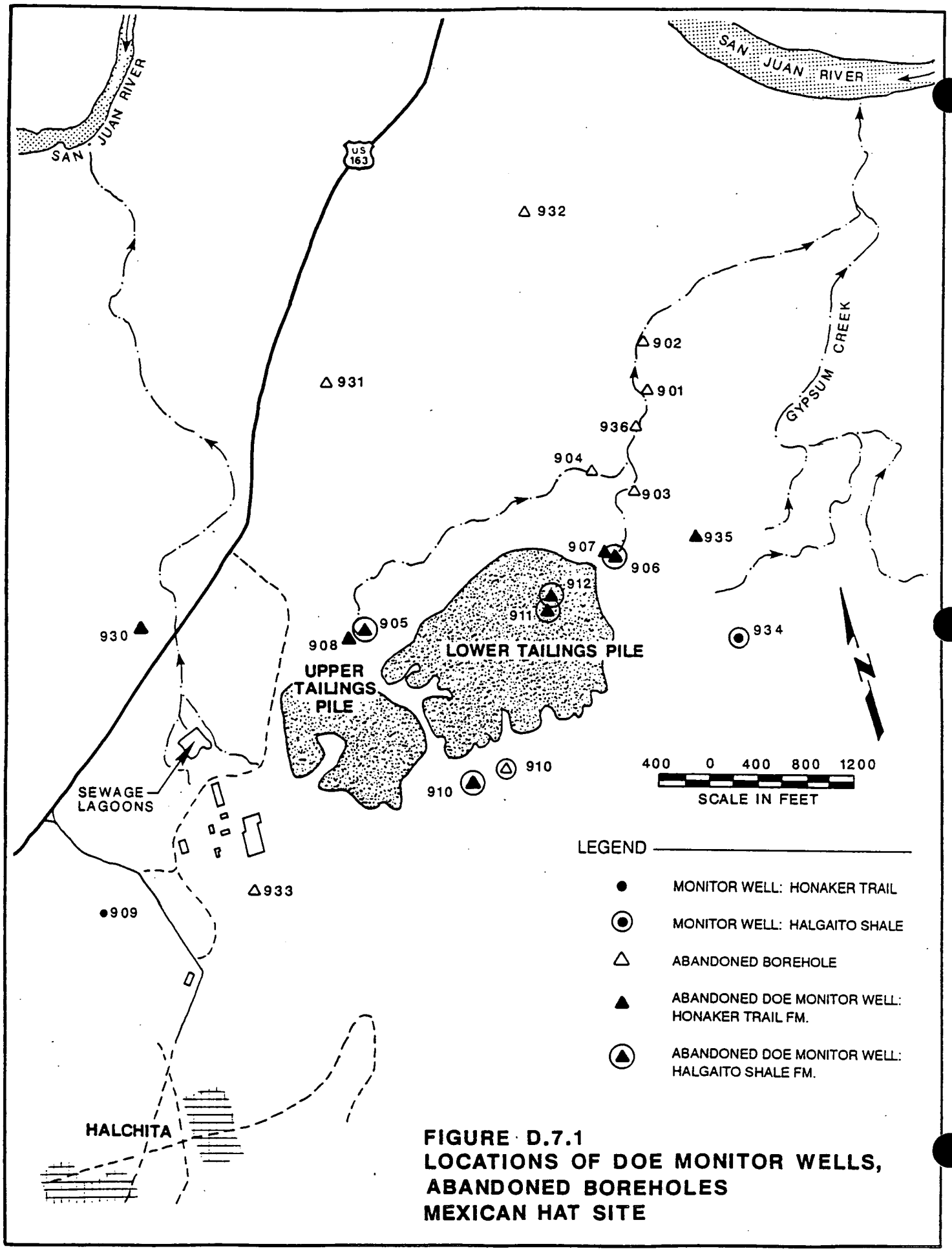
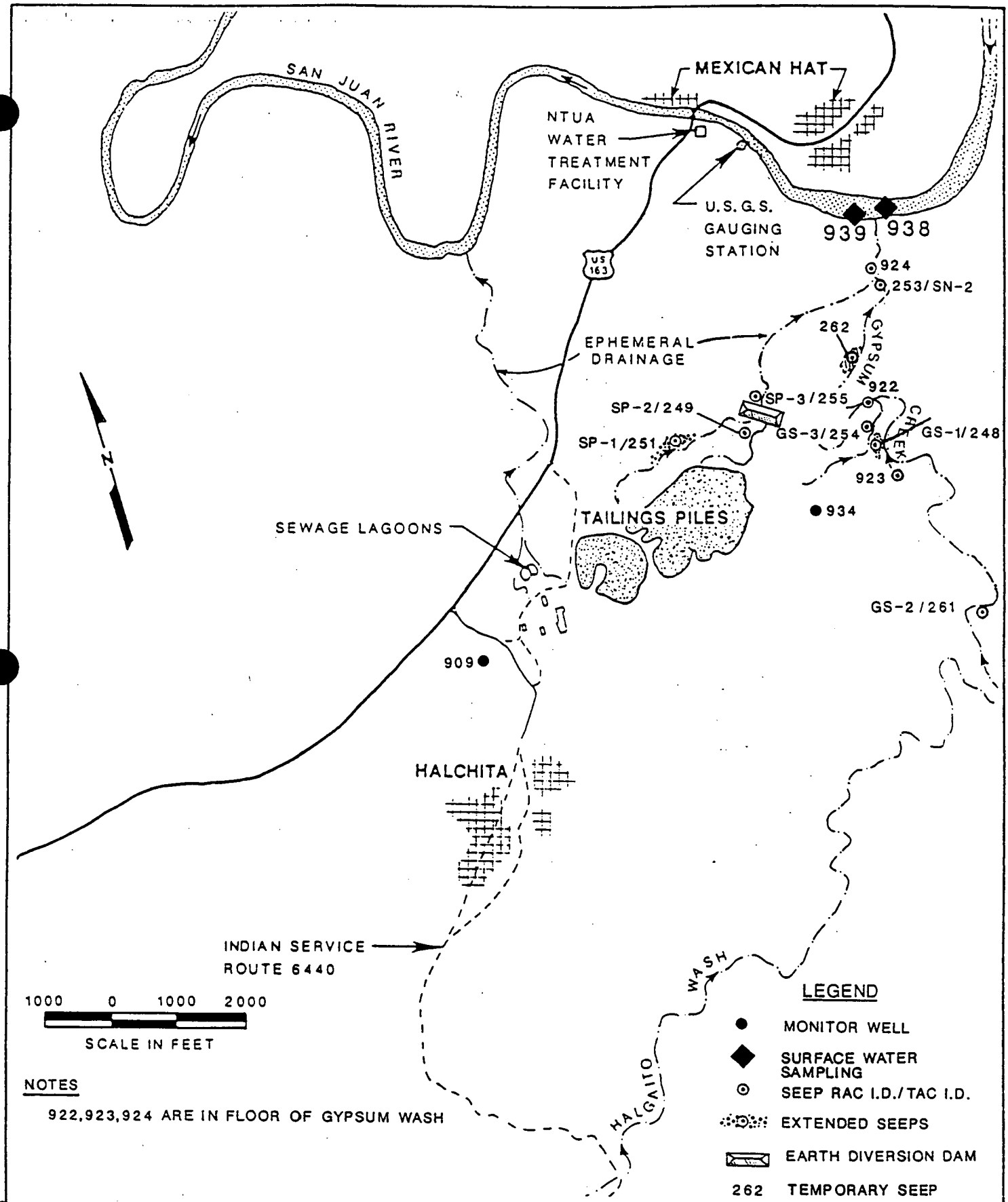


FIGURE D.7.1
LOCATIONS OF DOE MONITOR WELLS, ABANDONED BOREHOLES MEXICAN HAT SITE



NOTES

922,923,924 ARE IN FLOOR OF GYPSUM WASH

FIGURE D.7.2

SITE AREA AND LOCATIONS OF SEEPS, MONITOR WELLS AND SURFACE WATER SAMPLING AT THE MEXICAN HAT SITE, UTAH

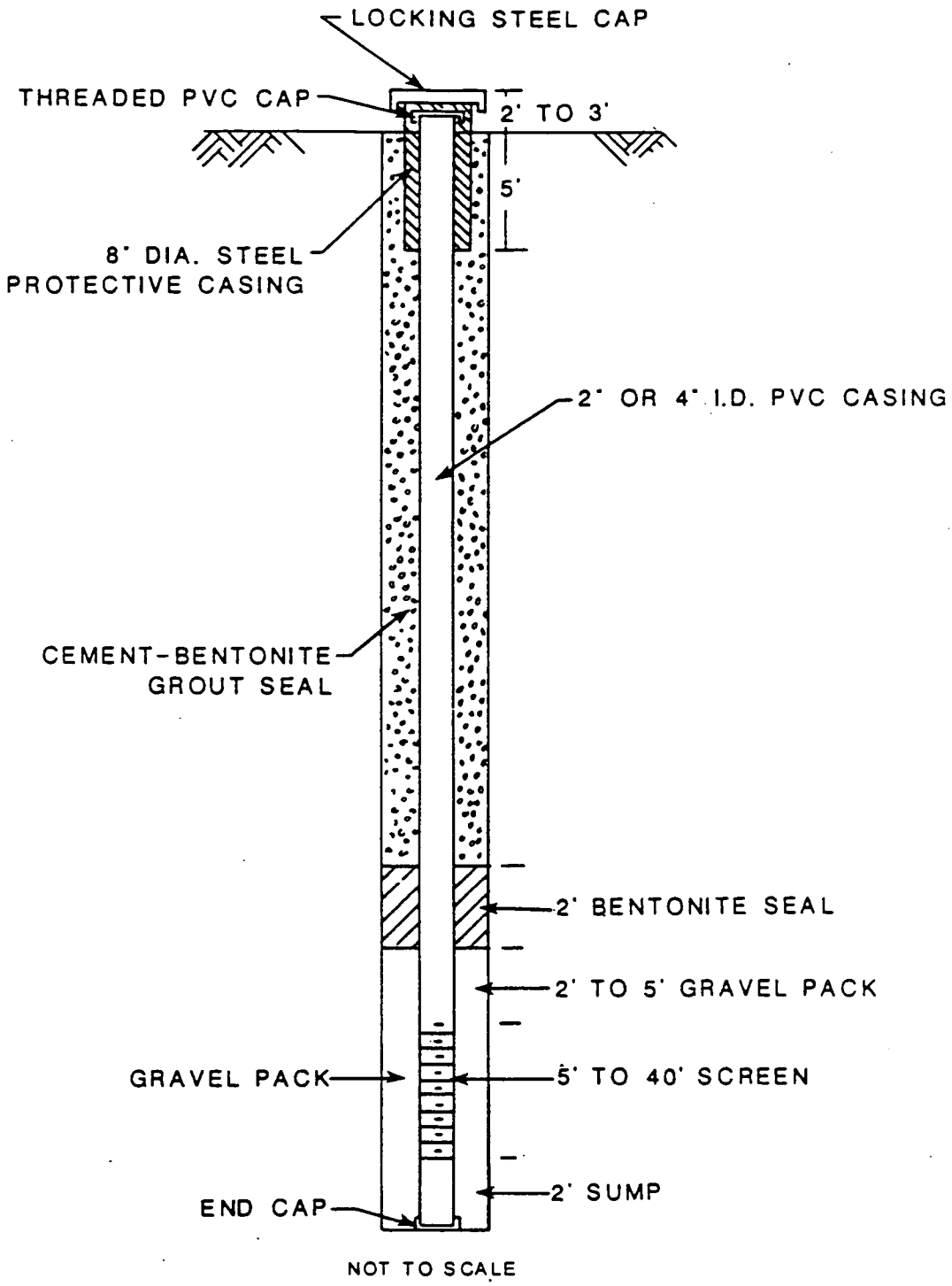


FIGURE D.7.3
TYPICAL DOE MONITOR WELL CONSTRUCTION

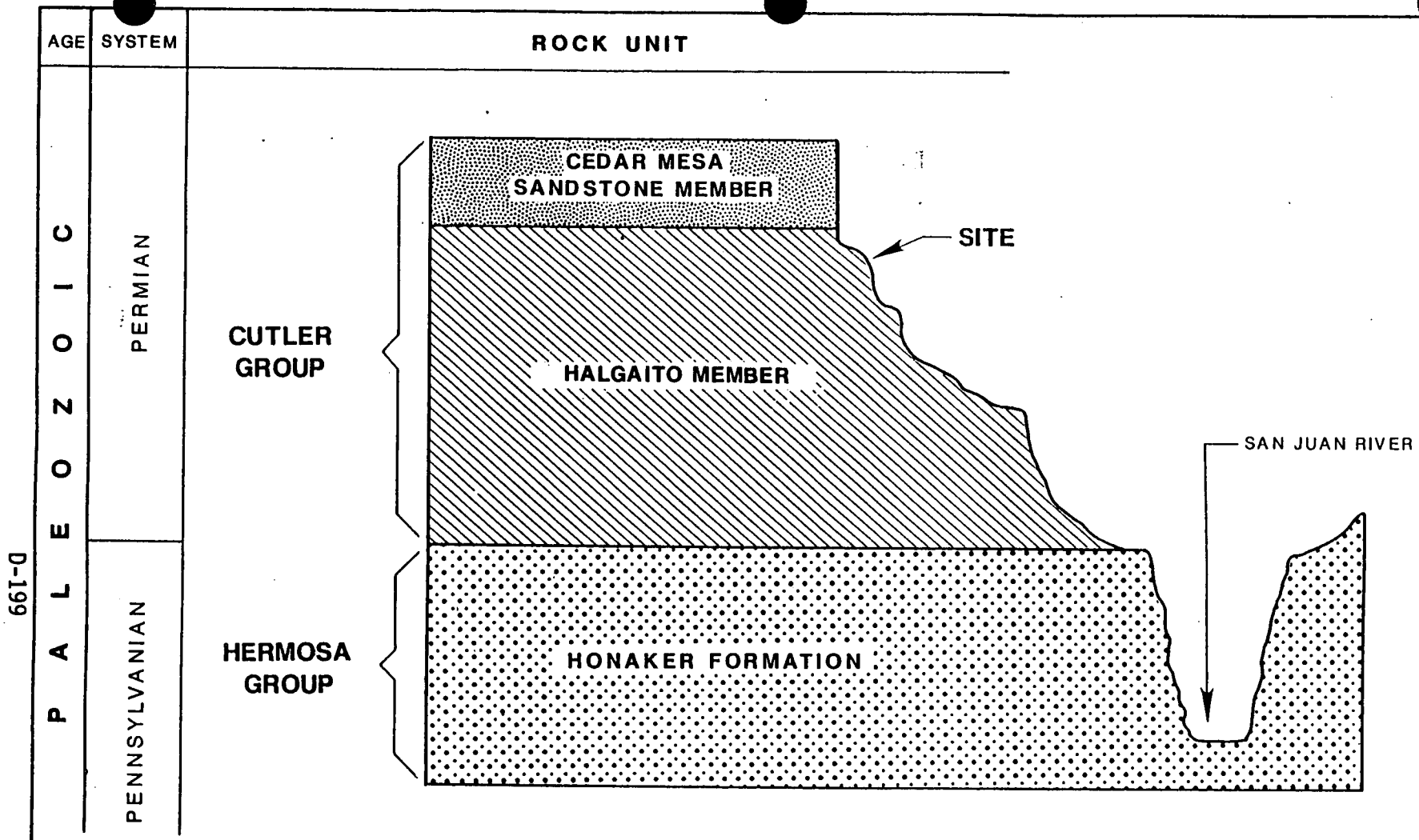


FIGURE D.7.4
GENERALIZED STRATIGRAPHIC SECTION
FOR THE MEXICAN HAT SITE REGION

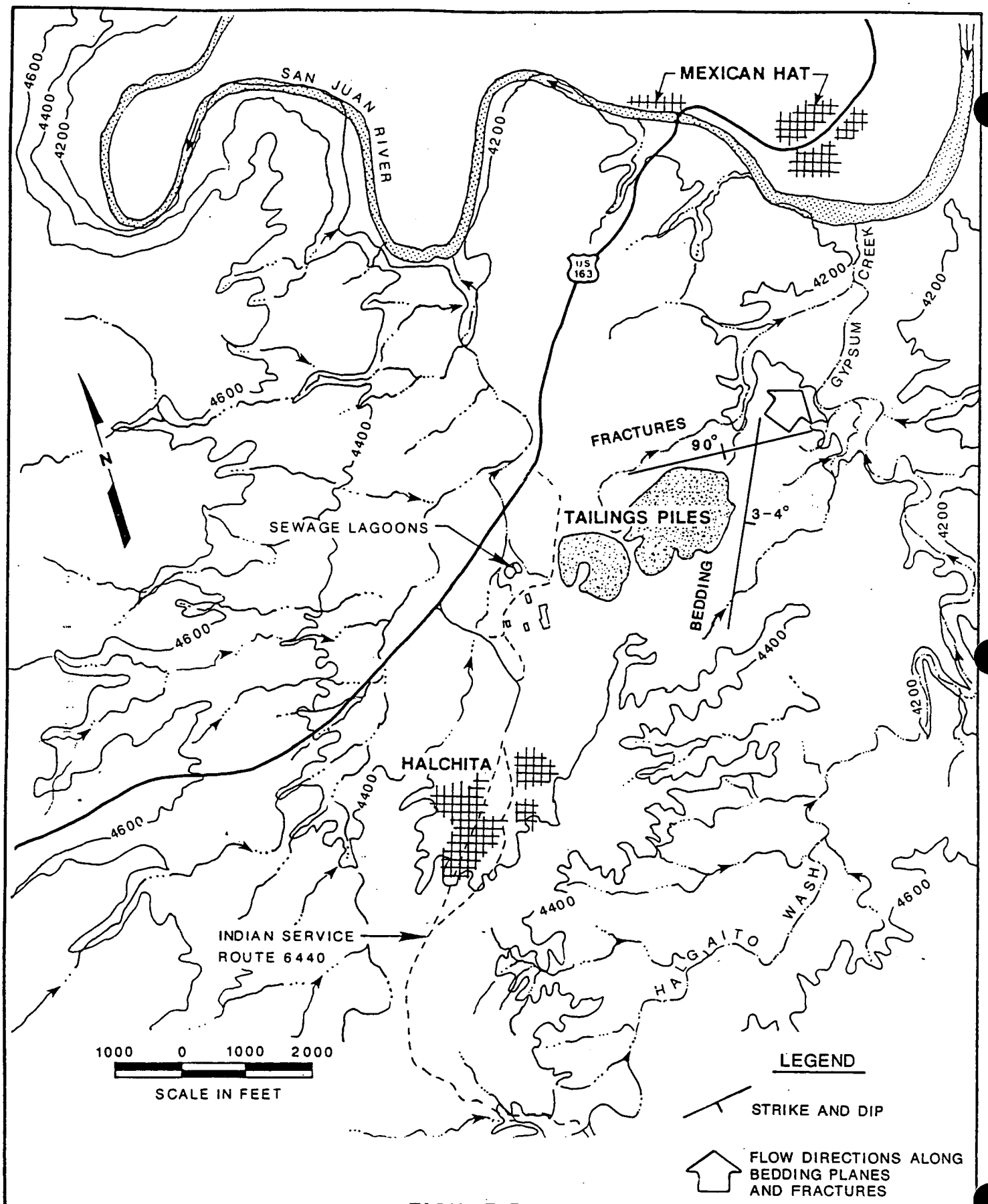


FIGURE D.7.5
PERCHED GROUNDWATER FLOW DIRECTIONS, BEDDING ORIENTATION, AND FRACTURE ORIENTATION - MEXICAN HAT SITE, UTAH

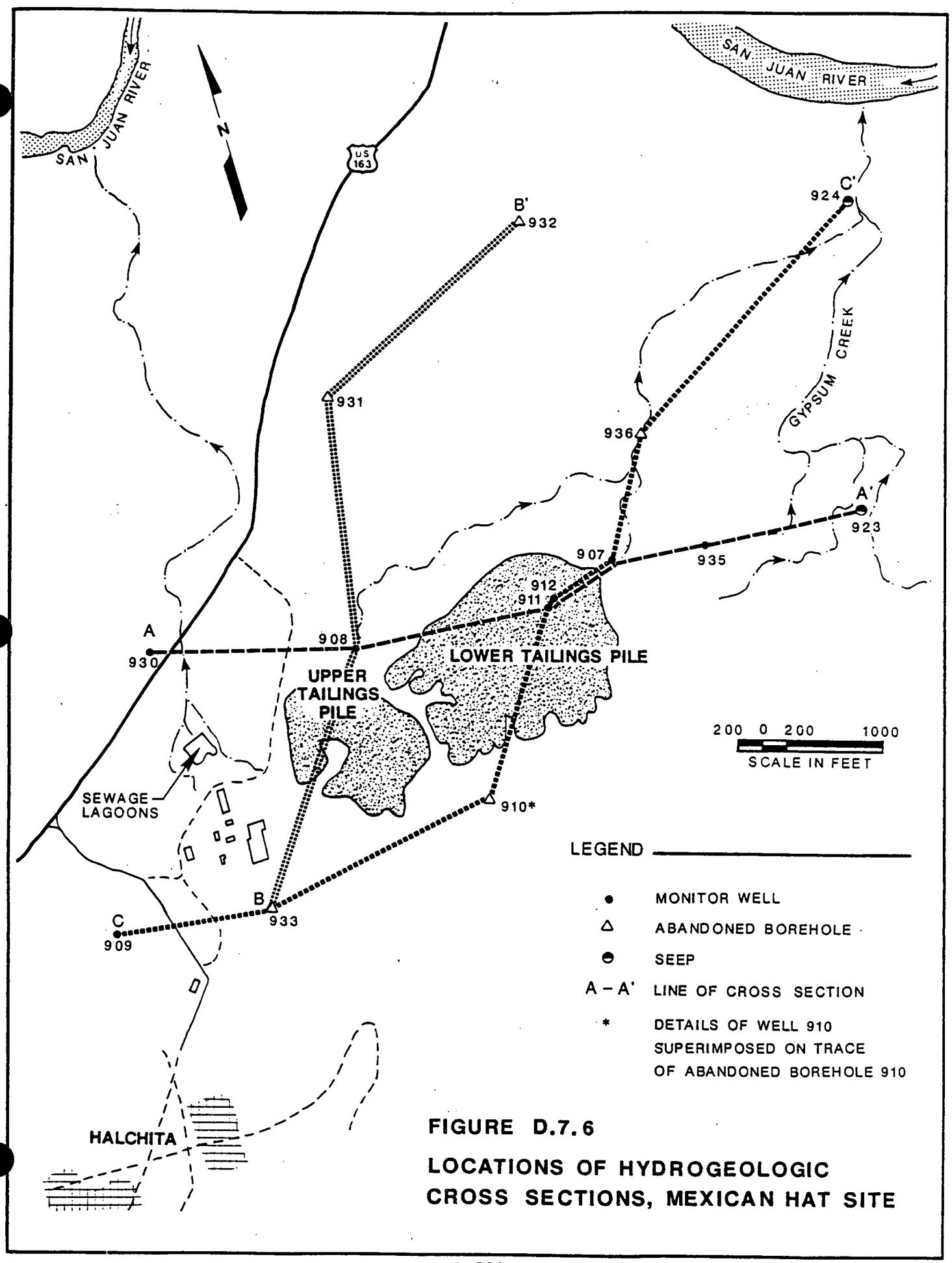


FIGURE D.7.6

LOCATIONS OF HYDROGEOLOGIC CROSS SECTIONS, MEXICAN HAT SITE

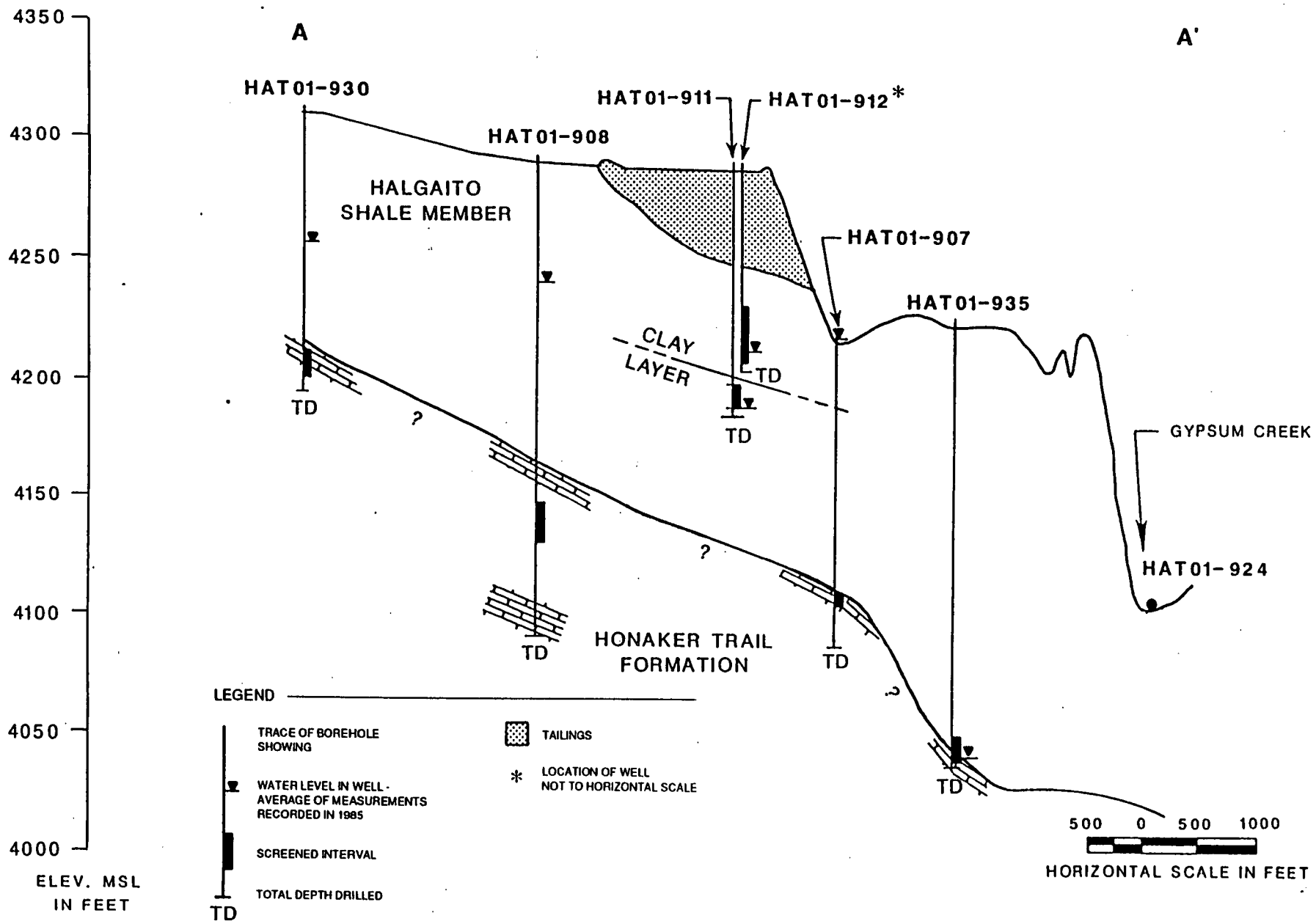


FIGURE D.7.7
HYDROGEOLOGIC CROSS-SECTION A-A'
MEXICAN HAT SITE

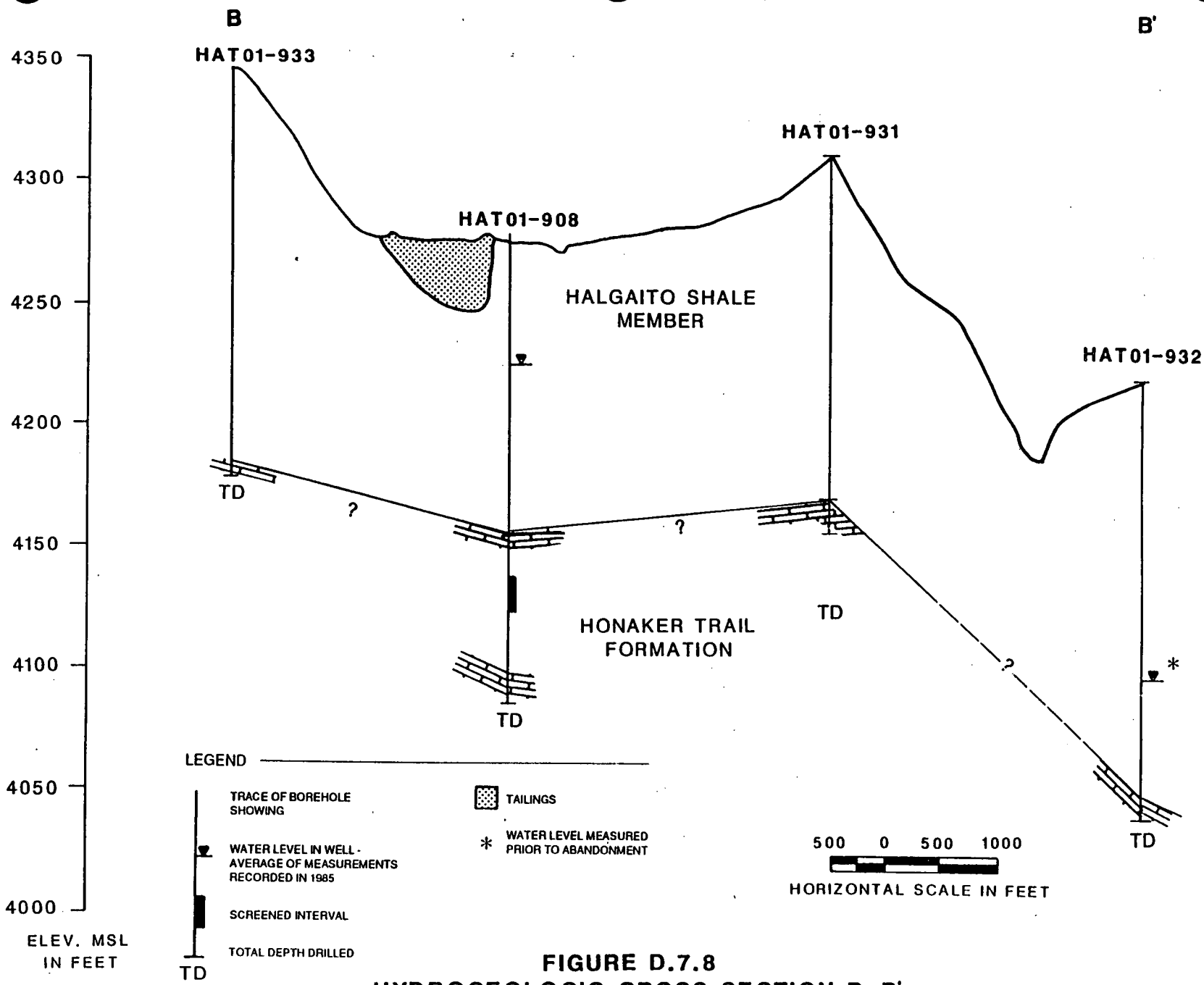


FIGURE D.7.8
HYDROGEOLOGIC CROSS-SECTION B-B'
MEXICAN HAT SITE

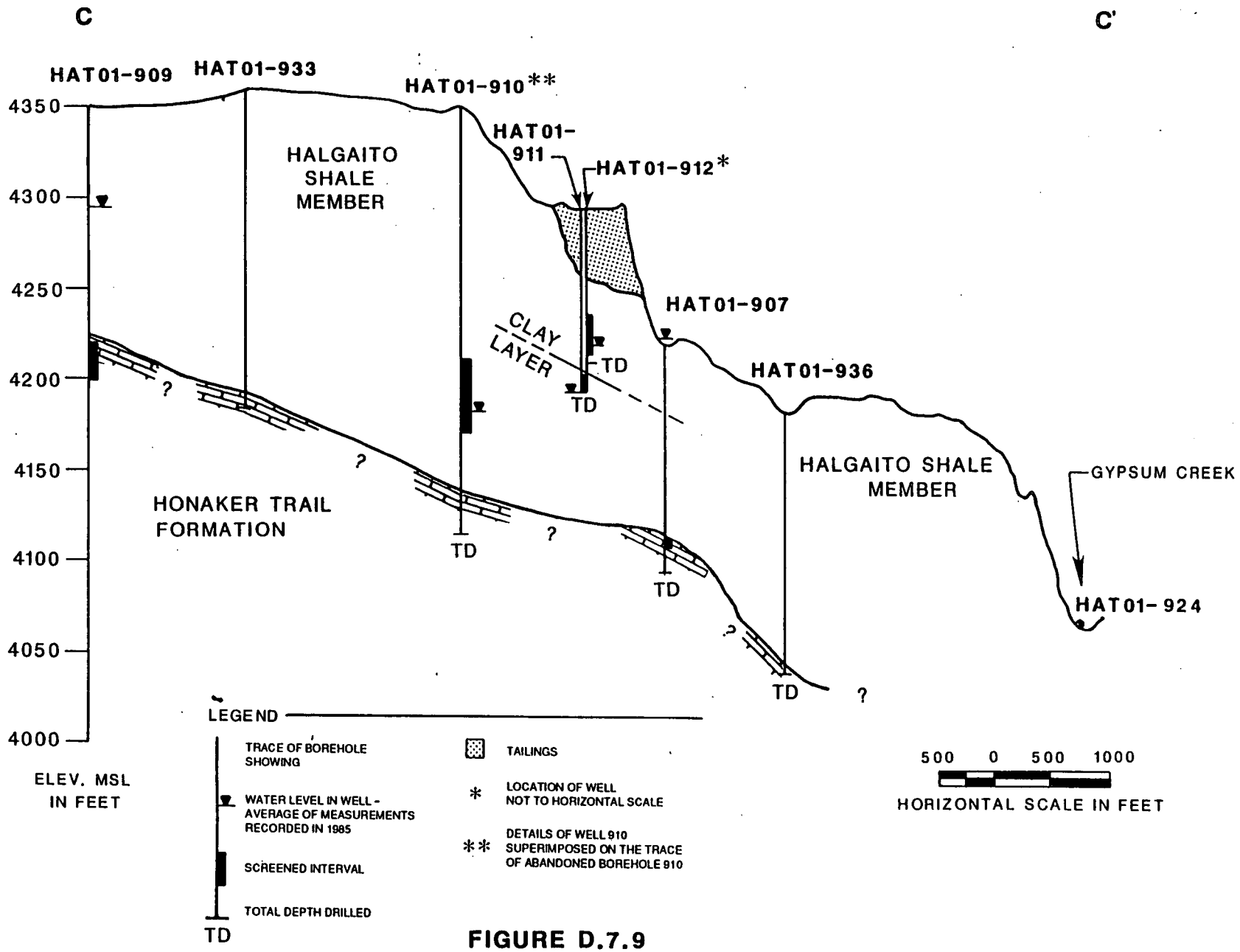


FIGURE D.7.9
HYDROGEOLOGIC CROSS-SECTION C-C'
MEXICAN HAT SITE

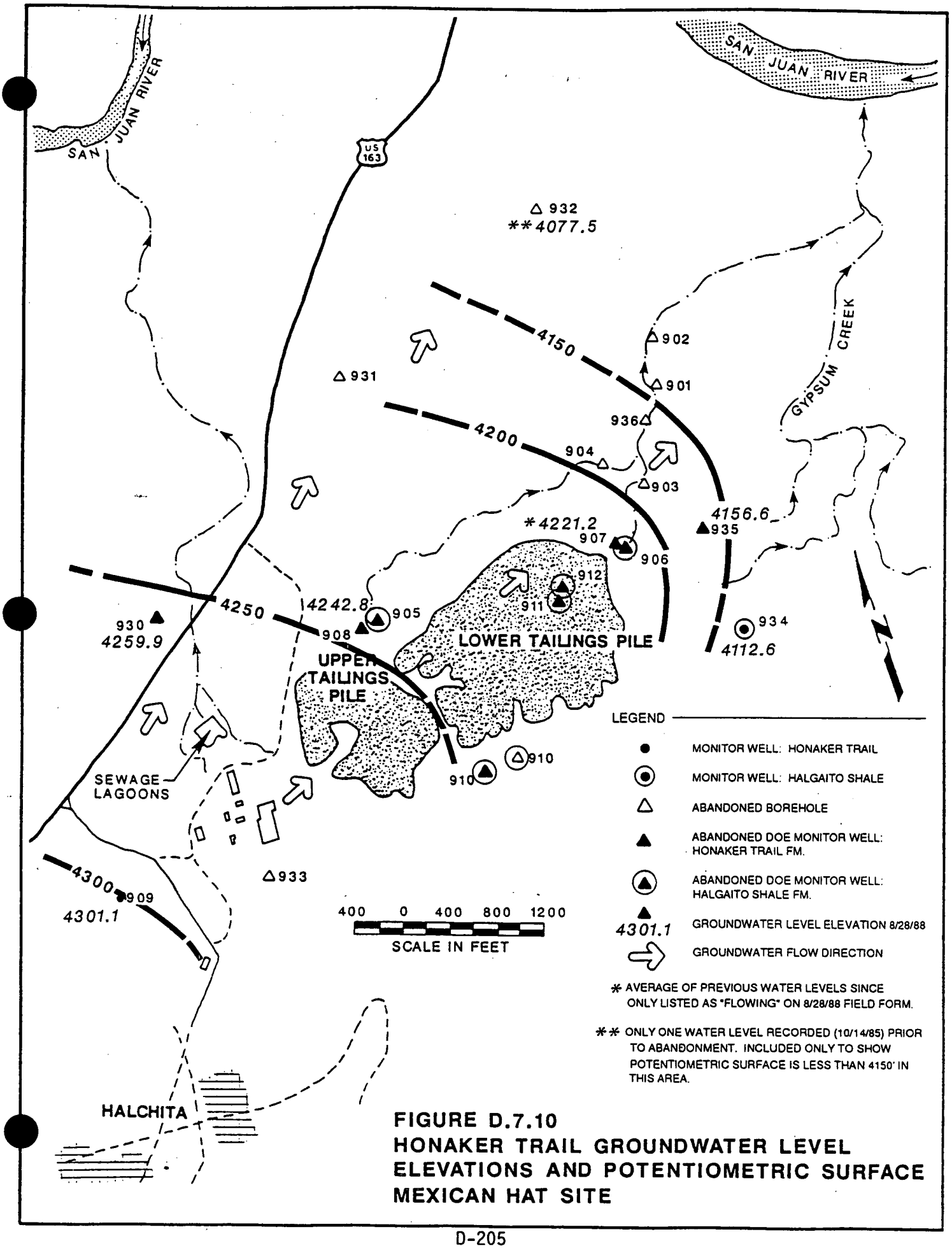
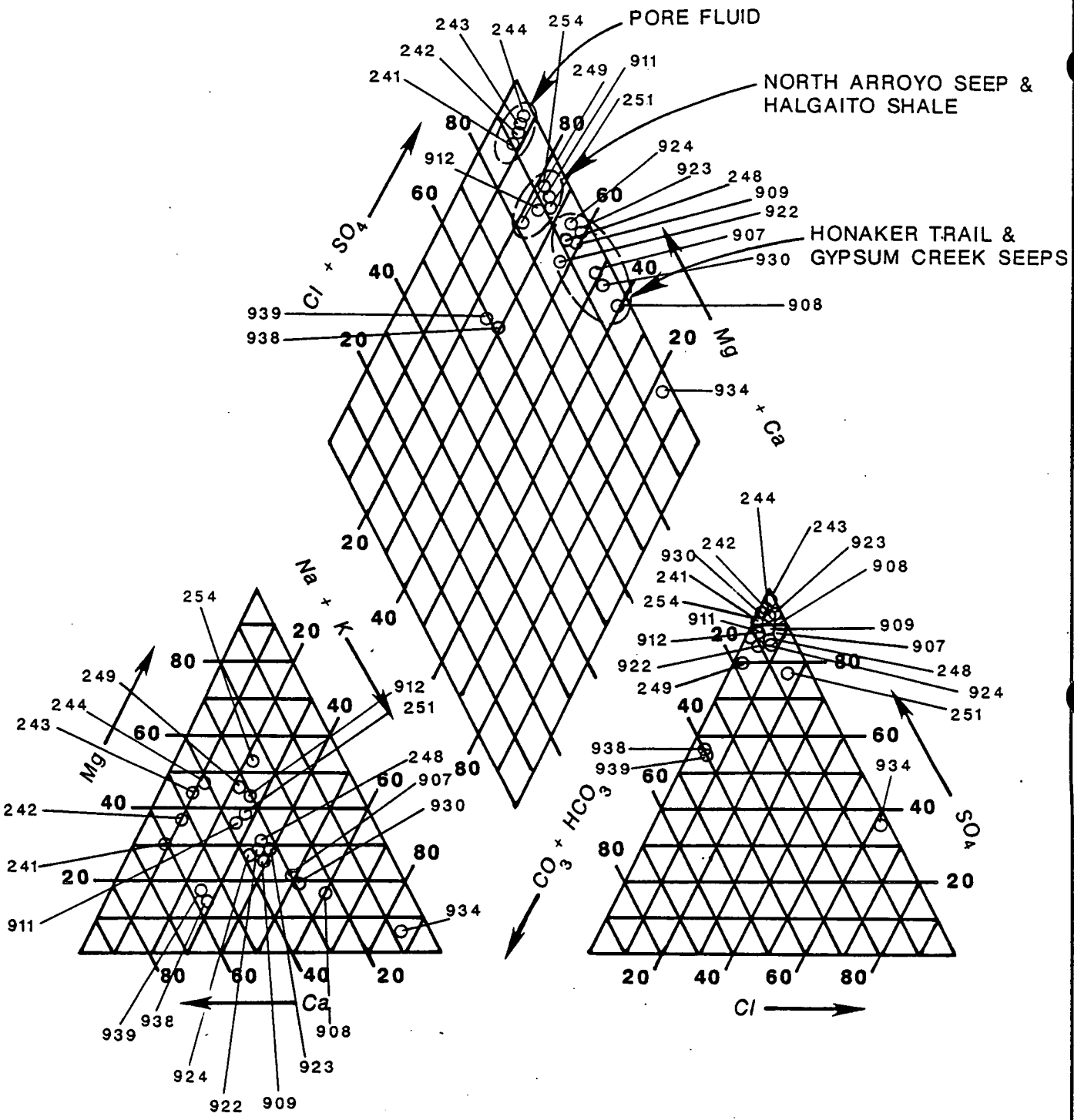


FIGURE D.7.10
HONAKER TRAIL GROUNDWATER LEVEL ELEVATIONS AND POTENTIOMETRIC SURFACE MEXICAN HAT SITE



1) TAILINGS PORE FLUIDS: 241, 242, 243, 244

2) SEEPS: 251 - North Arroyo (SP-1)
249 - North Arroyo (SP-2)
248 - Gypsum Creek (GS-1)
922 - Gypsum Creek
923 - Gypsum Creek
924 - Gypsum Creek
254 - Gypsum Creek Area (GS-3)

3) BACKGROUND GROUNDWATER IN THE HONAKER TRAIL FORMATION: 907, 908, 909, 930, 934?

4) SAN JUAN RIVER WATER: 938, 939

5) HALGAITO SHALE (Perched Water): 911, 912

FIGURE D.7.11
TRILINEAR DIAGRAM OF THE
MEXICAN HAT SITE, UTAH, WATER QUALITY COMPARISON - SUMMER 1990

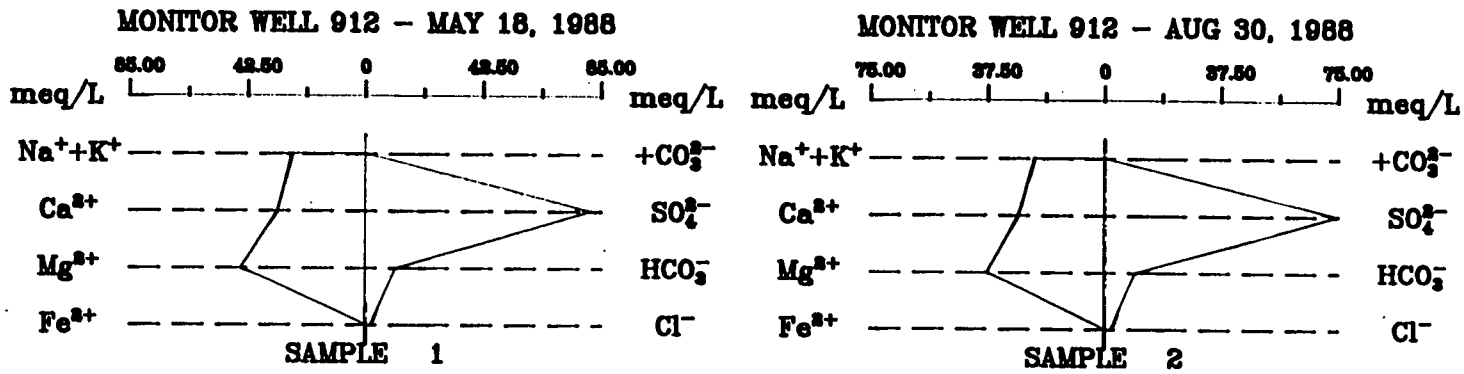


FIGURE D.7.12
STIFF DIAGRAMS FOR MONITOR WELL 912
MEXICAN HAT, UTAH, SITE

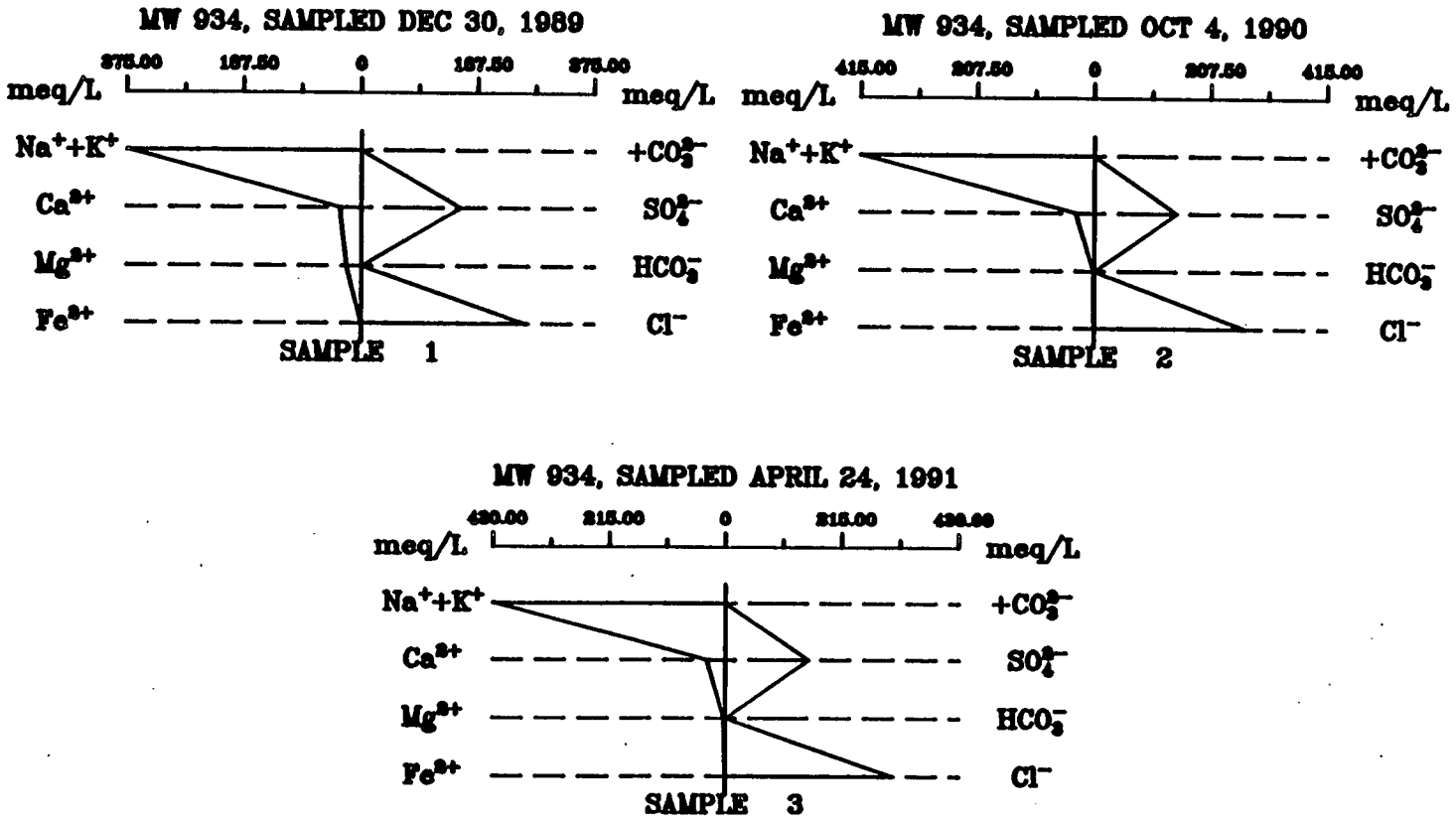


FIGURE D.7.13
STIFF DIAGRAMS FOR MONITOR WELL 934
MEXICAN HAT, UTAH, SITE

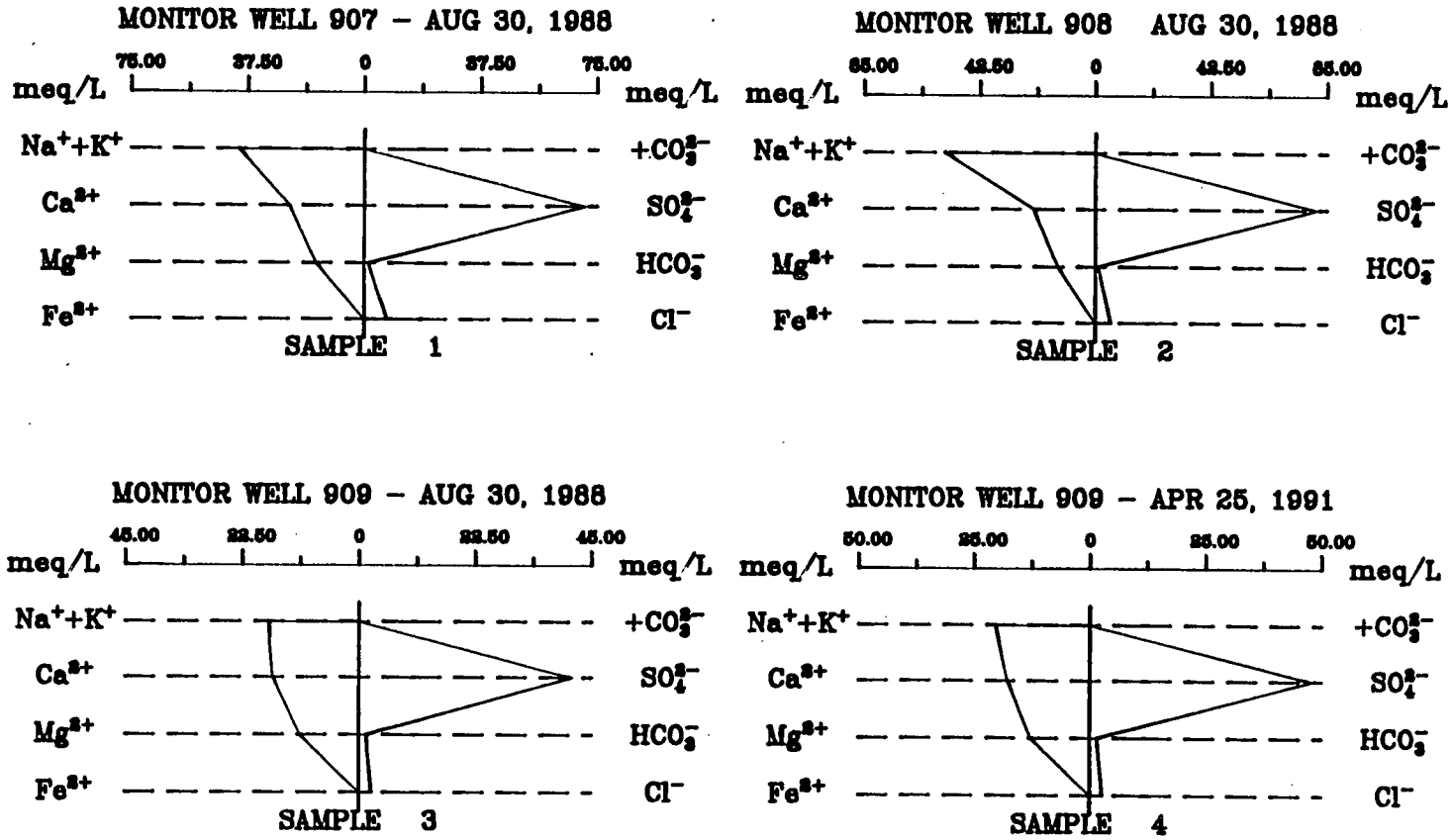


FIGURE D.7.14
STIFF DIAGRAMS FOR HONAKER TRAIL MONITOR WELLS
MEXICAN HAT, UTAH, SITE

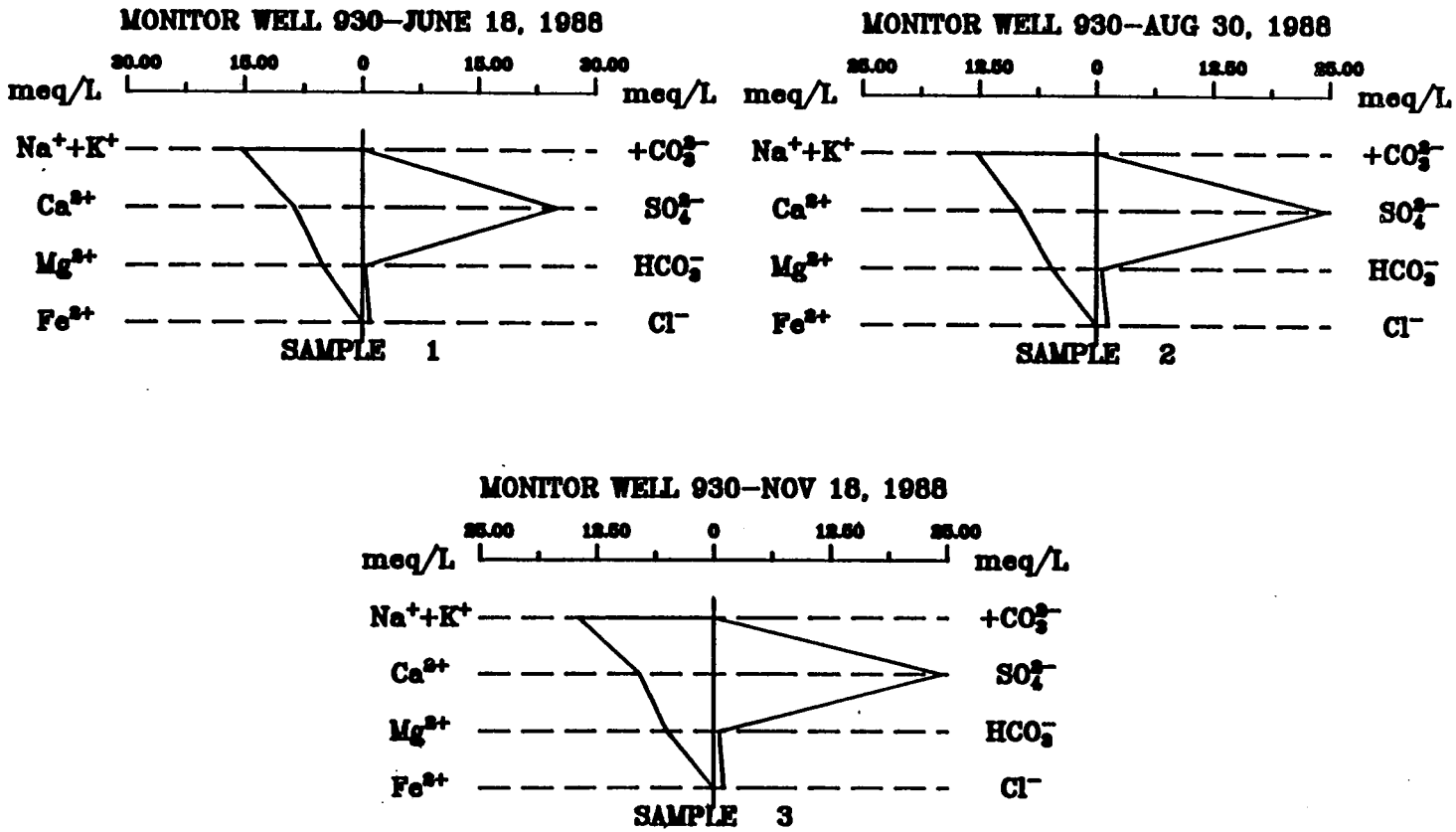


FIGURE D.7.14 (CONCLUDED)
STIFF DIAGRAMS FOR HONAKER TRAIL MONITOR WELLS
MEXICAN HAT, UTAH, SITE

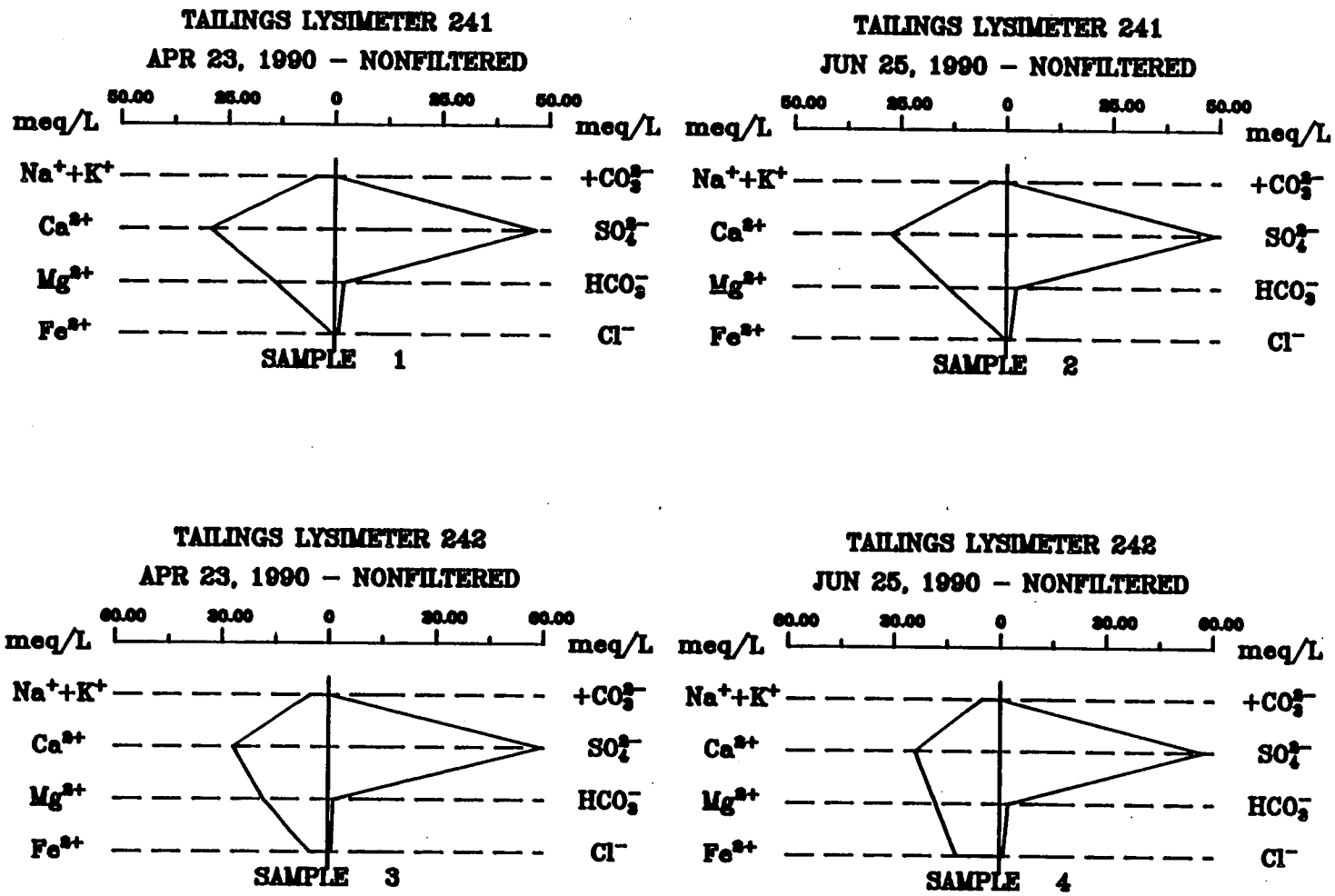


FIGURE D.7.15
STIFF DIAGRAMS FOR TAILINGS LYSIMETERS
MEXICAN HAT, UTAH, SITE

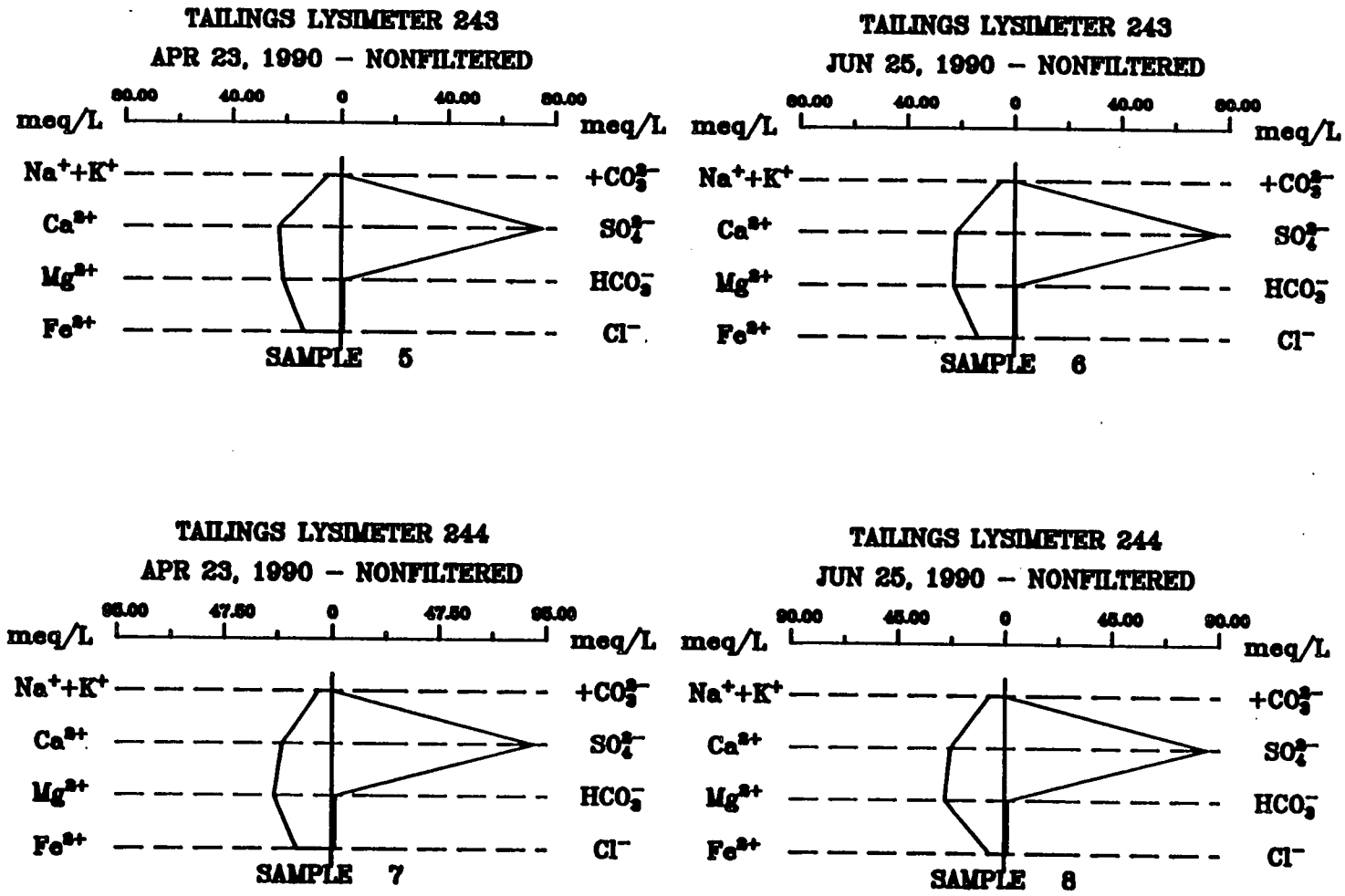


FIGURE D.7.15 (CONCLUDED)
STIFF DIAGRAMS FOR TAILINGS LYSIMETERS
MEXICAN HAT, UTAH, SITE

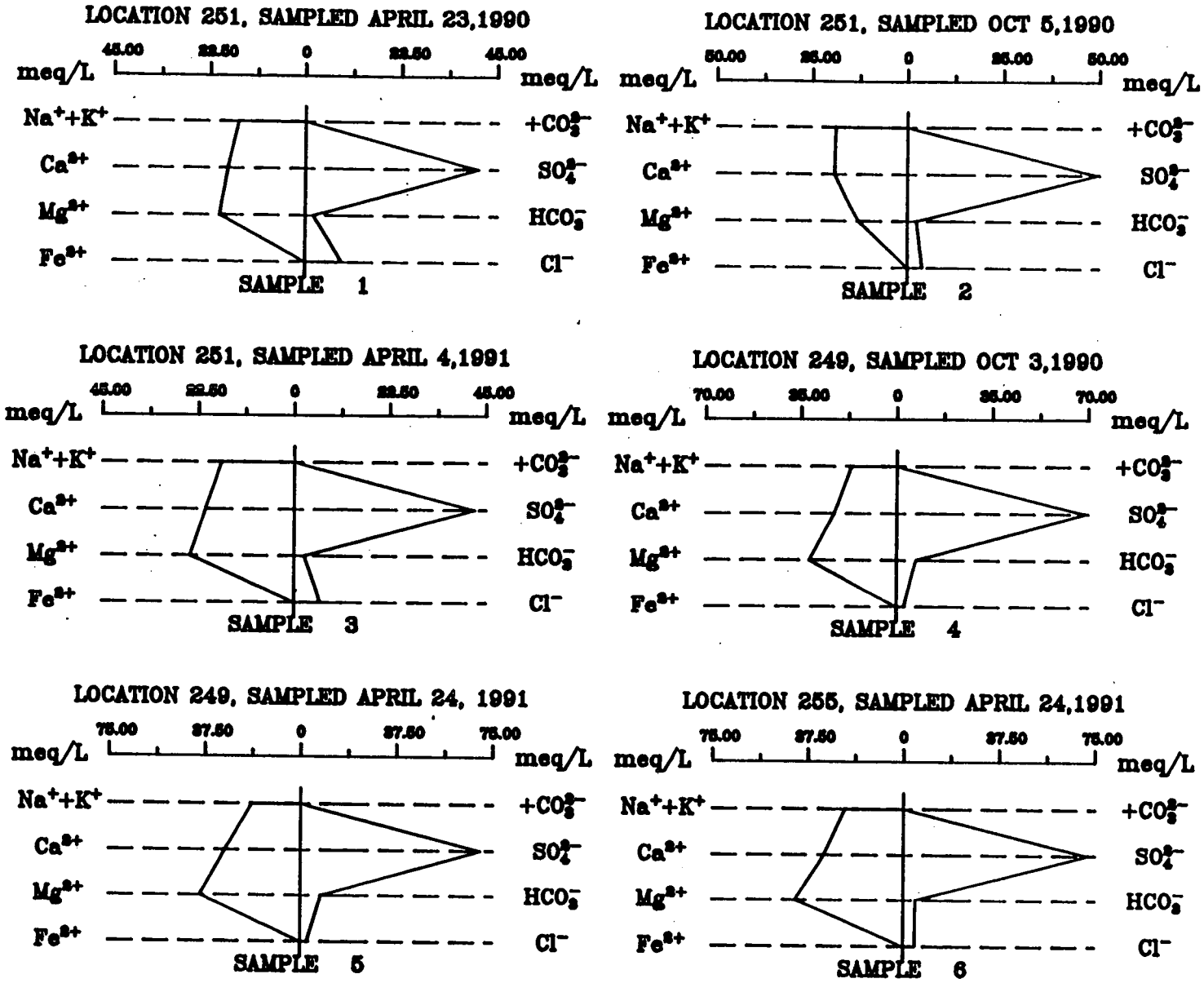


FIGURE D.7.16
STIFF DIAGRAMS FOR NORTH ARROYO SEEPS
MEXICAN HAT, UTAH, SITE

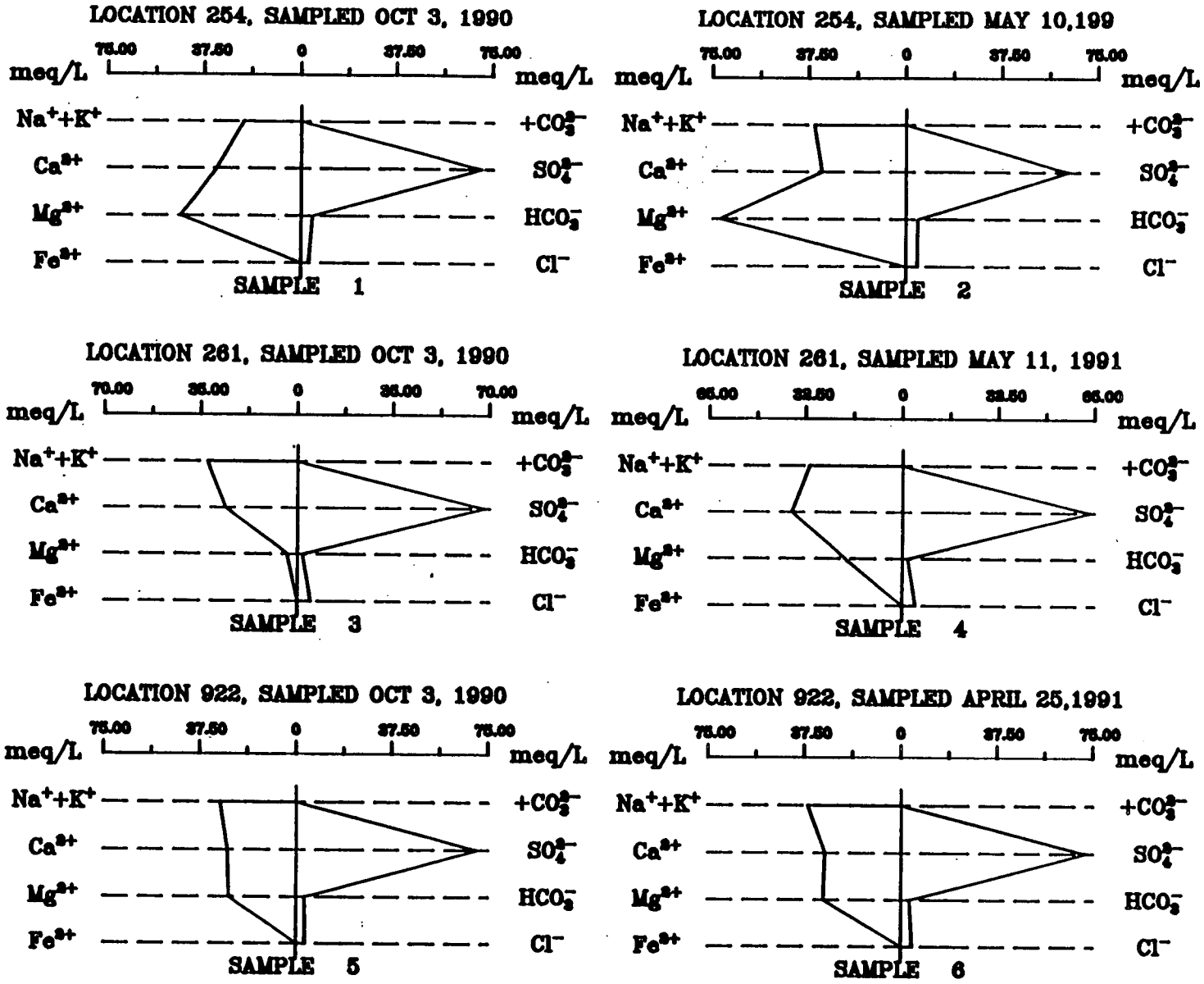
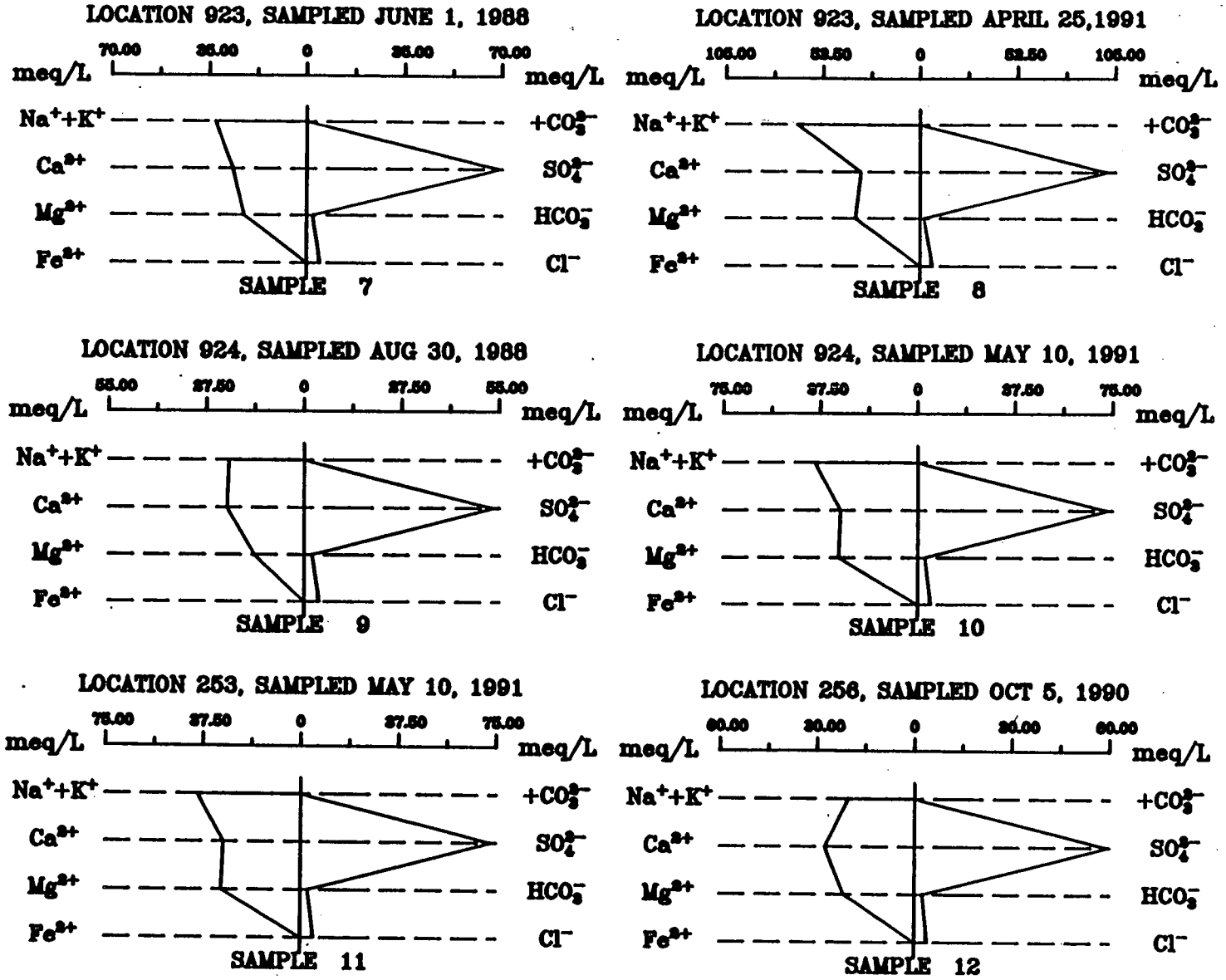


FIGURE D.7.17
STIFF DIAGRAMS FOR GYPSUM CREEK SEEPS
MEXICAN HAT, UTAH,



SITE FIGURE D.7.17 (CONCLUDED)
STIFF DIAGRAMS FOR GYPSUM CREEK SEEPS
MEXICAN HAT, UTAH, SITE

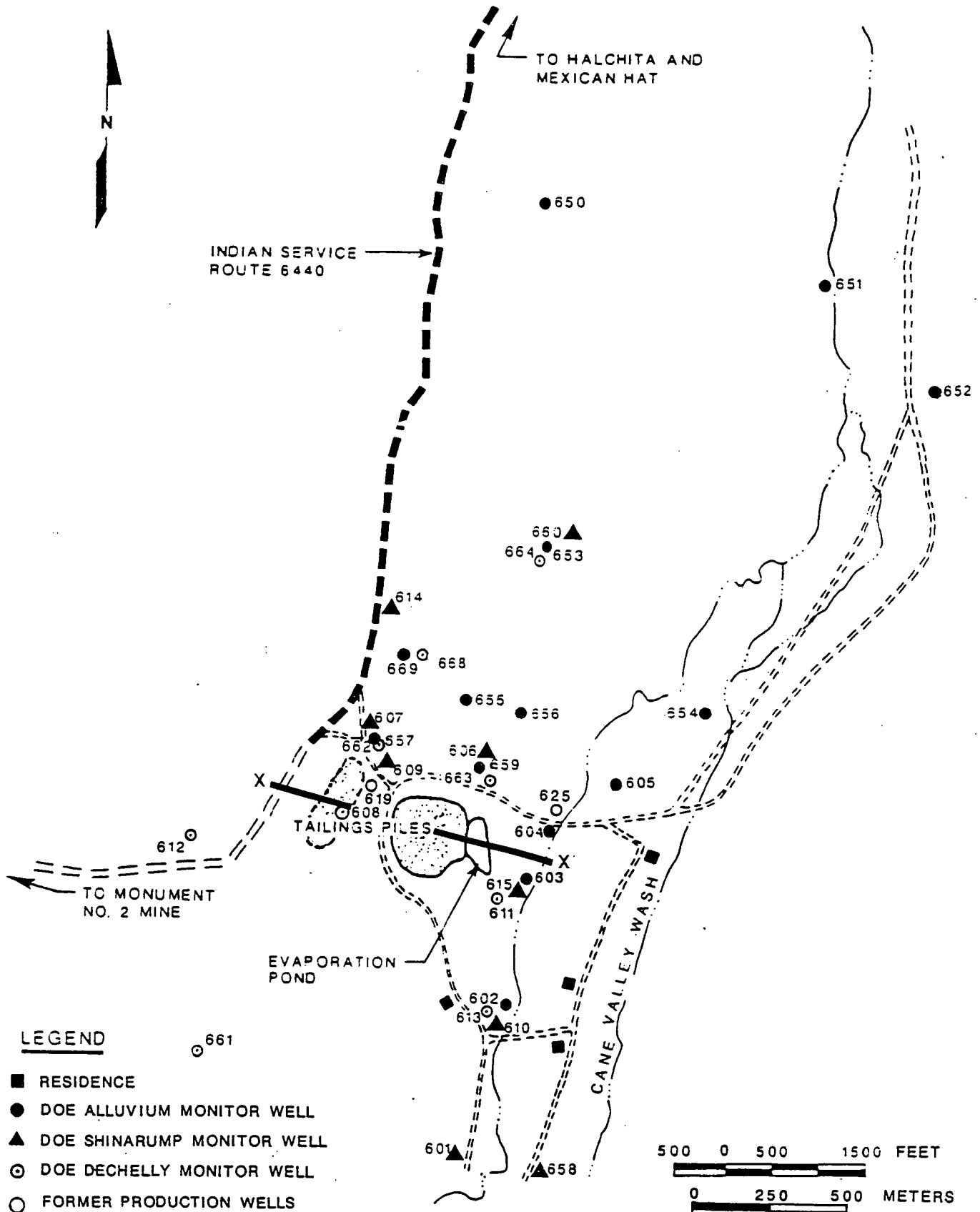


FIGURE D 7.18

LOCATIONS OF ALL MONITOR WELLS IN ALLUVIUM, SHINARUMP, AND DECHELLY AQUIFERS MONUMENT VALLEY SITE

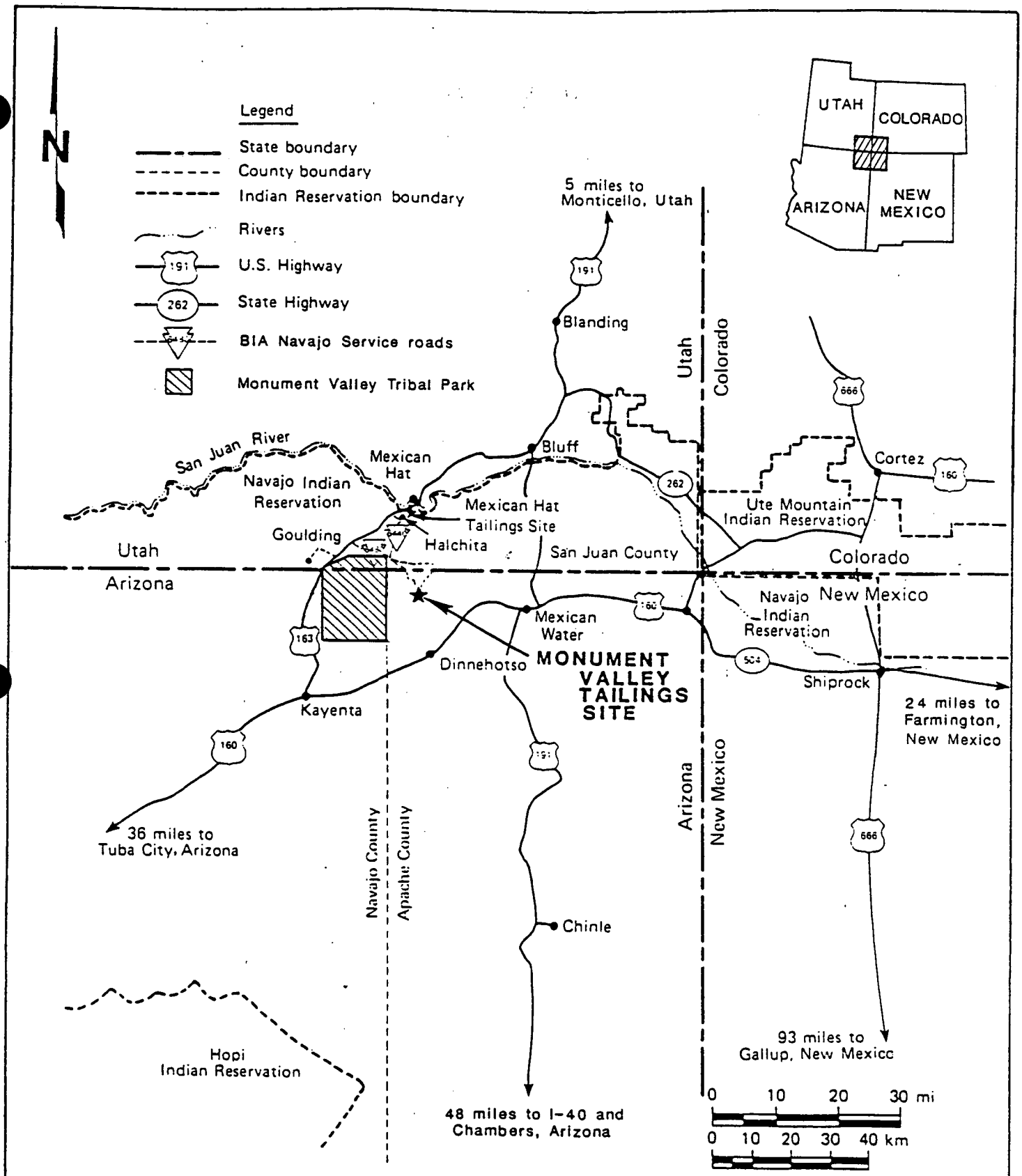


FIGURE D.7.19
MONUMENT VALLEY AND FOUR CORNERS AREA

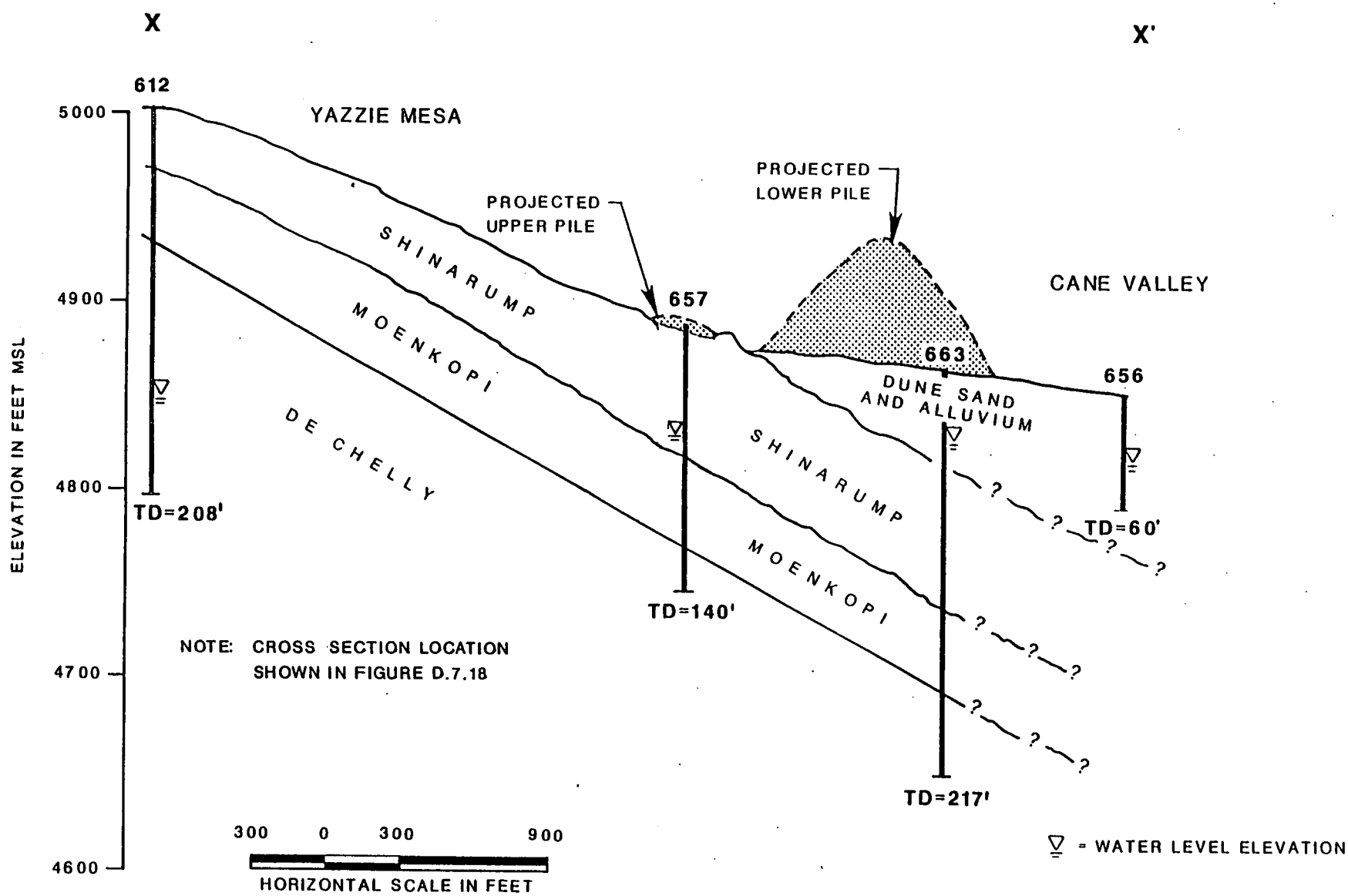


FIGURE D.7.20

STRATIGRAPHIC CROSS SECTION, MONUMENT VALLEY SITE

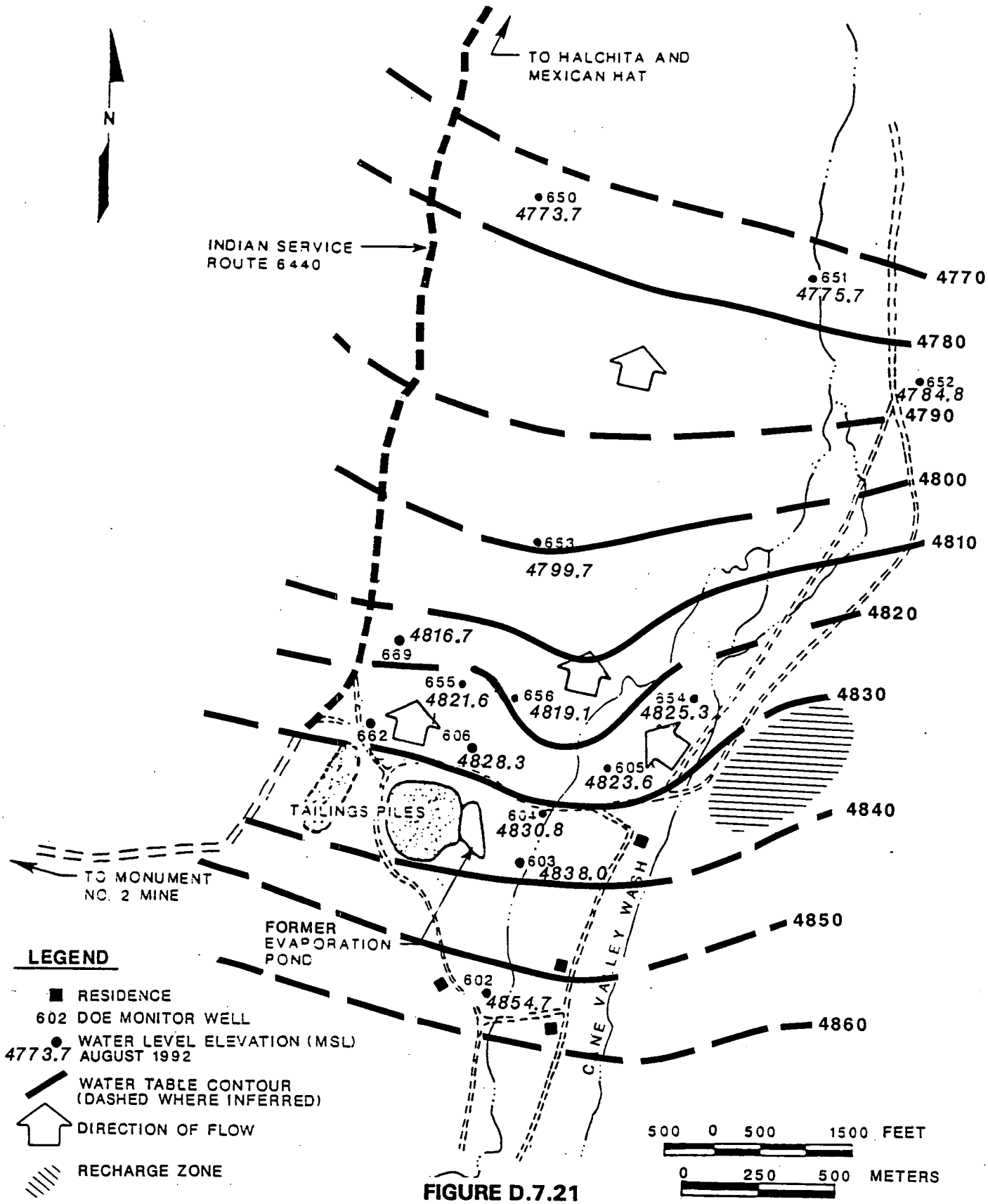


FIGURE D.7.21

ALLUVIUM MONITOR WELL LOCATIONS AND WATER TABLE SURFACE MONUMENT VALLEY SITE

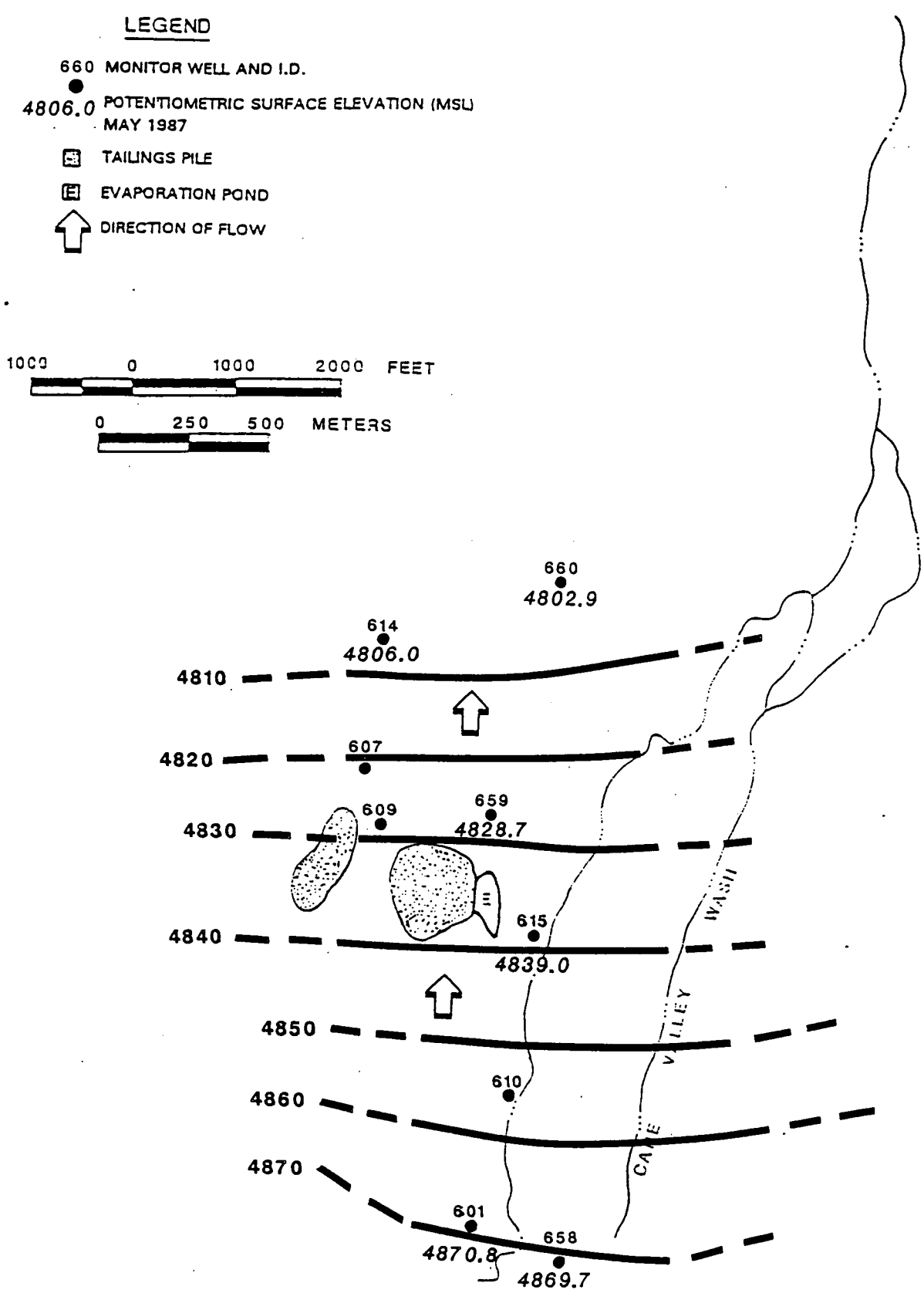


FIGURE D.7.22
LOCATIONS OF SHINARUMP MONITOR WELLS AND POTENTIOMETRIC SURFACE MONUMENT VALLEY SITE

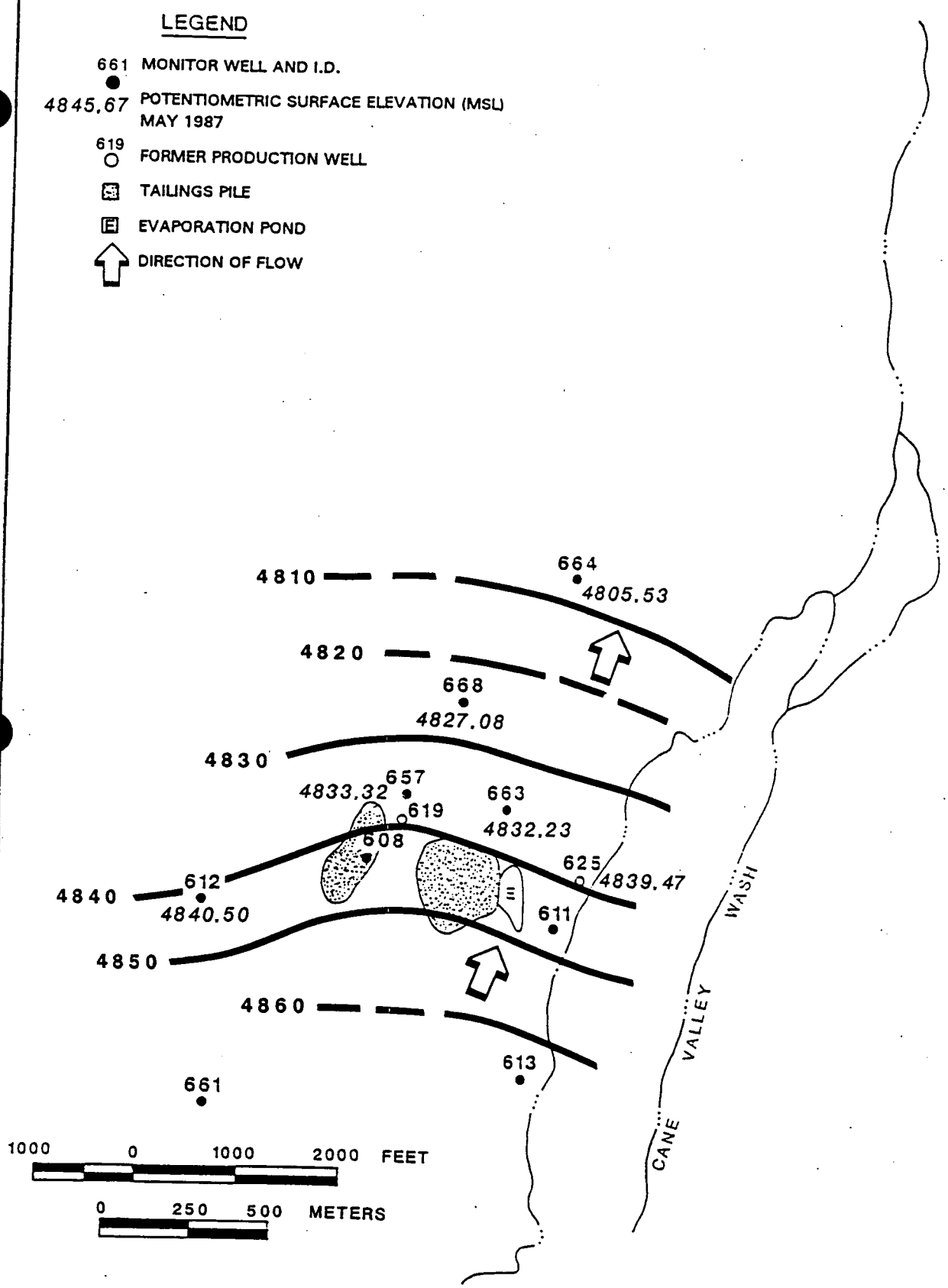


FIGURE D.7.23
LOCATIONS OF DE CHELLY SANDSTONE AQUIFER MONITOR WELLS AND POTENTIOMETRIC SURFACE MONUMENT VALLEY SITE

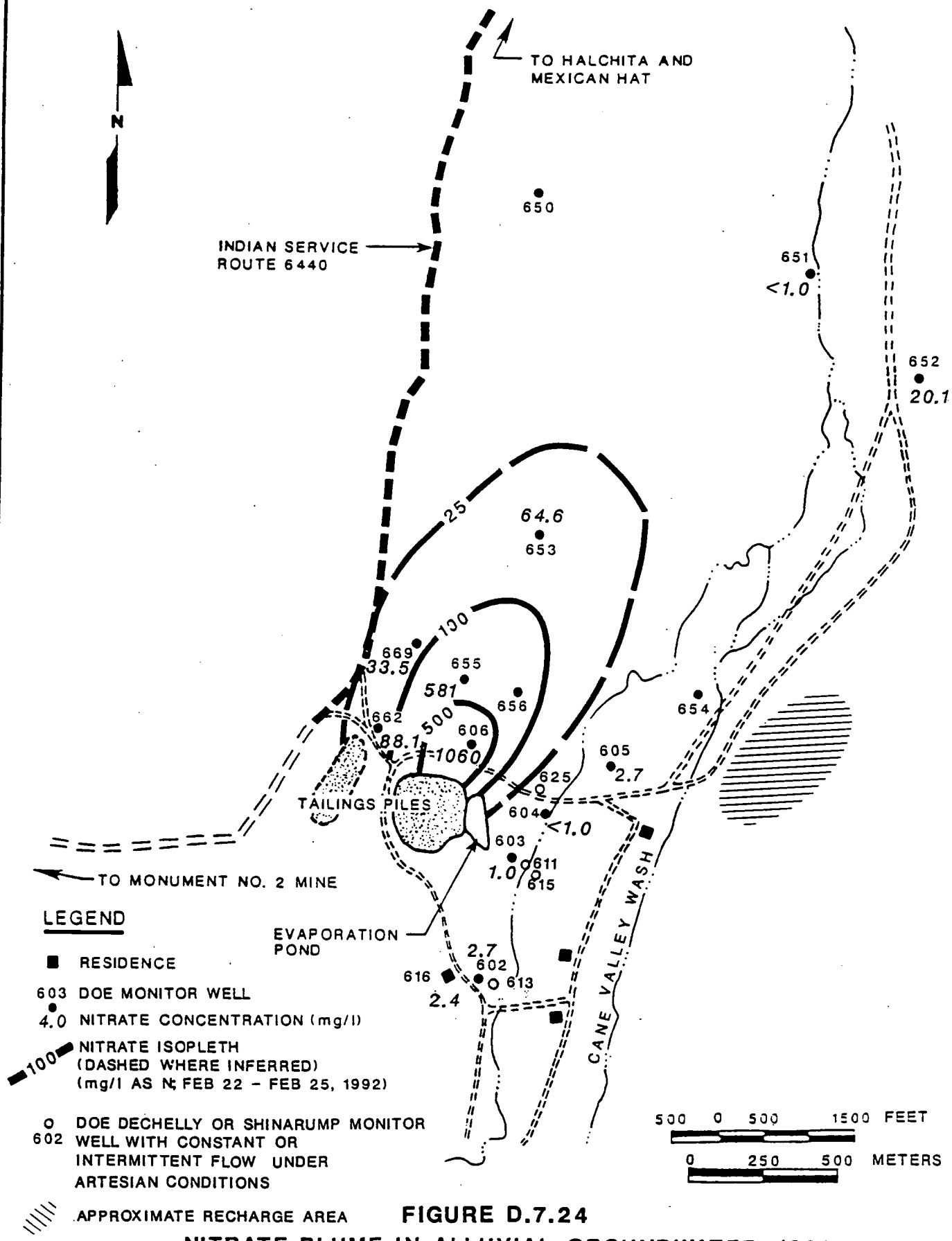


FIGURE D.7.24

NITRATE PLUME IN ALLUVIAL GROUNDWATER, 1991
MONUMENT VALLEY SITE

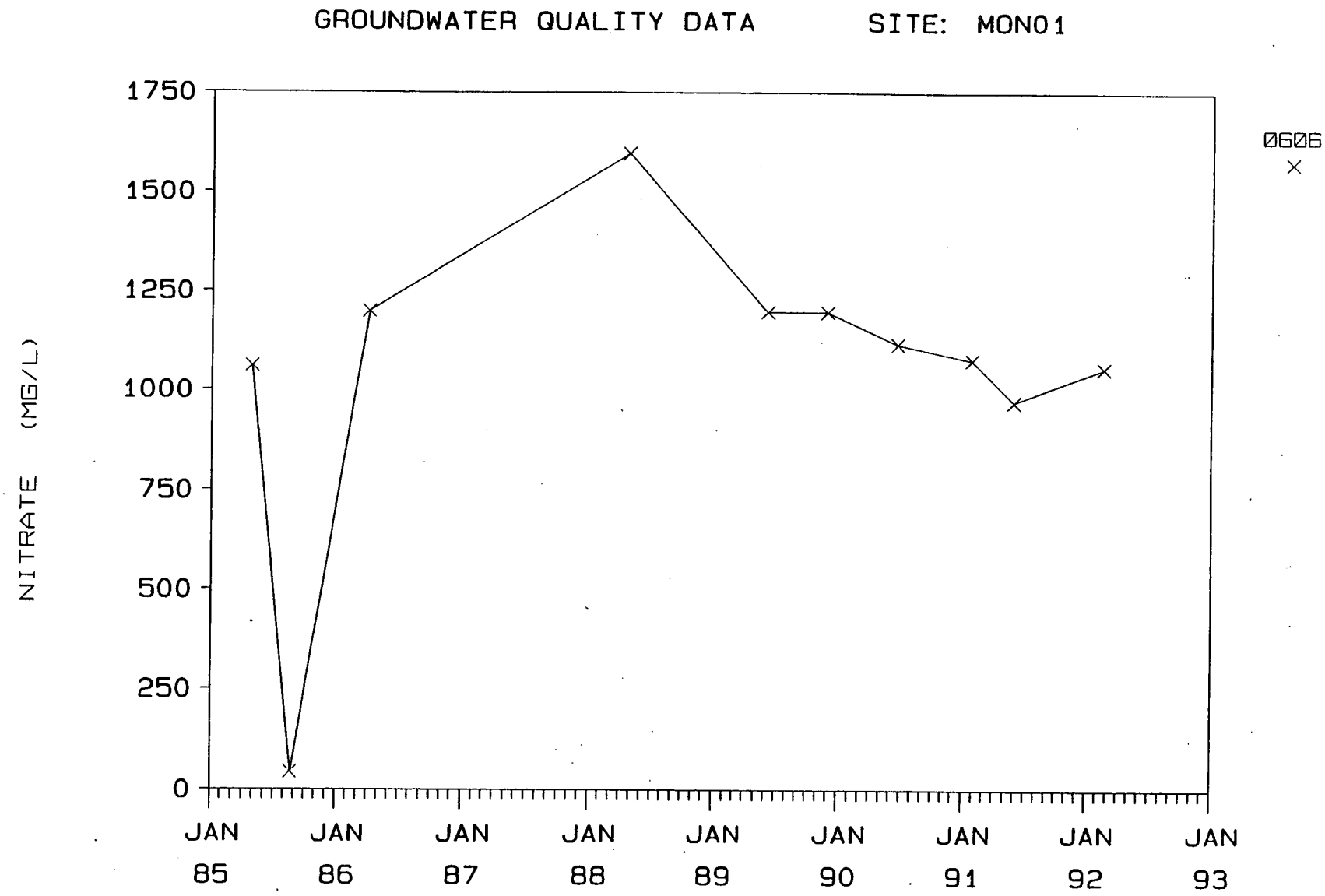


FIGURE D.7.25
NITRATE CONCENTRATIONS IN MONITOR WELL 606

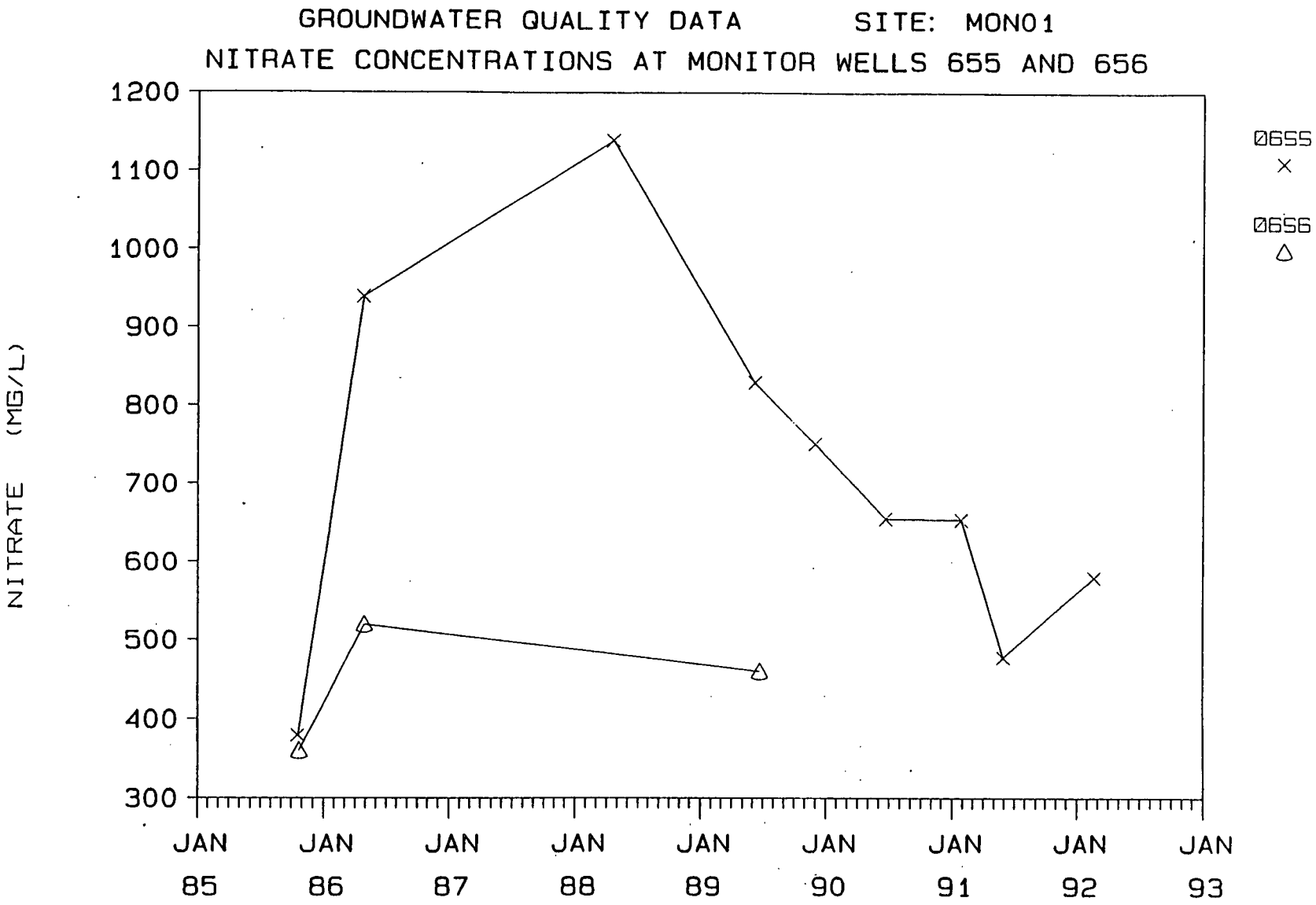


FIGURE D.7.26
NITRATE CONCENTRATIONS IN MONITOR WELLS 655 AND 656

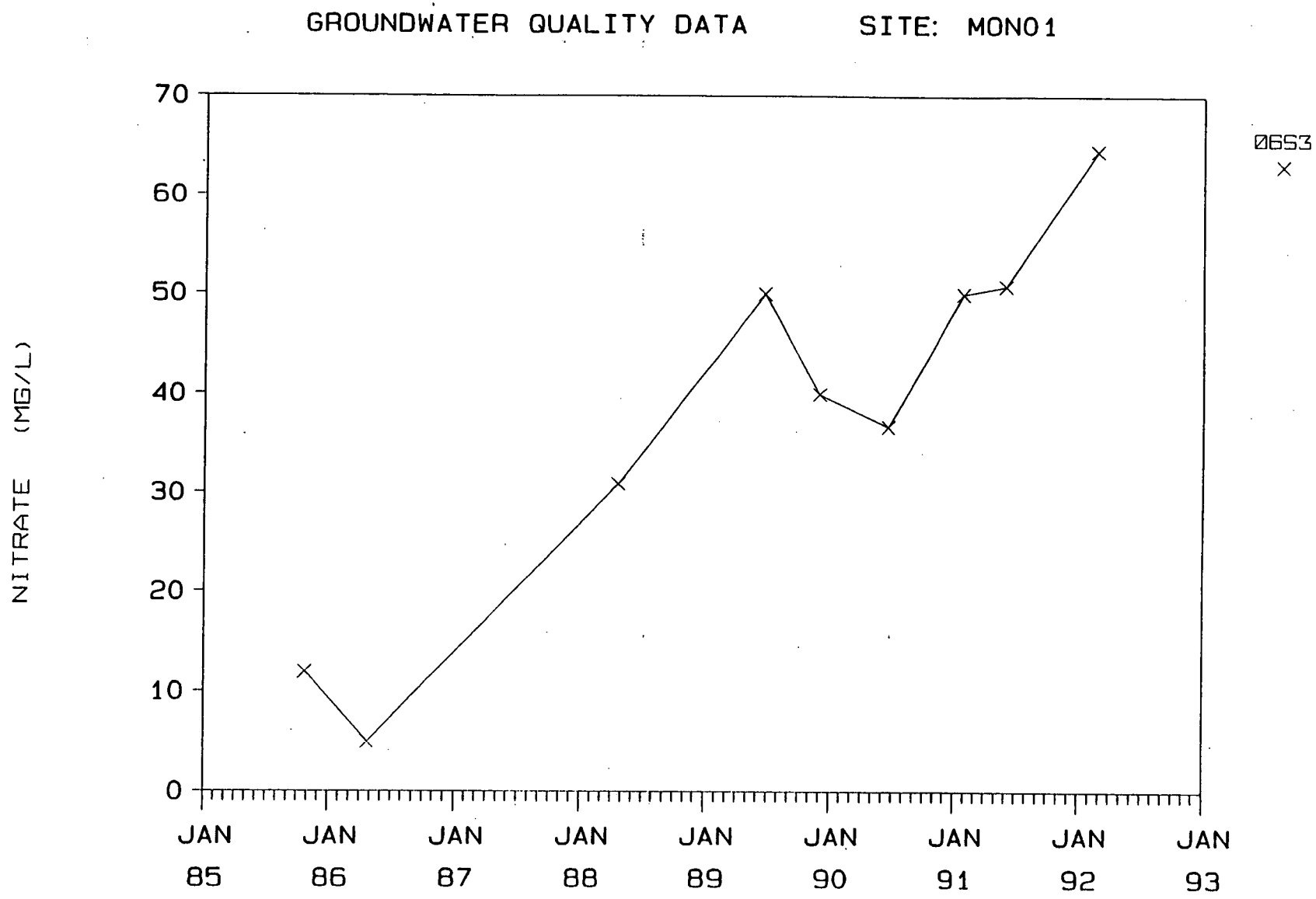


FIGURE D.7.27
NITRATE CONCENTRATIONS IN MONITOR WELL 653

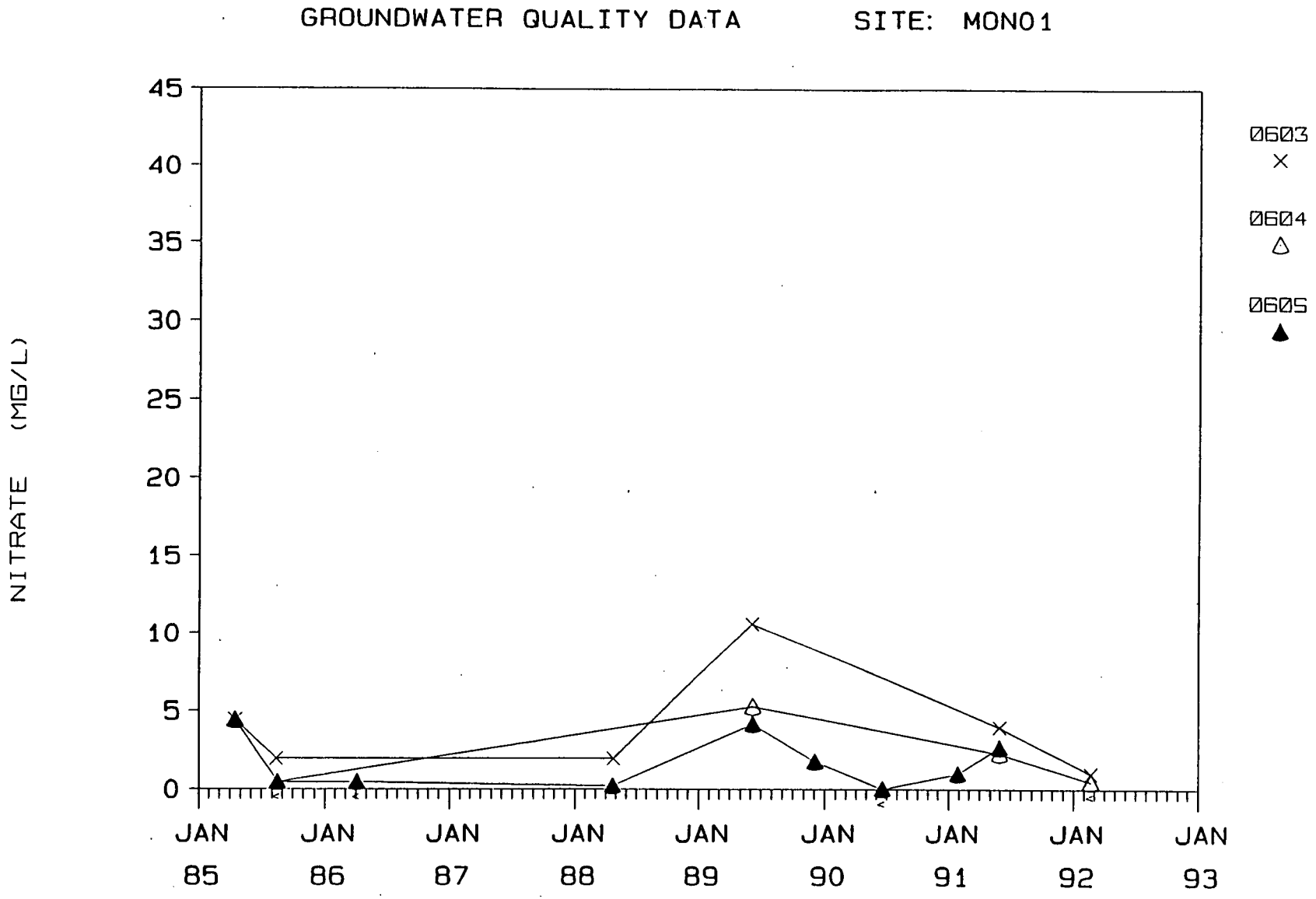


FIGURE D.7.28
NITRATE CONCENTRATIONS IN MONITOR WELLS 603, 604, AND 605

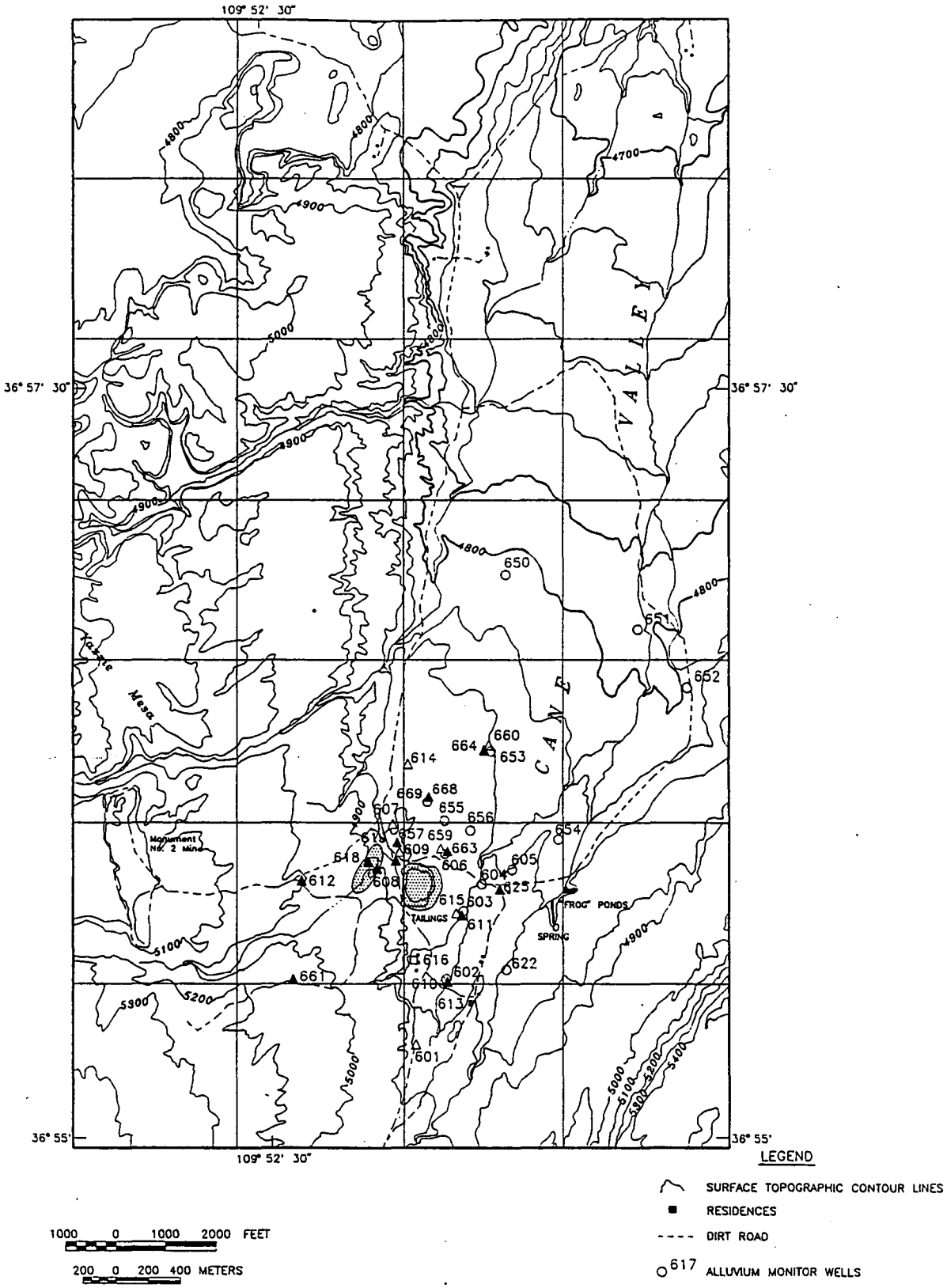


FIGURE D.7.29
SITE AREA, TOPOGRAPHY, MONITOR WELLS, AND DOMESTIC WELLS
MONUMENT VALLEY, UTAH

TABLE D.7.1 - MONITOR WELL INFORMATION: ALL EXISTING AND ABANDONED MONITOR WELLS COMPLETED IN THE HALGAITO SHALE AND HONAKER TRAIL FORMATION
SITE: HAT01 MEXICAN HAT
REPORT DATE: 02/10/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	GROUND ELEVATION (FT MSL)	BOREHOLE DEPTH (FT) *	CASING STICKUP (FT)	CASING ELEVATION (FT MSL)	CASING DEPTH (FT) *	CASING + DIAMETER (INCHES)	SCREEN * BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	FLOW CODE	FORMATION OF COMPLETION
0905	10006.3	9544.2	4294.13	12.00	1.50	4295.63	12.00	2.000	12.00	5.0	O	HM
0906	10137.5	11703.1	4220.83	11.75	2.21	4223.04	12.00	2.000	13.80	5.0	O	HM
0907	10154.1	11692.4	4220.51	125.00	1.15	4221.66	110.00	0.750	107.00	3.0	N	RI
0908	10019.3	9538.7	4294.60	163.00	-1.97	4292.63	162.00	2.000	145.00	37.0	N	RI
0909	7925.5	7134.4	4349.77	157.00	-14.47	4335.30	155.00	2.000	130.00	20.0	N	RI
0910	8336.5	10067.7	4353.22	182.00	18.38	4371.60	140.00	2.000	140.00	40.0	D	HM
0911	9508.4	11114.0	4294.35	105.00	-1.82	4292.53	105.00	2.000	93.00	10.0	O	HM
0912	9527.0	11133.4	4294.43	84.00	-2.23	4292.20	82.00	2.000	62.00	20.0	O	HM
0920	9865.0	10715.0	4290.00	57.58	-	-	-	-	-	-	N	NR
0921	9730.0	11140.0	4292.00	-	-	-	-	-	-	-	N	AL
0922	13366.9	12399.2	4066.09	-	-	-	-	-	-	-	N	NR
0923	11411.4	12369.1	4101.54	-	-	-	-	-	-	-	N	NR
0924	11552.4	13298.4	4118.64	-	-	-	-	-	-	-	N	NR
0930	10550.3	7733.0	4311.65	116.00	2.38	4314.03	114.00	4.000	104.00	10.0	N	RI
0931	12083.0	9971.0	4316.27	177.00	2.91	4319.18	-	-	-	-	N	NR
0932	13167.7	12636.3	4225.13	193.00	3.36	4228.49	-	-	-	-	N	NR
0933	7782.3	8444.7	4365.03	175.00	3.05	4368.08	-	-	-	-	N	NR
0934	9221.3	11989.9	4289.27	200.00	2.47	4291.74	200.00	4.000	188.00	10.0	D	HM
0935	10023.8	12468.3	4230.62	187.00	2.44	4233.06	190.00	4.000	178.00	10.0	D	RI
0936	11391.7	10912.3	4182.90	142.00	2.08	4184.98	-	-	-	-	N	NR

* DEPTH GIVEN IN FEET BELOW GROUND SURFACE

+ CASING DIAMETER = INSIDE DIAMETER

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER
RI - HONAKER TRAIL
NR - NO RECOVERY OF DATA FOR CLASSIFYING
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
O - ON-SITE
N - UNKNOWN
D - DOWN GRADIENT

DATA FILE: M:\DART\HAT01\MWI10000.DAT

FIELDS DISPLAYED WITH A DASH INDICATE THE DATA IS UNAVAILABLE

Table D.7.2 Summary of hydraulic characteristics of the Halgaito Shale Formation and Honaker Trail Formation at the Mexican Hat site[a]

Well number	Test method[b]	Tested interval[c]	Stratigraphic unit	Hydraulic conductivity (ft/day)[d]
908	F-K; C-B-P; Sk	145 - 160	Honaker Trail Formation	0.4
909	F-K; C-B-P; Sk	132 - 152	Honaker Trail Formation	0.03
911	P	53.5 - 64.5	Halgaito Shale Formation	0.75
		64.5 - 74.5		0.27
		74.5 - 84.5		0.19
		84.5 - 94.5		0.18
		94.5 - 104.5		0.014
912	B-R; H	62 - 82	Halgaito Shale Formation	0.6
930	F-K; Sk	106 - 116	Honaker Trail Formation	0.1
934	F-K; Sk	143 - 197	Honaker Trail Formation	0.04
		143 - 197		
935	F-K; Sk	170 - 187	Honaker Trail Formation	0.04
		170 - 187		

[a]Based on Mexican Hat Calculation HAT-07-91-14-02-00.
[b]Sk is Skibitske method; F-K is Ferris-Knowles method; C-B-P is Cooper-Bredehoeft-Papadopoulos method; P is packer test method; B-R is Bouwer-Rice method; H is Hvorslev method.
[c]Tested interval is in feet below the land surface.
[d]Arithmetic or geometric mean of all tests for the given interval.

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PVI	PARAMETER VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ALKALINITY	0910	07/30/85	0001	HM	D	MG/L CACO3		274.00		-	-
	0910	08/30/88	0001	HM	D			739.	!	-	-
	0911	04/13/85	0001	HM	O			294.00		-	-
	0912	04/13/85	0001	HM	O			887.00		-	-
	0912	07/29/85	0001	HM	O			790.00		-	-
	0912	05/18/88	0001	HM	O			1124.		-	-
	0912	08/30/88	0001	HM	O			1016.		-	-
ALUMINUM	0910	07/30/85	0001	HM	D	MG/L		0.20		0.1	-
	0910	08/30/88	0001	HM	D			0.1	!	0.1	-
	0911	04/13/85	0001	HM	O		<	0.10		0.1	-
	0912	04/13/85	0001	HM	O		<	0.10		0.1	-
	0912	07/29/85	0001	HM	O			0.40		0.1	-
	0912	05/18/88	0001	HM	O		<	0.1		0.1	-
	0912	08/30/88	0001	HM	O			0.3		0.1	-
AMMONIUM	0910	08/30/88	0001	HM	D	MG/L	<	0.1	!	0.1	-
	0911	04/13/85	0001	HM	O			12.00		-	-
	0912	04/13/85	0001	HM	O			38.00		-	-
	0912	07/29/85	0001	HM	O			3.80		0.1	-
	0912	05/18/88	0001	HM	O			46.		0.1	-
	0912	08/30/88	0001	HM	O			54.		0.1	-
ANTIMONY	0910	07/30/85	0001	HM	D	MG/L		0.011		0.003	-
	0911	04/13/85	0001	HM	O		<	0.003		0.003	-
	0912	04/13/85	0001	HM	O		<	0.003		0.003	-
	0912	07/29/85	0001	HM	O			0.005		0.003	-
ARSENIC	0910	07/30/85	0001	HM	D	MG/L	<	0.01		0.01	-
	0910	08/30/88	0001	HM	D			0.02	!	0.01	-
	0911	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	07/29/85	0001	HM	O		<	0.01		0.01	-
	0912	05/18/88	0001	HM	O		<	0.01		0.01	-
	0912	08/30/88	0001	HM	O			0.03		0.01	-
BARIUM	0910	07/30/85	0001	HM	D	MG/L		0.10		0.1	-
	0911	04/13/85	0001	HM	O		<	0.10		0.1	-
	0912	04/13/85	0001	HM	O		<	0.10		0.1	-

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
! - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
BARIUM	0912	07/29/85	0001	HM	O	MG/L	<	0.10		0.1	-
	0912	05/18/88	0001	HM	O		<	0.1		0.1	-
BORON	0910	07/30/85	0001	HM	D	MG/L	<	0.10		0.1	-
	0911	04/13/85	0001	HM	O			1.30		0.1	-
	0912	04/13/85	0001	HM	O			0.70		0.1	-
	0912	07/29/85	0001	HM	O			0.10		0.1	-
BROMIDE	0911	04/13/85	0001	HM	O	MG/L	<	2.00		2.	-
	0912	04/13/85	0001	HM	O		<	2.00		2.	-
	0912	05/18/88	0001	HM	O		<	2.0		2.	-
CADMIUM	0910	07/30/85	0001	HM	D	MG/L	<	0.001		0.001	-
	0911	04/13/85	0001	HM	O		<	0.001		0.001	-
	0912	04/13/85	0001	HM	O		<	0.001		0.001	-
	0912	07/29/85	0001	HM	O		<	0.001		0.001	-
	0912	05/18/88	0001	HM	O		<	0.001		0.001	-
CALCIUM	0910	07/30/85	0001	HM	D	MG/L		180.00		0.01	-
	0910	08/30/88	0001	HM	D			174.	!	0.01	-
	0911	04/13/85	0001	HM	O			575.00		0.01	-
	0912	04/13/85	0001	HM	O			610.00		0.01	-
	0912	07/29/85	0001	HM	O			530.00		0.01	-
	0912	05/18/88	0001	HM	O			640.		0.01	-
	0912	08/30/88	0001	HM	O			555.		0.01	-
CHLORIDE	0910	07/30/85	0001	HM	D	MG/L		170.00		1.	-
	0910	08/30/88	0001	HM	D			160.	!	1.	-
	0911	04/13/85	0001	HM	O			100.00		-	-
	0912	04/13/85	0001	HM	O			88.00		1.	-
	0912	07/29/85	0001	HM	O			81.00		1.	-
	0912	05/18/88	0001	HM	O			76.		1.	-
	0912	08/30/88	0001	HM	O			82.9		1.	-
CHROMIUM	0910	07/30/85	0001	HM	D	MG/L		0.06		0.01	-
	0910	08/30/88	0001	HM	D			0.07	!	0.01	-
	0911	04/13/85	0001	HM	O			0.04	I	0.01	-
	0912	04/13/85	0001	HM	O			0.03		0.01	-

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
O - ON-SITE
D - DOWN GRADIENT

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
! - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PVI	PARAMETER VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
CHROMIUM	0912	07/29/85	0001	HM	O	MG/L		0.08		0.01	-
	0912	05/18/88	0001	HM	O		<	0.01		0.01	-
	0912	08/30/88	0001	HM	O			0.16		0.01	-
COBALT	0910	07/30/85	0001	HM	D	MG/L	<	0.05		0.05	-
	0911	04/13/85	0001	HM	O		<	0.05		0.05	-
	0912	04/13/85	0001	HM	O		<	0.05		0.05	-
	0912	07/29/85	0001	HM	O		<	0.05		0.05	-
COPPER	0910	07/30/85	0001	HM	D	MG/L		0.04		0.02	-
	0911	04/13/85	0001	HM	O			0.02		0.02	-
	0912	04/13/85	0001	HM	O			0.02		0.02	-
	0912	07/29/85	0001	HM	O			0.05		0.02	-
CYANIDE	0911	04/13/85	0001	HM	O	MG/L	<	0.01		0.01	-
	0912	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	07/29/85	0001	HM	O		<	0.01		0.01	-
FLUORIDE	0910	07/30/85	0001	HM	D	MG/L		0.70		0.1	-
	0910	08/30/88	0001	HM	D			0.7	!	0.1	-
	0911	04/13/85	0001	HM	O			0.40		0.1	-
	0912	04/13/85	0001	HM	O			0.60		0.1	-
	0912	07/29/85	0001	HM	O			0.60		0.1	-
	0912	05/18/88	0001	HM	O			0.7		0.1	-
	0912	08/30/88	0001	HM	O			0.6		0.1	-
GROSS ALPHA	0910	08/30/88	0001	HM	D	PCI/L		39.	!	0.2	12.
	0911	04/13/85	0001	HM	O			330.00		0.2	50.00000
	0912	04/13/85	0001	HM	O			510.00		0.2	60.00000
	0912	07/29/85	0001	HM	O			620.00		0.2	80.00000
	0912	05/18/88	0001	HM	O			450.		0.2	64.
	0912	08/30/88	0001	HM	O			370.		0.2	70.
GROSS BETA	0910	08/30/88	0001	HM	D	PCI/L		13.	!	1.	6.
	0911	04/13/85	0001	HM	O			180.00		1.	20.00000
	0912	04/13/85	0001	HM	O			220.00		1.	20.00000
	0912	07/29/85	0001	HM	O			220.00		1.	30.00000
	0912	05/18/88	0001	HM	O			204.		1.	37.
	0912	08/30/88	0001	HM	O			200.		1.	30.

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
O - ON-SITE
D - DOWN GRADIENT

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
! - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
IRON	0910	07/30/85	0001	HM	D	MG/L		0.06		0.03	-
	0910	08/30/88	0001	HM	D			0.04	!	0.03	-
	0911	04/13/85	0001	HM	O			0.09		0.03	-
	0912	04/13/85	0001	HM	O			0.21		0.03	-
	0912	07/29/85	0001	HM	O			0.06		0.03	-
	0912	05/18/88	0001	HM	O		<	0.03		0.03	-
	0912	08/30/88	0001	HM	O			0.12		0.03	-
LEAD	0910	07/30/85	0001	HM	D	MG/L		0.03		0.01	-
	0911	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	07/29/85	0001	HM	O			0.02		0.01	-
LEAD-210	0911	04/13/85	0001	HM	O	PCI/L		1.10		1.5	1.80000
	0912	04/13/85	0001	HM	O			1.30		1.5	1.80000
	0912	07/29/85	0001	HM	O			1.10		1.5	0.80000
MAGNESIUM	0910	07/30/85	0001	HM	D	MG/L		86.90		0.001	-
	0910	08/30/88	0001	HM	D			89.6	!	0.001	-
	0911	04/13/85	0001	HM	O			348.00		-	-
	0912	04/13/85	0001	HM	O			423.00		-	-
	0912	07/29/85	0001	HM	O			430.00		0.001	-
	0912	05/18/88	0001	HM	O			550.		0.001	-
	0912	08/30/88	0001	HM	O			460.		0.001	-
MANGANESE	0910	07/30/85	0001	HM	D	MG/L		0.15		0.01	-
	0910	08/30/88	0001	HM	D			0.03	!	0.01	-
	0911	04/13/85	0001	HM	O			0.38		0.01	-
	0912	04/13/85	0001	HM	O			3.27		0.01	-
	0912	07/29/85	0001	HM	O			2.54		0.01	-
	0912	05/18/88	0001	HM	O			2.38		0.01	-
	0912	08/30/88	0001	HM	O			3.11		0.01	-
MERCURY	0910	07/30/85	0001	HM	D	MG/L	<	0.0002		0.0002	-
	0911	04/13/85	0001	HM	O		<	0.0002		0.0002	-
	0912	04/13/85	0001	HM	O			0.0004		0.0002	-
	0912	07/29/85	0001	HM	O		<	0.0002		0.0002	-
	0912	05/18/88	0001	HM	O			0.0006		0.0002	-
MOLYBDENUM	0910	07/30/85	0001	HM	D	MG/L		0.10		0.01	-

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
! - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MOLYBDENUM	0910	08/30/88	0001	HM	D	MG/L		0.04	I	0.01	-
	0911	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	07/29/85	0001	HM	O			0.15		0.01	-
	0912	05/18/88	0001	HM	O			0.01		0.01	-
	0912	08/30/88	0001	HM	O			0.11		0.01	-
NET GROSS ALPHA *	0910	08/30/88	0001	HM	D	PCI/L		17.53		-	-
	0911	04/13/85	0001	HM	O			-82.97		-	-
	0912	04/13/85	0001	HM	O			4.42		-	-
	0912	07/29/85	0001	HM	O			87.66		-	-
	0912	05/18/88	0001	HM	O			-71.36		-	-
	0912	08/30/88	0001	HM	O			-145.87		-	-
NICKEL	0910	07/30/85	0001	HM	D	MG/L		0.11		0.04	-
	0910	08/30/88	0001	HM	D		<	0.04	I	0.04	-
	0911	04/13/85	0001	HM	O			0.08		0.04	-
	0912	04/13/85	0001	HM	O			0.16		0.04	-
	0912	07/29/85	0001	HM	O			0.20		0.04	-
	0912	05/18/88	0001	HM	O			0.14		0.04	-
	0912	08/30/88	0001	HM	O			0.25		0.04	-
NITRATE	0910	08/30/88	0001	HM	D	MG/L		18.	I	1.	-
	0911	04/13/85	0001	HM	O			8.10		-	-
	0912	04/13/85	0001	HM	O			8.00		-	-
	0912	07/29/85	0001	HM	O		<	1.00		1.	-
	0912	05/18/88	0001	HM	O			286.		1.	-
	0912	08/30/88	0001	HM	O			230.		1.	-
NITRITE	0911	04/13/85	0001	HM	O	MG/L		0.00	c	0.	-
	0912	04/13/85	0001	HM	O			0.00	c	0.	-
	0912	07/29/85	0001	HM	O		<	0.10		0.1	-
NITRITE AND NITRATE	0910	08/30/88	0001	HM	D	MG/L		4.1	I	1.	-
	0912	05/18/88	0001	HM	O			65.		1.	-
	0912	08/30/88	0001	HM	O			52.		1.	-

* NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
I - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.
c - CHANGED DETECTION LIMIT

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
PH	0910	07/30/85	0001	HM	D	SU		7.36		-	-
	0910	08/30/88	0001	HM	D			7.40		-	-
	0911	04/13/85	0001	HM	O			7.74		-	-
	0912	04/13/85	0001	HM	O			6.69		-	-
	0912	07/29/85	0001	HM	O			6.15		-	-
	0912	05/18/88	0001	HM	O			6.39		-	-
	0912	08/30/88	0001	HM	O			6.48		-	-
PHOSPHATE	0910	07/30/85	0001	HM	D	MG/L	<	0.10		0.1	-
	0911	04/13/85	0001	HM	O			0.20		0.1	-
	0912	04/13/85	0001	HM	O			0.20		0.1	-
	0912	07/29/85	0001	HM	O		<	0.10		0.1	-
	0912	05/18/88	0001	HM	O		<	0.1		0.1	-
POLONIUM-210	0911	04/13/85	0001	HM	O	PCI/L	<	0.60000	b	1.	0.60000
	0912	04/13/85	0001	HM	O			0.40		1.	0.80000
	0912	07/29/85	0001	HM	O		<	0.70000	b	1.	0.70000
POTASSIUM	0910	07/30/85	0001	HM	D	MG/L		7.80		0.01	-
	0910	08/30/88	0001	HM	D			5.5	!	0.01	-
	0911	04/13/85	0001	HM	O			28.30		-	-
	0912	04/13/85	0001	HM	O			23.60		-	-
	0912	07/29/85	0001	HM	O			26.80		0.01	-
	0912	05/18/88	0001	HM	O			19.5		0.01	-
	0912	08/30/88	0001	HM	O			27.0		0.01	-
RADIUM-226	0910	08/30/88	0001	HM	D	PCI/L		0.2	!c	0.4	0.2
	0911	04/13/85	0001	HM	O			1.10		1.	0.60000
	0912	04/13/85	0001	HM	O			0.40	c	0.8	0.40000
	0912	07/29/85	0001	HM	O			0.30	c	0.5	0.20000
	0912	05/18/88	0001	HM	O			0.9		1.	0.5
	0912	08/30/88	0001	HM	O			0.2	c	0.4	0.2
RADIUM-226 + RADIUM-228	0910	08/30/88	0001	HM	D	PCI/L		1.00		-	-
	0911	04/13/85	0001	HM	O			1.60		-	-
	0912	04/13/85	0001	HM	O			1.00		-	-
	0912	07/29/85	0001	HM	O			0.80		-	-

FORMATION OF COMPLETION CODE:
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FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
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OTHER PARAMETER VALUE FLAGS:
! - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.
b - CHANGED PARAMETER VALUE
c - CHANGED DETECTION LIMIT

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
RADIUM-226 + RADIUM-228	0912	05/18/88	0001	HM	O	PCI/L		1.40		-	-
	0912	08/30/88	0001	HM	O			0.70		-	-
RADIUM-228	0910	08/30/88	0001	HM	D	PCI/L		0.8	!	1.	1.0
	0911	04/13/85	0001	HM	O			0.50		1.	2.40000
	0912	04/13/85	0001	HM	O			0.60		1.	2.00000
	0912	07/29/85	0001	HM	O		<	1.20000	b	1.	1.20000
	0912	05/18/88	0001	HM	O			0.5		1.	1.3
	0912	08/30/88	0001	HM	O		<	0.9	b	1.	0.9
SELENIUM	0910	07/30/85	0001	HM	D	MG/L	<	0.005		0.005	-
	0911	04/13/85	0001	HM	O		<	0.005		0.005	-
	0912	04/13/85	0001	HM	O		<	0.005		0.005	-
	0912	07/29/85	0001	HM	O		<	0.005		0.005	-
	0912	05/18/88	0001	HM	O		<	0.005		0.005	-
SILICA - SIO2	0910	08/30/88	0001	HM	D	MG/L		20.	!	2.	-
	0911	04/13/85	0001	HM	O			26.00		2.	-
	0912	04/13/85	0001	HM	O			32.00		2.	-
	0912	07/29/85	0001	HM	O			30.00		2.	-
	0912	05/18/88	0001	HM	O			36.		2.	-
	0912	08/30/88	0001	HM	O			34.		2.	-
SILVER	0910	07/30/85	0001	HM	D	MG/L	<	0.01		0.01	-
	0911	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	07/29/85	0001	HM	O		<	0.01		0.01	-
	0912	05/18/88	0001	HM	O		<	0.01		0.01	-
SODIUM	0910	07/30/85	0001	HM	D	MG/L		249.00		0.002	-
	0910	08/30/88	0001	HM	D			188.	!	0.002	-
	0911	04/13/85	0001	HM	O			454.00		-	-
	0912	04/13/85	0001	HM	O			340.00		-	-
	0912	07/29/85	0001	HM	O			390.00		0.002	-
	0912	05/18/88	0001	HM	O			600.		0.002	-
	0912	08/30/88	0001	HM	O			503.		0.002	-
SPECIFIC CONDUCTANCE	0910	07/30/85	0001	HM	D	UMHO/CM		2400.00		-	-

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
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D - DOWN GRADIENT

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
! - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.
b - CHANGED PARAMETER VALUE

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SPECIFIC CONDUCTANCE	0910	08/30/88	0001	HM	D	UMHO/CM		1750.		-	-
	0911	04/13/85	0001	HM	O			4500.00		-	-
	0912	04/13/85	0001	HM	O			4500.00		-	-
	0912	07/29/85	0001	HM	O			6550.00		-	-
	0912	05/18/88	0001	HM	O			4900.		-	-
	0912	08/30/88	0001	HM	O			4800.		-	-
STRONTIUM	0910	07/30/85	0001	HM	D	MG/L	<	0.10		0.1	-
	0911	04/13/85	0001	HM	O		<	0.10		0.1	-
	0912	04/13/85	0001	HM	O		<	0.10		0.1	-
	0912	07/29/85	0001	HM	O		<	0.10		0.1	-
SULFATE	0910	07/30/85	0001	HM	D	MG/L		947.00		0.1	-
	0910	08/30/88	0001	HM	D			901.	I	0.1	-
	0911	04/13/85	0001	HM	O			3170.00		-	-
	0912	04/13/85	0001	HM	O			3040.00		-	-
	0912	07/29/85	0001	HM	O			3100.00		0.1	-
	0912	05/18/88	0001	HM	O			3910.		0.1	-
	0912	08/30/88	0001	HM	O			3600.		0.1	-
SULFIDE	0911	04/13/85	0001	HM	O	MG/L	<	0.10		0.1	-
	0912	04/13/85	0001	HM	O		<	0.10		0.1	-
	0912	07/29/85	0001	HM	O		<	0.10		0.1	-
TEMPERATURE	0910	07/30/85	0001	HM	D	C - DEGREE		27.00		-	-
	0910	08/30/88	0001	HM	D			18.0		-	-
	0911	04/13/85	0001	HM	O			22.00		-	-
	0912	04/13/85	0001	HM	O			23.00		-	-
	0912	07/29/85	0001	HM	O			21.00		-	-
	0912	05/18/88	0001	HM	O			17.0		-	-
	0912	08/30/88	0001	HM	O			17.		-	-
THORIUM-230	0910	08/30/88	0001	HM	D	PCI/L	<	0.3	Id	0.1	0.3
	0911	04/13/85	0001	HM	O			7.20		1.	1.90000
	0912	04/13/85	0001	HM	O			1.30		1.	1.00000
	0912	07/29/85	0001	HM	O			0.20	c	0.7	0.50000
	0912	05/18/88	0001	HM	O			0.3	c	0.4	0.1

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
I - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.
c - CHANGED DETECTION LIMIT
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
THORIUM-230	0912	08/30/88	0001	HM	O	PCI/L	<	0.3	d	0.1	0.3
TIN	0910	07/30/85	0001	HM	D	MG/L	<	0.005		0.005	-
	0911	04/13/85	0001	HM	O		<	0.005		0.005	-
	0912	04/13/85	0001	HM	O		<	0.005		0.005	-
	0912	07/29/85	0001	HM	O		<	0.005		0.005	-
TOTAL DISSOLVED SOLIDS	0910	07/30/85	0001	HM	D	MG/L		1870.00		10.	-
	0910	08/30/88	0001	HM	D			1670.	I	10.	-
	0911	04/13/85	0001	HM	O			1960.00		10.	-
	0912	04/13/85	0001	HM	O			5250.00		10.	-
	0912	07/29/85	0001	HM	O			5390.00		10.	-
	0912	05/18/88	0001	HM	O			6670.		10.	-
	0912	08/30/88	0001	HM	O			6190.		10.	-
TOTAL ORGANIC CARBON	0912	07/29/85	0001	HM	O	MG/L		140.00		1.	-
URANIUM	0910	07/30/85	0001	HM	D	MG/L		0.0334		0.003	-
	0910	08/30/88	0001	HM	D			0.0313	I	0.003	-
	0911	04/13/85	0001	HM	O			0.602		0.003	-
	0912	04/13/85	0001	HM	O			0.737		0.003	-
	0912	07/29/85	0001	HM	O			0.776		0.003	-
	0912	05/18/88	0001	HM	O			0.76		0.003	-
	0912	08/30/88	0001	HM	O			0.752		0.003	-
VANADIUM	0910	07/30/85	0001	HM	D	MG/L		0.40		0.01	-
	0910	08/30/88	0001	HM	D			0.05	I	0.01	-
	0911	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	04/13/85	0001	HM	O		<	0.01		0.01	-
	0912	07/29/85	0001	HM	O			0.40		0.01	-
	0912	05/18/88	0001	HM	O			0.06		0.01	-
	0912	08/30/88	0001	HM	O			0.15		0.01	-
ZINC	0910	07/30/85	0001	HM	D	MG/L		0.178		0.005	-
	0910	08/30/88	0001	HM	D			0.030	I	0.005	-
	0911	04/13/85	0001	HM	O			0.05		0.005	-
	0912	04/13/85	0001	HM	O			0.06		0.005	-
	0912	07/29/85	0001	HM	O			0.028		0.005	-

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
O - ON-SITE
D - DOWN GRADIENT

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
I - THE DATA FAILED THE CATION/ANION QUALITY CONTROL TEST.
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE

TABLE D.7.3 - GROUNDWATER QUALITY DATA BY PARAMETER: HALGAITO SHALE
MONITOR WELLS 910, 911, AND 912
SITE: HAT01 MEXICAN HAT
04/13/85 TO 08/30/88
REPORT DATE: 02/11/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ZINC	0912	05/18/88	0001	HM	O	MG/L		0.034		0.005	-
	0912	08/30/88	0001	HM	O			0.052		0.005	-

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER

FLOW RELATIONSHIP CODE:
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

DATA FILE NAME: M:\DART\HAT01\GWQ10005.DAT

TABLE D.7.4 - GROUNDWATER QUALITY STATISTICS BY LOCATION: HALGAITO SHALE
DOWNGRADIENT MONITOR WELL 934
SITE: HAT01 MEXICAN HAT
08/30/88 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME					UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY					MG/L CACO3							
0934	9	110.0000	743.0000	184.0000	246.6667	196.2314	0.7955	0.0	57.2380	436.0953	NORMAL	
ALUMINUM					MG/L							
0934	9	** 0.0500	0.2000	0.0500	NA	NA	NA	88.9	** 0.0500	0.2000	NONPARAMETRIC	2
AMMONIUM					MG/L							
0934	6	** 0.1000	0.8000	+ 0.3900	NA	NA	NA	16.7	** 0.1000	0.8000	NONPARAMETRIC	2,6
ANTIMONY					MG/L							
0934	6	** 0.0030	0.1000	+ 0.0150	NA	NA	NA	100.0	** 0.0030	0.1000	NONPARAMETRIC	2,6
ARSENIC					MG/L							
0934	9	0.0050	0.1000	0.0500	NA	NA	NA	55.6	0.0050	0.1000	NONPARAMETRIC	2
BARIUM					MG/L							
0934	7	0.0110	0.0500	0.0300	NA	NA	NA	57.1	0.0110	0.0500	NONPARAMETRIC	2
BERYLLIUM					MG/L							
0934	4	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
BORON					MG/L							
0934	5	0.3400	1.1000	0.6000	0.7180	0.3607	0.5024	0.0	0.1135	1.3225	NORMAL	
BROMIDE					MG/L							
0934	2	25.9000	39.0000	+ 32.4500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.4 - GROUNDWATER QUALITY STATISTICS BY LOCATION: HALGAITO SHALE
DOWNGRADIENT MONITOR WELL 934
SITE: HAT01 MEXICAN HAT
08/30/88 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME					UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CADMIUM					MG/L							
0934	7	** 0.0010	0.0500	0.0050	NA	NA	NA	71.4	** 0.0010	0.0500	NONPARAMETRIC	2
CALCIUM					MG/L							
0934	9	530.0000	720.0000	639.0000	622.7778	59.0228	0.0948	0.0	565.8011	679.7545	NORMAL	
CHLORIDE					MG/L							
0934	9	7150.0000	14000.0000	9620.0000	9776.6667	2089.6890	0.2137	0.0	7759.4202	11793.9131	NORMAL	
CHROMIUM					MG/L							
0934	9	0.0050	0.5100	0.2600	NA	NA	NA	33.3	0.0050	0.5100	NONPARAMETRIC	2
COBALT					MG/L							
0934	6	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	** 0.0300	** 0.0300	NONPARAMETRIC	2,6
COPPER					MG/L							
0934	7	0.0100	0.1000	0.0110	NA	NA	NA	28.6	0.0100	0.1000	NONPARAMETRIC	2
CYANIDE					MG/L							
0934	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
FLUORIDE					MG/L							
0934	8	0.5000	2.4000	+ 1.1500	1.1512	0.6466	0.5617	0.0	0.4658	1.8367	NORMAL	
GROSS ALPHA					PCI/L							
0934	5	** 0.2000	200.0000	18.2000	NA	NA	NA	20.0	** 0.2000	200.0000	NONPARAMETRIC	2,5

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.4 - GROUNDWATER QUALITY STATISTICS BY LOCATION: HALGAITO SHALE
DOWNGRADIENT MONITOR WELL 934
SITE: HAT01: MEXICAN HAT
08/30/88 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME					UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN		MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
GROSS BETA					PCI/L								
0934	5	** 0.5000	311.0000		34.3000	NA	NA	NA	0.0	** 0.5000	311.0000	NONPARAMETRIC	9,5
IRON					MG/L								
0934	9	0.0150	1.0000		0.0150	NA	NA	NA	55.6	0.0150	1.0000	NONPARAMETRIC	2
LEAD					MG/L								
0934	6	** 0.0100	0.0500	+	0.0200	NA	NA	NA	83.3	** 0.0100	0.0500	NONPARAMETRIC	2,6
MAGNESIUM					MG/L								
0934	9	4.8700	268.0000		27.3000	42.0960	5.1649	NA	0.0	8.6278	205.3905	LOGNORMAL	7,8
MANGANESE					MG/L								
0934	9	0.0050	0.4600		0.0050	NA	NA	NA	55.6	0.0050	0.4600	NONPARAMETRIC	2
MERCURY					MG/L								
0934	5	** 0.0001	0.0001		0.0001	NA	NA	NA	100.0	** 0.0001	0.0001	NONPARAMETRIC	2,5
MOLYBDENUM					MG/L								
0934	9	0.0600	0.1500		0.1000	0.0989	0.0242	0.2448	0.0	0.0755	0.1223	NORMAL	
NET GROSS ALPHA ***					PCI/L								
0934	5	-23.9100	199.6600		17.8600	NA	NA	NA	0.0	-23.9100	199.6600	NONPARAMETRIC	9,5
NICKEL					MG/L								
0934	9	** 0.0400	0.0500	**	0.0400	NA	NA	NA	88.9	** 0.0400	0.0500	NONPARAMETRIC	2

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.4 - GROUNDWATER QUALITY STATISTICS BY LOCATION: HALGAITO SHALE
DOWNGRADIENT MONITOR WELL 934
SITE: HAT01 MEXICAN HAT
08/30/88 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NITRATE					MG/L							
0934	8	0.5000	32.0000	+ 4.0000	3.5107	4.3522	NA	12.5	0.7386	16.6876	LOGNORMAL	7,8
NITRITE AND NITRATE					MG/L							
0934	4	0.5000	2.2300	+ 0.9050	NA	NA	NA	50.0	0.5000	2.2300	NONPARAMETRIC	2,4
PH					SU							
0934	9	7.7000	11.1700	10.5300	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE					MG/L							
0934	4	** 0.1000	0.2000	** 0.1000	NA	NA	NA	50.0	** 0.1000	0.2000	NONPARAMETRIC	2,4
POTASSIUM					MG/L							
0934	9	31.0000	95.9000	49.0000	53.2778	18.0794	0.3393	0.0	35.8251	70.7304	NORMAL	
RADIUM-226					PCI/L							
0934	6	** 0.9000	2.3000	** 0.9000	** 0.9000	0.7396	0.8701	0.0	** 0.9000	1.8660	NORMAL	
RADIUM-226 + RADIUM-228					PCI/L							
0934	6	1.4000	12.0000	+ 2.2500	2.6489	2.1583	NA	0.0	0.9206	7.6216	LOGNORMAL	7,8
RADIUM-228					PCI/L							
0934	6	** 1.0000	11.3000	+ 1.4000	1.2362	4.5571	NA	0.0	** 1.0000	9.9306	LOGNORMAL	7,8
REDOX POTENTIAL					mVOLTS							
0934	1	401.0000	401.0000	401.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.4 - GROUNDWATER QUALITY STATISTICS BY LOCATION: HALGAITO SHALE
DOWNGRADIENT MONITOR WELL 934
SITE: HAT01 MEXICAN HAT
08/30/88 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME				UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SELENIUM				MG/L								
0934	7	** 0.0050	0.0650	0.0250	NA	NA	NA	85.7	** 0.0050	0.0650	NONPARAMETRIC	2
SILICA - SIO2				MG/L								
0934	7	2.8000	8.0000	6.0000	5.5000	2.0191	0.3671	0.0	3.1015	7.8985	NORMAL	
SILVER				MG/L								
0934	7	** 0.0100	0.0145	** 0.0100	NA	NA	NA	85.7	** 0.0100	0.0145	NONPARAMETRIC	2
SODIUM				MG/L								
0934	9	5920.0000	9800.0000	8520.0000	8185.5556	1290.5727	0.1577	0.0	6939.7228	9431.3884	NORMAL	
SPECIFIC CONDUCTANCE				UMHO/CM								
0934	9	300.0000	31600.0000	27000.0000	21051.1111	11733.8404	0.5574	0.0	9724.0438	32378.1784	NORMAL	
STRONTIUM				MG/L								
0934	5	12.0000	14.5000	13.0000	13.3200	1.0569	0.0793	0.0	11.5490	15.0910	NORMAL	
SULFATE				MG/L								
0934	8	811.0000	7890.0000	+ 7145.0000	6131.5375	2467.1032	0.4024	0.0	3516.5239	8746.5511	NORMAL	
SULFIDE				MG/L								
0934	3	** 0.1000	20.4000	0.3000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
TEMPERATURE				C - DEGREE								
0934	9	15.3000	22.5000	17.9000	18.0222	2.0401	0.1132	0.0	16.0529	19.9916	NORMAL	
THALLIUM				MG/L								
0934	4	** 0.0100	0.0500	+ 0.0350	NA	NA	NA	75.0	** 0.0100	0.0500	NONPARAMETRIC	2,4

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1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.4 - GROUNDWATER QUALITY STATISTICS BY LOCATION: HALGAITO SHALE
DOWNGRADIENT MONITOR WELL 934
SITE: HAT01 MEXICAN HAT
08/30/88 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
THORIUM-230					PCI/L							
0934	3	** 0.1000	0.6000	0.2000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
TIN					MG/L							
0934	6	** 0.0050	0.5740	+ 0.0200	NA	NA	NA	66.7	** 0.0050	0.5740	NONPARAMETRIC	2,6
TOTAL DISSOLVED SOLIDS					MG/L							
0934	9	22000.0000	29000.0000	25700.0000	25748.0000	2351.8495	0.0913	0.0	23477.6813	28018.3187	NORMAL	
TOTAL KJELDAHL NITROGEN					MG/L							
0934	2	** 1.0000	3.0000	+ 1.7500	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
TOTAL ORGANIC CARBON					MG/L							
0934	1	19.0000	19.0000	19.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
URANIUM					MG/L							
0934	8	** 0.0003	0.0480	+ 0.0077	NA	NA	NA	37.5	** 0.0003	0.0480	NONPARAMETRIC	2
VANADIUM					MG/L							
0934	9	** 0.0100	0.0700	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.0700	NONPARAMETRIC	2
ZINC					MG/L							
0934	9	** 0.0026	0.0860	0.0130	NA	NA	NA	33.3	** 0.0026	0.0860	NONPARAMETRIC	2

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

INPUT DATA FILENAME: M:\DART\HAT01\GWQ10001.DAT

TABLE D.7.5 - GROUNDWATER QUALITY STATISTICS BY PARAMETER
HONAKER TRAIL MONITOR WELLS 907, 908, 909, AND 930
SITE: HAT01 MEXICAN HAT
05/18/88 TO 12/13/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY	MG/L CACO3	10	34.0000	159.0000	+ 143.5000	115.7000	48.2172	0.4167	0.0	72.6865	158.7135	NORMAL	
ALUMINUM	MG/L	10	0.0250	0.2000	+ 0.0525	NA	NA	NA	50.0	0.0250	0.2000	NONPARAMETRIC	2
AMMONIUM	MG/L	8	** 0.1000	0.4000	+ 0.1000	NA	NA	NA	37.5	** 0.1000	0.4000	NONPARAMETRIC	2
ANTIMONY	MG/L	3	** 0.0030	0.0100	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
ARSENIC	MG/L	10	** 0.0020	0.0500	+ 0.0050	NA	NA	NA	60.0	0.0050	0.0300	NONPARAMETRIC	2
BARIUM	MG/L	4	** 0.0022	0.0500	+ 0.0050	NA	NA	NA	100.0	** 0.0022	0.0500	NONPARAMETRIC	2,4
BERYLLIUM	MG/L	1	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
BORON	MG/L	1	0.5900	0.5900	0.5900	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
BROMIDE	MG/L	2	0.6000	1.0000	+ 0.8000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
CADMIUM	MG/L	4	** 0.0010	0.0048	** 0.0010	NA	NA	NA	75.0	** 0.0010	0.0048	NONPARAMETRIC	2,4

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.5 - GROUNDWATER QUALITY STATISTICS BY PARAMETER
HONAKER TRAIL MONITOR WELLS 907, 908, 909, AND 930
SITE: HAT01 : MEXICAN HAT
05/18/88 TO 12/13/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CALCIUM	MG/L	10	158.0000	480.0000	+ 340.5000	316.6000	115.6299	0.3652	0.0	213.4491	419.7509	NORMAL	
CHLORIDE	MG/L	10	36.0000	260.0000	+ 92.0000	106.5000	73.3261	0.6885	0.0	41.0873	171.9127	NORMAL	
CHROMIUM	MG/L	10	0.0042	0.1000	+ 0.0050	NA	NA	NA	50.0	0.0050	0.1000	NONPARAMETRIC	2
COBALT	MG/L	2	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
COPPER	MG/L	3	0.0050	0.0066	0.0050	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
CYANIDE	MG/L	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
FLUORIDE	MG/L	9	1.2000	1.5000	1.3000	1.3556	0.1014	0.0748	0.0	1.2577	1.4534	NORMAL	
GROSS ALPHA	PCI/L	10	** 0.2000	32.8000	+ 14.5000	14.9300	11.5155	0.7713	10.0	4.6573	25.2027	NORMAL	
GROSS BETA	PCI/L	10	0.7000	53.0000	+ 25.0000	22.8800	14.9932	0.6553	0.0	9.5049	36.2551	NORMAL	
IRON	MG/L	10	0.0150	0.1800	+ 0.0275	NA	NA	NA	50.0	0.0150	0.1400	NONPARAMETRIC	2

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.

TABLE D.7.5 - GROUNDWATER QUALITY STATISTICS BY PARAMETER
HONAKER TRAIL MONITOR WELLS 907, 908, 909, AND 930
SITE: HAT01 MEXICAN HAT
05/18/88 TO 12/13/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
LEAD	MG/L	3	** 0.0017	0.0025	0.0025	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
MAGNESIUM	MG/L	10	57.6000	187.0000	+ 145.5000	127.6600	48.7921	0.3822	0.0	84.1336	171.1864	NORMAL	
MANGANESE	MG/L	10	0.0050	0.1500	+ 0.0100	NA	NA	NA	30.0	0.0050	0.0300	NONPARAMETRIC	2
MERCURY	MG/L	3	** 0.0001	0.0001	0.0001	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
MOLYBDENUM	MG/L	10	0.0200	0.0500	+ 0.0350	0.0344	0.0131	0.3806	0.0	0.0227	0.0461	NORMAL	
NET GROSS ALPHA ***	PCI/L	10	-37.6300	19.9700	+ 0.1850	NA	NA	NA	0.0	-22.6300	16.3900	NONPARAMETRIC	9
NICKEL	MG/L	10	0.0078	0.0500	+ 0.0200	NA	NA	NA	60.0	0.0200	0.0500	NONPARAMETRIC	2
NITRATE	MG/L	10	0.5000	11.1000	+ 2.8500	NA	NA	NA	50.0	0.5000	9.7000	NONPARAMETRIC	2
NITRITE AND NITRATE	MG/L	8	0.5000	2.5000	+ 0.5000	NA	NA	NA	62.5	0.5000	2.5000	NONPARAMETRIC	2

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.5 - GROUNDWATER QUALITY STATISTICS BY PARAMETER
HONAKER TRAIL MONITOR WELLS 907, 908, 909, AND 930
SITE: HAT01 MEXICAN HAT
05/18/88 TO 12/13/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
PH	SU	10	4.0800	9.9500	+ 7.2671	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE	MG/L	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
POTASSIUM	MG/L	10	3.0000	9.1000	+ 6.5000	5.9300	2.0699	0.3491	0.0	4.0835	7.7765	NORMAL	
RADIUM-226	PCI/L	10	** 0.3000	4.1000	** 0.3000	** 0.3000	3.1740	NA	0.0	** 0.3000	0.7648	LOGNORMAL	7,8
RADIUM-226 + RADIUM-228	PCI/L	10	0.2000	8.6000	+ 1.2000	1.2417	3.6988	NA	0.0	0.3866	3.9881	LOGNORMAL	7,8
RADIUM-228	PCI/L	10	** 1.0000	8.5000	** 1.0000	** 1.0000	4.6148	NA	10.0	** 1.0000	2.7746	LOGNORMAL	7,8
REDOX POTENTIAL	mVOLTS	1	350.8000	350.8000	350.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SELENIUM	MG/L	4	0.0025	0.0400	+ 0.0170	NA	NA	NA	50.0	0.0025	0.0400	NONPARAMETRIC	2,4
SILICA - SIO2	MG/L	8	12.0000	17.1000	+ 15.3500	15.2250	1.8321	0.1203	0.0	13.2831	17.1669	NORMAL	

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.5 - GROUNDWATER QUALITY STATISTICS BY PARAMETER
HONAKER TRAIL MONITOR WELLS 907, 908, 909, AND 930
SITE: HAT01 MEXICAN HAT
05/18/88 TO 12/13/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS											
# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SILVER	MG/L										
4	0.0050	0.0053	+ 0.0050	NA	NA	NA	75.0	0.0050	0.0053	NONPARAMETRIC	2,4
SODIUM	MG/L										
10	292.0000	1270.0000	+ 425.0000	536.0000	312.2104	0.5825	0.0	257.4838	814.5162	NORMAL	
SPECIFIC CONDUCTANCE	UMHO/CM										
10	1650.0000	6000.0000	+ 3090.0000	3301.0000	1443.9102	0.4374	0.0	2012.9187	4589.0813	NORMAL	
STRONTIUM	MG/L										
3	8.2600	8.7600	8.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SULFATE	MG/L										
9	1180.0000	3890.0000	2090.0000	2174.4444	967.2398	0.4448	0.0	1240.7357	3108.1532	NORMAL	
SULFIDE	MG/L										
2	3.6000	64.4000	+ 34.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
TEMPERATURE	C - DEGREE										
10	15.6000	19.0000	+ 17.1500	17.4800	1.2182	0.0697	0.0	16.3933	18.5667	NORMAL	
THALLIUM	MG/L										
1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
THORIUM-230	PCI/L										
8	** 0.1000	1.4000	+ 0.1500	NA	NA	NA	37.5	** 0.1000	1.4000	NONPARAMETRIC	2
TIN	MG/L										
2	** 0.0050	0.0150	+ 0.0087	NA	NA	NA	100.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.5 - GROUNDWATER QUALITY STATISTICS BY PARAMETER
HONAKER TRAIL MONITOR WELLS 907, 908, 909, AND 930
SITE: HAT01 MEXICAN HAT
05/18/88 TO 12/13/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
TOTAL DISSOLVED SOLIDS	MG/L	10	1820.0000	6580.0000	+ 3530.0000	3537.0000	1566.1563	0.4428	0.0	2139.8656	4934.1344	NORMAL	
TOTAL KJELDAHL NITROGEN	MG/L	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
TOTAL ORGANIC CARBON	MG/L	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
URANIUM	MG/L	10	0.0015	0.0636	+ 0.0211	NA	NA	NA	20.0	0.0015	0.0500	NONPARAMETRIC	2
VANADIUM	MG/L	10	** 0.0051	0.0900	+ 0.0500	NA	NA	NA	20.0	** 0.0051	0.0600	NONPARAMETRIC	2
ZINC	MG/L	10	** 0.0026	0.0260	** 0.0026	NA	NA	NA	70.0	** 0.0026	0.0060	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.

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TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME				UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
# OF SAMP	MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY				MG/L CACO3								
14	8.0000	244.0000	+	121.0000	127.9286	81.9056	0.6402	0.0	69.9195	185.9376	NORMAL	
ALUMINUM				MG/L								
16	0.1600	24.0000	+	0.9750	2.0258	6.3583	NA	0.0	0.6082	6.7478	LOGNORMAL	7,8
ALUMINUM (TOTAL)				MG/L								
8	** 0.1000	2.4000	+	0.6000	NA	NA	NA	25.0	** 0.1000	2.4000	NONPARAMETRIC	2
AMMONIUM				MG/L								
4	6.9000	94.1000	+	13.4000	18.4690	3.0962	NA	0.0	1.4192	240.3585	LOGNORMAL	7,8
AMMONIUM (TOTAL)				MG/L								
4	12.2000	102.0000	+	15.6500	23.3947	2.7020	NA	0.0	2.4489	223.4937	LOGNORMAL	7,8
ANTIMONY				MG/L								
16	** 0.0030	0.0380	+	0.0100	NA	NA	NA	56.3	0.0030	0.0200	NONPARAMETRIC	2
ANTIMONY (TOTAL)				MG/L								
8	** 0.0030	0.0400	+	0.0037	NA	NA	NA	50.0	** 0.0030	0.0400	NONPARAMETRIC	2
ARSENIC				MG/L								
16	** 0.0020	5.4000	+	0.1925	NA	NA	NA	43.8	0.0050	3.5000	NONPARAMETRIC	2
ARSENIC (TOTAL)				MG/L								
8	** 0.0100	4.8000	+	0.3300	NA	NA	NA	25.0	** 0.0100	4.8000	NONPARAMETRIC	2
BARIUM				MG/L								
16	** 0.0022	0.0200	+	0.0100	NA	NA	NA	25.0	** 0.0022	0.0100	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS													
# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
BARIUM (TOTAL)	MG/L										
8	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2
BERYLLIUM	MG/L										
4	** 0.0050	0.0090	** 0.0050	NA	NA	NA	50.0	** 0.0050	0.0090	NONPARAMETRIC	2,4
BERYLLIUM (TOTAL)	MG/L										
8	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
BORON	MG/L										
8	0.1000	1.8100	+ 0.2200	0.2408	2.3899	NA	12.5	0.0956	0.6064	LOGNORMAL	7,8
BORON (TOTAL)	MG/L										
8	0.2000	1.0000	+ 0.3000	0.4250	0.3012	0.7087	0.0	0.1058	0.7442	NORMAL	
BROMIDE	MG/L										
8	** 0.1000	0.4000	+ 0.1500	0.1938	0.1266	0.6534	12.5	** 0.1000	0.3279	NORMAL	
CADMIUM	MG/L										
16	** 0.0010	0.1110	+ 0.0320	NA	NA	NA	18.8	0.0098	0.0510	NONPARAMETRIC	2
CADMIUM (TOTAL)	MG/L										
8	0.0020	0.0550	+ 0.0055	0.0082	3.8876	NA	0.0	0.0019	0.0345	LOGNORMAL	7,8
CALCIUM	MG/L										
16	410.0000	596.0000	+ 461.5000	474.8125	49.0975	0.1034	0.0	442.8746	506.7504	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS								STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CALCIUM (TOTAL)	MG/L										
8	433.0000	583.0000	+ 471.0000	491.7500	56.1649	0.1142	0.0	432.2178	551.2822	NORMAL	
CHLORIDE	MG/L										
16	22.0000	40.0000	+ 30.5000	32.8750	6.1522	0.1871	0.0	28.8730	36.8770	NORMAL	
CHLORIDE (TOTAL)	MG/L										
8	32.0000	46.0000	+ 34.5000	36.7500	5.6505	0.1538	0.0	30.7607	42.7393	NORMAL	
CHROMIUM	MG/L										
16	** 0.0032	0.1300	+ 0.0050	NA	NA	NA	87.5	** 0.0032	0.0050	NONPARAMETRIC	2
CHROMIUM (TOTAL)	MG/L										
8	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
COBALT	MG/L										
12	1.3200	3.9000	+ 1.7650	2.1742	0.8141	0.3745	0.0	1.5354	2.8130	NORMAL	
COBALT (TOTAL)	MG/L										
8	0.9300	2.4200	+ 1.2500	1.4650	0.5070	0.3461	0.0	0.9276	2.0024	NORMAL	
COPPER	MG/L										
16	0.0050	14.1000	+ 0.0590	0.1924	13.1707	NA	6.3	0.0360	1.0294	LOGNORMAL	7,8
COPPER (TOTAL)	MG/L										
8	** 0.0200	0.6100	** 0.0200	NA	NA	NA	50.0	** 0.0200	0.6100	NONPARAMETRIC	2
FLUORIDE	MG/L										
12	0.1900	5.1000	+ 2.7500	2.7242	1.3978	0.5131	0.0	1.6274	3.8209	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
FLUORIDE (TOTAL)	MG/L	4	0.3000	1.8000	+ 0.5500	0.8000	0.7071	0.8839	0.0	** 0.1000	2.4055	NORMAL	
GROSS ALPHA	PCI/L	11	170.0000	2264.0000	1673.0000	1280.7273	850.7636	0.6643	0.0	571.7202	1989.7343	NORMAL	
GROSS BETA	PCI/L	11	110.0000	1197.0000	677.0000	591.2727	427.4614	0.7230	0.0	235.0361	947.5093	NORMAL	
IRON	MG/L	16	0.0150	732.0000	+ 182.5000	32.6857	38.5930	NA	6.3	3.0362	351.8691	LOGNORMAL	7,8
IRON (TOTAL)	MG/L	8	5.5400	426.0000	+ 254.0000	231.1488	170.0834	0.7358	0.0	50.8683	411.4292	NORMAL	
LEAD	MG/L	16	** 0.0017	0.0370	+ 0.0150	NA	NA	NA	87.5	0.0025	0.0210	NONPARAMETRIC	2
LEAD (TOTAL)	MG/L	8	** 0.0100	0.0100	** 0.0100	NA	NA	NA	50.0	** 0.0100	0.0100	NONPARAMETRIC	2
MAGNESIUM	MG/L	16	199.0000	362.0000	+ 277.5000	275.0000	54.9315	0.1998	0.0	239.2671	310.7329	NORMAL	
MAGNESIUM (TOTAL)	MG/L	8	167.0000	306.0000	+ 237.5000	239.0000	54.4006	0.2276	0.0	181.3379	296.6621	NORMAL	
MANGANESE	MG/L	16	26.0000	136.0000	+ 34.6500	56.1437	40.9536	0.7294	0.0	29.5035	82.7840	NORMAL	

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME			UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
MANGANESE (TOTAL)			MG/L								
8	27.9000	115.0000	+ 30.0000	49.9000	37.7881	0.7573	0.0	9.8464	89.9536	NORMAL	
MERCURY			MG/L								
8	** 0.0001	0.0003	+ 0.0001	NA	NA	NA	87.5	** 0.0001	0.0003	NONPARAMETRIC	2
MERCURY (TOTAL)			MG/L								
8	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2
MOLYBDENUM			MG/L								
16	** 0.0048	0.1800	+ 0.0050	NA	NA	NA	68.8	** 0.0048	0.0200	NONPARAMETRIC	2
MOLYBDENUM (TOTAL)			MG/L								
8	0.0200	0.1500	+ 0.0450	0.0638	0.0463	0.7258	0.0	0.0147	0.1128	NORMAL	
NET GROSS ALPHA ***			PCI/L								
11	-13.3400	1843.3200	623.4200	NA	NA	NA	0.0	152.5800	1563.7000	NONPARAMETRIC	9
NICKEL			MG/L								
16	1.3500	2.6000	+ 1.8650	1.8950	0.3392	0.1790	0.0	1.6743	2.1157	NORMAL	
NICKEL (TOTAL)			MG/L								
8	0.7300	2.2000	+ 1.2000	1.3850	0.4906	0.3542	0.0	0.8650	1.9050	NORMAL	
NITRATE			MG/L								
12	** 0.2200	6.5000	+ 1.3000	NA	NA	NA	41.7	** 0.2200	4.0000	NONPARAMETRIC	2

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NITRATE (TOTAL)	MG/L	4	1.2000	4.3000	+ 2.8500	2.8000	1.4445	0.5159	0.0	** 1.0000	6.0798	NORMAL	
NITRITE AND NITRATE	MG/L	4	0.4300	1.4700	+ 0.7350	0.8425	0.4649	0.5518	0.0	** 0.0500	1.8980	NORMAL	
NITRITE AND NITRATE (TOTAL)	MG/L	4	0.2000	1.0000	+ 0.6500	0.6250	0.3500	0.5600	0.0	** 0.2000	1.4197	NORMAL	
PH	SU	20	2.9700	6.5500	+ 5.6547	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE	MG/L	4	0.1000	2.8000	+ 1.4000	1.4250	1.4221	0.9980	0.0	** 0.1000	4.6540	NORMAL	
PHOSPHATE (TOTAL)	MG/L	8	** 0.1000	1.2000	+ 0.4000	NA	NA	NA	25.0	** 0.1000	1.2000	NONPARAMETRIC	2
POTASSIUM	MG/L	16	9.8000	46.0000	+ 14.5000	20.9875	13.9486	0.6646	0.0	11.9140	30.0610	NORMAL	
POTASSIUM (TOTAL)	MG/L	8	12.7000	48.3000	+ 17.6000	23.9750	14.3297	0.5977	0.0	8.7862	39.1638	NORMAL	
SELENIUM	MG/L	16	** 0.0016	0.0150	+ 0.0150	NA	NA	NA	100.0	** 0.0016	0.0150	NONPARAMETRIC	2
SELENIUM (TOTAL)	MG/L	8	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME			UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SILICA - SIO2			MG/L								
8	31.8000	125.0000	+ 79.6000	75.5375	32.2912	0.4275	0.0	41.3104	109.7646	NORMAL	
SILICA - SIO2 (TOTAL)			MG/L								
8	41.0000	93.0000	+ 59.5000	61.8750	18.0984	0.2925	0.0	42.6915	81.0585	NORMAL	
SILVER			MG/L								
15	0.0050	0.0800	0.0050	NA	NA	NA	66.7	0.0050	0.0250	NONPARAMETRIC	2
SILVER (TOTAL)			MG/L								
8	** 0.0100	0.0200	** 0.0100	NA	NA	NA	50.0	** 0.0100	0.0200	NONPARAMETRIC	2
SODIUM			MG/L								
15	90.0000	145.0000	116.0000	112.1333	17.7638	0.1584	0.0	100.0981	124.1686	NORMAL	
SODIUM (TOTAL)			MG/L								
8	89.7000	128.0000	+ 112.0000	109.2125	12.7679	0.1169	0.0	95.6792	122.7458	NORMAL	
SPECIFIC CONDUCTANCE			UMHO/CM								
16	2470.0000	5060.0000	+ 3700.0000	3800.0000	797.9307	0.2100	0.0	3280.9461	4319.0539	NORMAL	
STRONTIUM			MG/L								
15	3.3400	7.5000	5.3900	5.4660	1.3728	0.2512	0.0	4.5359	6.3961	NORMAL	
STRONTIUM (TOTAL)			MG/L								
8	4.4700	6.8100	+ 5.3100	5.4750	0.8377	0.1530	0.0	4.5871	6.3629	NORMAL	
SULFATE			MG/L								
8	498.0000	3900.0000	+ 2300.0000	2336.8750	1300.7501	0.5566	0.0	958.1410	3715.6090	NORMAL	

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SULFATE (TOTAL)	MG/L	8	2260.0000	4330.0000	+ 3245.0000	3242.6875	789.9126	0.2436	0.0	2405.4172	4079.9578	NORMAL	
SULFIDE	MG/L	4	** 0.8000	** 0.8000	** 0.8000	NA	NA	NA	100.0	** 0.8000	** 0.8000	NONPARAMETRIC	2,4
TEMPERATURE	C - DEGREE	20	5.9000	22.4000	+ 17.9500	16.1550	5.4908	0.3399	0.0	13.0377	19.2723	NORMAL	
THALLIUM	MG/L	4	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	** 0.0300	** 0.0300	NONPARAMETRIC	2,4
THALLIUM (TOTAL)	MG/L	8	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
TIN	MG/L	11	** 0.0050	0.0250	0.0250	NA	NA	NA	72.7	0.0053	0.0250	NONPARAMETRIC	2
TIN (TOTAL)	MG/L	8	0.0100	0.2240	+ 0.0350	0.0315	2.7208	NA	0.0	0.0109	0.0911	LOGNORMAL	7,8
TOTAL DISSOLVED SOLIDS	MG/L	16	3540.0000	6490.0000	+ 5390.0000	5171.8750	905.4739	0.1751	0.0	4582.8643	5760.8857	NORMAL	
TOTAL DISSOLVED SOLIDS (TOTAL)	MG/L	8	3330.0000	6300.0000	+ 4750.0000	4690.0000	1136.1212	0.2422	0.0	3485.7648	5894.2352	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.6 - LYSIMETER WATER QUALITY STATISTICS BY PARAMETER
ALL LYSIMETERS INCLUDED (241, 242, 243, AND 244)
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/12/91
REPORT DATE: 02/09/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
TOTAL KJELDAHL NITROGEN	MG/L	4	7.0000	72.0000	+ 10.5000	15.3446	2.8542	NA	0.0	1.4183	166.0129	LOGNORMAL	7,8
URANIUM	MG/L	14	0.0050	1.5300	+ 0.4355	0.5315	0.4549	0.8559	0.0	0.2093	0.8537	NORMAL	
URANIUM (TOTAL)	MG/L	8	0.0560	1.2500	+ 0.3170	0.3942	0.3749	0.9510	0.0	** 0.0030	0.7917	NORMAL	
VANADIUM	MG/L	15	** 0.0051	0.6700	** 0.0051	NA	NA	NA	66.7	** 0.0051	0.1900	NONPARAMETRIC	2
VANADIUM (TOTAL)	MG/L	8	** 0.0100	0.2500	+ 0.0400	0.0437	3.9561	NA	12.5	0.0102	0.1876	LOGNORMAL	7,8
ZINC	MG/L	15	0.4060	6.8800	3.6000	3.4457	1.9108	0.5545	0.0	2.1511	4.7403	NORMAL	
ZINC (TOTAL)	MG/L	8	0.9070	45.3000	+ 3.3500	3.4097	3.5866	NA	0.0	0.8806	13.2025	LOGNORMAL	7,8

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

INPUT DATA FILENAME: M:\DART\HAT01\LYS10000.DAT

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ALKALINITY	0249	04/23/90	0001	NR	N	MG/L CACO3		763.		-	-
	0249	06/25/90	N001	NR	N			805.		-	-
	0249	10/03/90	0001	NR	N			725.		-	-
	0249	04/24/91	0001	NR	N			820.		-	-
	0251	04/23/90	0001	NR	N			190.		-	-
	0251	10/05/90	0001	NR	N			238.		-	-
	0251	04/24/91	0001	NR	N			245.		-	-
	0253	05/10/91	0001	NR	N			275.		-	-
	0253	08/25/91	0001	NR	N			292.		-	-
	0254	10/03/90	0001	NR	N			452.		-	-
	0254	05/10/91	0001	NR	N			473.		-	-
	0255	04/24/91	0001	NR	N			490.		-	-
	0255	08/24/91	0001	NR	N			404.		-	-
	0255	12/13/91	0001	NR	N			587		-	-
ALUMINUM	0249	04/23/90	0001	NR	N	MG/L	<	0.1		0.1	-
	0249	10/03/90	0001	NR	N		<	0.05		0.05	-
	0249	04/24/91	0001	NR	N		<	0.05		0.05	-
	0251	04/23/90	0001	NR	N		<	0.1		0.1	-
	0251	10/05/90	0001	NR	N		<	0.05		0.05	-
	0251	04/24/91	0001	NR	N		<	0.05		0.05	-
	0253	05/10/91	0001	NR	N		<	0.05		0.05	-
	0253	08/25/91	0001	NR	N			0.072		0.0067	-
	0254	10/03/90	0001	NR	N		<	0.05		0.05	-
	0254	05/10/91	0001	NR	N		<	0.05		0.05	-
	0255	04/24/91	0001	NR	N		<	0.05		0.05	-
	0255	08/24/91	0001	NR	N			0.046		0.0067	-
	0255	12/13/91	0001	NR	N		<	0.05		0.05	-
ALUMINUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.1		0.1	-
AMMONIUM	0249	04/23/90	0001	NR	N	MG/L		32.3		0.1	-
	0249	10/03/90	0001	NR	N			33.2		0.1	-
	0249	04/24/91	0001	NR	N			31.6		0.1	-
	0251	04/23/90	0001	NR	N		<	0.1		0.1	-
	0251	10/05/90	0001	NR	N		<	0.1		0.1	-
	0251	04/24/91	0001	NR	N			0.13		0.1	-
	0253	05/10/91	0001	NR	N			0.14		0.1	-
	0254	10/03/90	0001	NR	N			3.17		0.1	-
	0254	05/10/91	0001	NR	N			3.44		0.1	-
	0255	04/24/91	0001	NR	N			6.70		0.1	-
AMMONIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		34.9		0.1	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

FLOW RELATIONSHIP CODE:
N - UNKNOWN

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ANTIMONY	0249	04/23/90	0001	NR	N	MG/L		0.024		0.003	-
	0249	10/03/90	0001	NR	N		<	0.006	Ic	0.006	-
	0249	04/24/91	0001	NR	N		<	0.003		0.003	-
	0251	04/23/90	0001	NR	N			0.021		0.003	-
	0251	10/05/90	0001	NR	N		<	0.006	Ic	0.006	-
	0251	04/24/91	0001	NR	N		<	0.003		0.003	-
	0253	05/10/91	0001	NR	N		<	0.003		0.003	-
	0253	08/25/91	0001	NR	N			0.042		0.02	-
	0254	10/03/90	0001	NR	N			0.006		0.003	-
	0254	05/10/91	0001	NR	N		<	0.003		0.003	-
	0255	04/24/91	0001	NR	N		<	0.003		0.003	-
	0255	08/24/91	0001	NR	N		<	0.020		0.02	-
	0255	12/13/91	0001	NR	N		<	0.003		0.003	-
ANTIMONY (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.004		0.003	-
ARSENIC	0249	04/23/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0249	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0249	04/24/91	0001	NR	N		<	0.01		0.01	-
	0251	04/23/90	0001	NR	N		<	0.01		0.01	-
	0251	10/05/90	0001	NR	N		<	0.05	Ic	0.05	-
	0251	04/24/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0253	08/25/91	0001	NR	N			0.0034		0.002	-
	0254	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0254	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0255	04/24/91	0001	NR	N		<	0.01		0.01	-
	0255	08/24/91	0001	NR	N			0.0043		0.002	-
	0255	12/13/91	0001	NR	N		<	0.01		0.01	-
ARSENIC (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.01		0.01	-
BARIUM	0249	04/23/90	0001	NR	N	MG/L	<	0.1		0.1	-
	0249	10/03/90	0001	NR	N		<	0.01		0.01	-
	0249	04/24/91	0001	NR	N		<	0.01		0.01	-
	0251	04/23/90	0001	NR	N		<	0.1		0.1	-
	0251	10/05/90	0001	NR	N		<	0.01		0.01	-
	0251	04/24/91	0001	NR	N			0.01		0.01	-
	0253	05/10/91	0001	NR	N			0.01		0.01	-
	0253	08/25/91	0001	NR	N		<	0.0022		0.0022	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
BARIUM	0254	05/10/91	0001	NR	N	MG/L		0.01		0.01	-
	0255	04/24/91	0001	NR	N		<	0.01		0.01	-
	0255	08/24/91	0001	NR	N		<	0.0022		0.0022	-
	0255	12/13/91	0001	NR	N		<	0.01		0.01	-
BARIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.1		0.1	-
BERYLLIUM	0249	04/23/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0249	04/24/91	0001	NR	N		<	0.005		0.005	-
	0251	04/23/90	0001	NR	N		<	0.01		0.01	-
	0251	04/24/91	0001	NR	N		<	0.005		0.005	-
	0253	05/10/91	0001	NR	N		<	0.005		0.005	-
	0254	05/10/91	0001	NR	N		<	0.005		0.005	-
	0255	04/24/91	0001	NR	N		<	0.005		0.005	-
BERYLLIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.01		0.01	-
BORON	0249	04/23/90	0001	NR	N	MG/L		0.9		0.1	-
	0249	10/03/90	0001	NR	N			0.64		0.05	-
	0249	04/24/91	0001	NR	N			0.78		0.05	-
	0251	04/23/90	0001	NR	N			0.6		0.1	-
	0251	10/05/90	0001	NR	N			0.59		0.05	-
	0251	04/24/91	0001	NR	N			0.60		0.05	-
	0253	05/10/91	0001	NR	N			0.81		0.05	-
	0254	10/03/90	0001	NR	N			0.88		0.05	-
	0254	05/10/91	0001	NR	N			1.20		0.05	-
	0255	04/24/91	0001	NR	N			0.62		0.05	-
BORON (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.8		0.1	-
BROMIDE	0249	10/03/90	0001	NR	N	MG/L		0.3		0.1	-
	0249	04/24/91	0001	NR	N			0.9		0.1	-
	0251	10/05/90	0001	NR	N			0.5		0.1	-
	0251	04/24/91	0001	NR	N			1.1		0.1	-
	0253	05/10/91	0001	NR	N			1.1		0.1	-
	0254	10/03/90	0001	NR	N		<	0.5	Ic	0.5	-
	0254	05/10/91	0001	NR	N		<	1.0	I	1.	-
	0255	04/24/91	0001	NR	N			0.7		0.1	-
CADMIUM	0249	04/23/90	0001	NR	N	MG/L	<	0.001		0.001	-
	0249	10/03/90	0001	NR	N		<	0.001		0.001	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
CADMIUM	0249	04/24/91	0001	NR	N	MG/L	<	0.001		0.001	-
	0251	04/23/90	0001	NR	N		<	0.001		0.001	-
	0251	10/05/90	0001	NR	N		<	0.001		0.001	-
	0251	04/24/91	0001	NR	N		<	0.001		0.001	-
	0253	05/10/91	0001	NR	N			0.001		0.001	-
	0253	08/25/91	0001	NR	N		<	0.0046		0.0046	-
	0254	10/03/90	0001	NR	N		<	0.001		0.001	-
	0254	05/10/91	0001	NR	N			0.001		0.001	-
	0255	04/24/91	0001	NR	N		<	0.001		0.001	-
	0255	08/24/91	0001	NR	N		<	0.0046		0.0046	-
	0255	12/13/91	0001	NR	N		<	0.001		0.001	-
CADMIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.001		0.001	-
CALCIUM	0249	04/23/90	0001	NR	N	MG/L		554.		0.01	-
	0249	10/03/90	0001	NR	N			460.		0.01	-
	0249	04/24/91	0001	NR	N			595.		2.	-
	0251	04/23/90	0001	NR	N			367.		0.01	-
	0251	10/05/90	0001	NR	N			385.		0.01	-
	0251	04/24/91	0001	NR	N			419.		0.5	-
	0253	05/10/91	0001	NR	N			595.		2.	-
	0253	08/25/91	0001	NR	N			440		0.009	-
	0254	10/03/90	0001	NR	N			656.		0.01	-
	0254	05/10/91	0001	NR	N			650.		2.	-
	0255	04/24/91	0001	NR	N			625.		2.	-
	0255	08/24/91	0001	NR	N			430		0.009	-
	0255	12/13/91	0001	NR	N			520.		2.	-
CALCIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		534.		0.01	-
CHLORIDE	0249	04/23/90	0001	NR	N	MG/L		90.		1.	-
	0249	10/03/90	0001	NR	N			98.		1.	-
	0249	04/24/91	0001	NR	N			102.		1.	-
	0251	04/23/90	0001	NR	N			307.		1.	-
	0251	10/05/90	0001	NR	N			139.		1.	-
	0251	04/24/91	0001	NR	N			330.		0.5	-
	0253	05/10/91	0001	NR	N			185.		1.	-
	0253	08/25/91	0001	NR	N			190		0.5	-
	0254	10/03/90	0001	NR	N			113.		1.	-
	0254	05/10/91	0001	NR	N			164.		1.	-
	0255	04/24/91	0001	NR	N			169.		1.	-
	0255	08/24/91	0001	NR	N			96		0.5	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
CHLORIDE	0255	12/13/91	0001	NR	N	MG/L		133.		1.	-
CHLORIDE (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		95.		1.	-
CHROMIUM	0249	04/23/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0249	10/03/90	0001	NR	N		<	0.01		0.01	-
	0249	04/24/91	0001	NR	N		<	0.01		0.01	-
	0251	04/23/90	0001	NR	N		<	0.01		0.01	-
	0251	10/05/90	0001	NR	N		<	0.01		0.01	-
	0251	04/24/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N		<	0.0032		0.0032	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N		<	0.01		0.01	-
	0255	04/24/91	0001	NR	N		<	0.01		0.01	-
	0255	08/24/91	0001	NR	N		<	0.0032		0.0032	-
	0255	12/13/91	0001	NR	N		<	0.01		0.01	-
CHROMIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.01		0.01	-
COBALT	0249	04/23/90	0001	NR	N	MG/L	<	0.05		0.05	-
	0249	10/03/90	0001	NR	N		<	0.03		0.03	-
	0249	04/24/91	0001	NR	N		<	0.03		0.03	-
	0251	04/23/90	0001	NR	N		<	0.05		0.05	-
	0251	10/05/90	0001	NR	N		<	0.03		0.03	-
	0251	04/24/91	0001	NR	N		<	0.03		0.03	-
	0253	05/10/91	0001	NR	N		<	0.03		0.03	-
	0254	10/03/90	0001	NR	N			0.04		0.03	-
	0254	05/10/91	0001	NR	N		<	0.03		0.03	-
	0255	04/24/91	0001	NR	N		<	0.03		0.03	-
	0255	12/13/91	0001	NR	N		<	0.03		0.03	-
COBALT (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.05		0.05	-
COPPER	0249	04/23/90	0001	NR	N	MG/L	<	0.02		0.02	-
	0249	10/03/90	0001	NR	N		<	0.01		0.01	-
	0249	04/24/91	0001	NR	N		<	0.01		0.01	-
	0251	04/23/90	0001	NR	N		<	0.02		0.02	-
	0251	10/05/90	0001	NR	N		<	0.01		0.01	-
	0251	04/24/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N			0.028		0.0005	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
COPPER	0254	10/03/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0254	05/10/91	0001	NR	N			0.02		0.01	-
	0255	04/24/91	0001	NR	N		<	0.01		0.01	-
	0255	08/24/91	0001	NR	N			0.0069		0.0005	-
	0255	12/13/91	0001	NR	N		<	0.01		0.01	-
COPPER (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.03		0.02	-
CYANIDE	0249	10/03/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0251	10/05/90	0001	NR	N		<	0.01		0.01	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
FLUORIDE	0249	04/23/90	0001	NR	N	MG/L		0.4		0.1	-
	0249	10/03/90	0001	NR	N			0.5		0.1	-
	0249	04/24/91	0001	NR	N			0.5		0.1	-
	0251	04/23/90	0001	NR	N			0.8		0.1	-
	0251	10/05/90	0001	NR	N			0.7		0.1	-
	0251	04/24/91	0001	NR	N			1.1		0.1	-
	0253	05/10/91	0001	NR	N			0.6		0.1	-
	0253	08/25/91	0001	NR	N			0.68		0.1	-
	0254	10/03/90	0001	NR	N			0.5		0.1	-
	0254	05/10/91	0001	NR	N			0.5		0.1	-
	0255	04/24/91	0001	NR	N			0.5		0.1	-
	0255	08/24/91	0001	NR	N			0.49		0.1	-
FLUORIDE (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.3		0.1	-
GROSS ALPHA	0249	10/03/90	0001	NR	N	PCI/L		888.		1.	145.
	0249	04/24/91	0001	NR	N			403.		1.	78.7
	0251	10/05/90	0001	NR	N			108.		1.	44.0
	0251	04/24/91	0001	NR	N			378.		1.	64.3
	0253	05/10/91	0001	NR	N			218.		1.	63.5
	0253	08/25/91	0001	NR	N			180		1.	50
	0254	10/03/90	0001	NR	N			332.		1.	69.0
	0254	05/10/91	0001	NR	N			796.		1.	131.
	0255	04/24/91	0001	NR	N			473.		1.	83.7
	0255	08/24/91	0001	NR	N			310		1.	60
	0255	12/13/91	0001	NR	N			494.		1.	86.4
GROSS BETA	0249	10/03/90	0001	NR	N	PCI/L		240.		0.5	33.4
	0249	04/24/91	0001	NR	N			221.		0.5	34.6
	0251	10/05/90	0001	NR	N			61.6		0.5	18.7

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
GROSS BETA	0251	04/24/91	0001	NR	N	PCI/L		186.		0.5	26.8
	0253	05/10/91	0001	NR	N			85.1		0.5	28.8
	0253	08/25/91	0001	NR	N			96		0.5	24
	0254	10/03/90	0001	NR	N			246.		0.5	33.7
	0254	05/10/91	0001	NR	N			291.		0.5	50.3
	0255	04/24/91	0001	NR	N			287.		0.5	37.2
	0255	08/24/91	0001	NR	N			120		0.5	20
	0255	12/13/91	0001	NR	N			199.		0.5	36.1
IRON	0249	04/23/90	0001	NR	N	MG/L		0.16		0.03	-
	0249	10/03/90	0001	NR	N		<	0.03		0.03	-
	0249	04/24/91	0001	NR	N		<	0.03		0.03	-
	0251	04/23/90	0001	NR	N			0.13		0.03	-
	0251	10/05/90	0001	NR	N		<	0.03		0.03	-
	0251	04/24/91	0001	NR	N		<	0.03		0.03	-
	0253	05/10/91	0001	NR	N		<	0.03		0.03	-
	0253	08/25/91	0001	NR	N		<	0.0053		0.0053	-
	0254	10/03/90	0001	NR	N		<	0.03		0.03	-
	0254	05/10/91	0001	NR	N		<	0.03		0.03	-
	0255	04/24/91	0001	NR	N		<	0.03		0.03	-
	0255	08/24/91	0001	NR	N			0.037		0.0053	-
	0255	12/13/91	0001	NR	N		<	0.03		0.03	-
IRON (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.38		0.03	-
LEAD	0249	04/23/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0249	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0249	04/24/91	0001	NR	N		<	0.005		0.005	-
	0251	04/23/90	0001	NR	N		<	0.01		0.01	-
	0251	10/05/90	0001	NR	N		<	0.03	Ic	0.03	-
	0251	04/24/91	0001	NR	N		<	0.005		0.005	-
	0253	05/10/91	0001	NR	N		<	0.005		0.005	-
	0253	08/25/91	0001	NR	N		<	0.0017		0.0017	-
	0254	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0254	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0255	04/24/91	0001	NR	N		<	0.005		0.005	-
	0255	08/24/91	0001	NR	N		<	0.0085	I	0.0085	-
	0255	12/13/91	0001	NR	N		<	0.005		0.005	-
LEAD (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.01		0.01	-
LEAD-210	0249	10/03/90	0001	NR	N	PCI/L		1.2		1.5	2.7

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
LEAD-210	0251	10/05/90	0001	NR	N	PCI/L		0.2		1.5	2.7
	0254	10/03/90	0001	NR	N		<	2.5	b	1.5	2.5
MAGNESIUM	0249	04/23/90	0001	NR	N	MG/L		454.		0.001	-
	0249	10/03/90	0001	NR	N			390.		0.001	-
	0249	04/24/91	0001	NR	N			479.		0.5	-
	0251	04/23/90	0001	NR	N			246.		0.001	-
	0251	10/05/90	0001	NR	N			157.		0.001	-
	0251	04/24/91	0001	NR	N			297.		0.5	-
	0253	05/10/91	0001	NR	N			371.		0.5	-
	0253	08/25/91	0001	NR	N			240		0.014	-
	0254	10/03/90	0001	NR	N			570.		0.001	-
	0254	05/10/91	0001	NR	N			880.		2.	-
	0255	04/24/91	0001	NR	N			515.		2.	-
	0255	08/24/91	0001	NR	N			290		0.014	-
	0255	12/13/91	0001	NR	N			406.		0.5	-
MAGNESIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		435.		0.001	-
MANGANESE	0249	04/23/90	0001	NR	N	MG/L		2.22		0.01	-
	0249	10/03/90	0001	NR	N			1.87		0.01	-
	0249	04/24/91	0001	NR	N			2.27		0.01	-
	0251	04/23/90	0001	NR	N			0.01		0.01	-
	0251	10/05/90	0001	NR	N		<	0.05	Ic	0.05	-
	0251	04/24/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.05	I	0.05	-
	0253	08/25/91	0001	NR	N			0.028		0.0019	-
	0254	10/03/90	0001	NR	N			1.59		0.01	-
	0254	05/10/91	0001	NR	N			0.48		0.01	-
	0255	04/24/91	0001	NR	N			0.78		0.01	-
	0255	08/24/91	0001	NR	N			0.88		0.0019	-
	0255	12/13/91	0001	NR	N			1.25		0.01	-
MANGANESE (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		2.40		0.01	-
MERCURY	0249	04/23/90	0001	NR	N	MG/L	<	0.0002		0.0002	-
	0249	10/03/90	0001	NR	N		<	0.0002		0.0002	-
	0251	04/23/90	0001	NR	N		<	0.0002		0.0002	-
	0251	10/05/90	0001	NR	N		<	0.0002		0.0002	-
	0253	08/25/91	0001	NR	N		<	0.00010		0.0001	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
b - CHANGED PARAMETER VALUE
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MERCURY	0254	10/03/90	0001	NR	N	MG/L	<	0.0002		0.0002	-
	0255	08/24/91	0001	NR	N		<	0.00010		0.0001	-
	0255	12/13/91	0001	NR	N		<	0.0002		0.0002	-
MERCURY (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.0002		0.0002	-
MOLYBDENUM	0249	04/23/90	0001	NR	N	MG/L		0.02		0.01	-
	0249	10/03/90	0001	NR	N			0.02		0.01	-
	0249	04/24/91	0001	NR	N			0.02		0.01	-
	0251	04/23/90	0001	NR	N			0.43		0.01	-
	0251	10/05/90	0001	NR	N			0.12		0.01	-
	0251	04/24/91	0001	NR	N			0.45		0.01	-
	0253	05/10/91	0001	NR	N			0.08		0.01	-
	0253	08/25/91	0001	NR	N			0.12		0.0048	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N			0.01		0.01	-
	0255	04/24/91	0001	NR	N			0.06		0.01	-
	0255	08/24/91	0001	NR	N			0.063		0.0048	-
	0255	12/13/91	0001	NR	N			0.06		0.01	-
MOLYBDENUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.01		0.01	-
NET GROSS ALPHA *	0249	10/03/90	0001	NR	N	PCI/L		335.08		-	-
	0249	04/24/91	0001	NR	N			71.66		-	-
	0251	10/05/90	0001	NR	N			-14.11		-	-
	0251	04/24/91	0001	NR	N			98.80		-	-
	0253	05/10/91	0001	NR	N			75.31		-	-
	0253	08/25/91	0001	NR	N			-65.59		-	-
	0254	10/03/90	0001	NR	N			-205.82		-	-
	0254	05/10/91	0001	NR	N			266.41		-	-
	0255	04/24/91	0001	NR	N			42.19		-	-
	0255	08/24/91	0001	NR	N			-79.65		-	-
	0255	12/13/91	0001	NR	N			-19.13		-	-
NICKEL	0249	04/23/90	0001	NR	N	MG/L		0.13		0.04	-
	0249	10/03/90	0001	NR	N			0.09		0.04	-
	0249	04/24/91	0001	NR	N			0.12		0.04	-
	0251	04/23/90	0001	NR	N			0.04		0.04	-
	0251	10/05/90	0001	NR	N		<	0.04		0.04	-
	0251	04/24/91	0001	NR	N			0.05		0.04	-

* NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
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N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
NICKEL	0253	05/10/91	0001	NR	N	MG/L		0.04		0.04	-
	0253	08/25/91	0001	NR	N			0.029		0.0061	-
	0254	10/03/90	0001	NR	N			0.21		0.04	-
	0254	05/10/91	0001	NR	N			0.29		0.04	-
	0255	04/24/91	0001	NR	N			0.07		0.04	-
	0255	08/24/91	0001	NR	N			0.061		0.0061	-
	0255	12/13/91	0001	NR	N			0.06		0.04	-
NICKEL (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.14		0.04	-
NITRATE	0249	04/23/90	0001	NR	N	MG/L		155.		1.	-
	0249	10/03/90	0001	NR	N			170.		1.	-
	0249	04/24/91	0001	NR	N			153.		1.	-
	0251	04/23/90	0001	NR	N			260.		1.	-
	0251	10/05/90	0001	NR	N			29.7		1.	-
	0251	04/24/91	0001	NR	N			357.		1.	-
	0253	05/10/91	0001	NR	N			36.7		1.	-
	0253	08/25/91	0001	NR	N			16		0.22	-
	0254	10/03/90	0001	NR	N			994.		1.	-
	0254	05/10/91	0001	NR	N			753.		1.	-
	0255	04/24/91	0001	NR	N			303.		1.	-
	0255	08/24/91	0001	NR	N			170		0.22	-
	0255	12/13/91	0001	NR	N			168.		10.	-
NITRATE (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		114.		1.	-
NITRITE AND NITRATE	0249	10/03/90	0001	NR	N	MG/L		38.6		1.	-
	0249	04/24/91	0001	NR	N			34.8		0.05	-
	0251	10/05/90	0001	NR	N			6.70		1.	-
	0251	04/24/91	0001	NR	N			80.6		0.05	-
	0253	05/10/91	0001	NR	N			8.28		0.05	-
	0254	10/03/90	0001	NR	N			225.		1.	-
	0254	05/10/91	0001	NR	N			176.		0.05	-
	0255	04/24/91	0001	NR	N			68.8		0.05	-
PH	0249	04/23/90	0001	NR	N	SU		6.58		-	-
	0249	06/25/90	N001	NR	N			6.48		-	-
	0249	10/03/90	0001	NR	N			6.40		-	-
	0249	04/24/91	0001	NR	N			7.03		-	-
	0251	04/23/90	0001	NR	N			8.05		-	-
	0251	10/05/90	0001	NR	N			7.27		-	-
	0251	04/24/91	0001	NR	N			7.96		-	-

FORMATION OF COMPLETION CODE:
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PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
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SAMPLE ID CODES:
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TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
PH	0253	05/10/91	0001	NR	N	SU		7.52		-	-
	0253	08/25/91	0001	NR	N			7.73		-	-
	0254	10/03/90	0001	NR	N			7.96		-	-
	0254	05/10/91	0001	NR	N			7.94		-	-
	0255	04/24/91	0001	NR	N			7.11		-	-
	0255	08/24/91	0001	NR	N			6.60		-	-
	0255	12/13/91	0001	NR	N			6.98		-	-
PHOSPHATE	0249	04/23/90	0001	NR	N	MG/L	<	0.1		0.1	-
	0249	10/03/90	0001	NR	N			0.1		0.1	-
	0251	04/23/90	0001	NR	N		<	0.1		0.1	-
	0251	10/05/90	0001	NR	N			0.1		0.1	-
	0254	10/03/90	0001	NR	N			0.1		0.1	-
PHOSPHATE (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.1		0.1	-
POLONIUM-210	0249	10/03/90	0001	NR	N	PCI/L	<	0.3	d	0.1	0.3
	0251	10/05/90	0001	NR	N			0.1	c	0.5	0.4
	0254	10/03/90	0001	NR	N			0.1	c	0.3	0.2
POTASSIUM	0249	04/23/90	0001	NR	N	MG/L		25.0		0.01	-
	0249	10/03/90	0001	NR	N			17.		0.01	-
	0249	04/24/91	0001	NR	N			18.		5.	-
	0251	04/23/90	0001	NR	N			7.3		0.01	-
	0251	10/05/90	0001	NR	N			9.5		0.01	-
	0251	04/24/91	0001	NR	N			6.8		0.1	-
	0253	05/10/91	0001	NR	N			9.		5.	-
	0253	08/25/91	0001	NR	N			14		0.0005	-
	0254	10/03/90	0001	NR	N			19.		0.01	-
	0254	05/10/91	0001	NR	N			28.		5.	-
	0255	04/24/91	0001	NR	N			13.		5.	-
	0255	08/24/91	0001	NR	N			14		0.0005	-
	0255	12/13/91	0001	NR	N			12.		5.	-
POTASSIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		25.5		0.01	-
RADIUM-226	0249	04/23/90	0001	NR	N	PCI/L	<	0.1	d	0.1	0.1
	0249	10/03/90	0001	NR	N			0.2	c	0.4	0.2
	0249	04/24/91	0001	NR	N			0.0		1.	0.2
	0251	04/23/90	0001	NR	N		<	0.1	d	0.1	0.1

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
c - CHANGED DETECTION LIMIT
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
RADIUM-226	0251	10/05/90	0001	NR	N	PCI/L		0.5	c	0.8	0.3
	0251	04/24/91	0001	NR	N			0.2		1.	0.3
	0253	05/10/91	0001	NR	N			0.2		1.	0.3
	0253	08/25/91	0001	NR	N			0.0		1.	0.1
	0254	10/03/90	0001	NR	N			0.1	c	0.3	0.2
	0254	05/10/91	0001	NR	N			0.3		1.	0.3
	0255	04/24/91	0001	NR	N			0.0		1.	0.2
	0255	08/24/91	0001	NR	N			0.0		1.	0.1
	0255	12/13/91	0001	NR	N			0.3		1.	0.2
RADIUM-226 (TOTAL)	0249	06/25/90	N001	NR	N	PCI/L		0.2	c	0.4	0.2
RADIUM-226 + RADIUM-228	0249	04/23/90	0001	NR	N	PCI/L		0.65		-	-
	0249	10/03/90	0001	NR	N			1.70		-	-
	0249	04/24/91	0001	NR	N			0.00		-	-
	0251	04/23/90	0001	NR	N			0.75		-	-
	0251	10/05/90	0001	NR	N			1.80		-	-
	0251	04/24/91	0001	NR	N			0.20		-	-
	0253	05/10/91	0001	NR	N			3.90		-	-
	0253	08/25/91	0001	NR	N			0.10		-	-
	0254	10/03/90	0001	NR	N			1.10		-	-
	0254	05/10/91	0001	NR	N			7.40		-	-
	0255	04/24/91	0001	NR	N			0.00		-	-
	0255	08/24/91	0001	NR	N			0.00		-	-
	0255	12/13/91	0001	NR	N			0.30		-	-
RADIUM-226 + RADIUM-228 TOTAL	0249	06/25/90	N001	NR	N	PCI/L		0.30		-	-
RADIUM-228	0249	04/23/90	0001	NR	N	PCI/L		0.6		1.	0.9
	0249	10/03/90	0001	NR	N			1.5		1.	1.5
	0249	04/24/91	0001	NR	N			0.0		1.	2.3
	0251	04/23/90	0001	NR	N			0.7		1.	0.9
	0251	10/05/90	0001	NR	N			1.3		1.	1.4
	0251	04/24/91	0001	NR	N			0.0		1.	2.1
	0253	05/10/91	0001	NR	N			3.7		1.	2.5
	0253	08/25/91	0001	NR	N			0.1		1.	1.3
	0254	10/03/90	0001	NR	N			1.0		1.	1.6
	0254	05/10/91	0001	NR	N			7.1		1.	2.7
	0255	04/24/91	0001	NR	N			0.0		1.	2.4
	0255	08/24/91	0001	NR	N			0.0		1.	1.4
	0255	12/13/91	0001	NR	N			0.0		1.	2.3

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
RADIUM-228 (TOTAL)	0249	06/25/90	N001	NR	N	PCI/L		0.1		1.	0.9
SELENIUM	0249	04/23/90	0001	NR	N	MG/L		0.005		0.005	-
	0249	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0249	04/24/91	0001	NR	N			0.010		0.005	-
	0251	04/23/90	0001	NR	N			0.005		0.005	-
	0251	10/05/90	0001	NR	N		<	0.03	Ic	0.03	-
	0251	04/24/91	0001	NR	N			0.011		0.005	-
	0253	05/10/91	0001	NR	N			0.025		0.005	-
	0253	08/25/91	0001	NR	N			0.0090		0.0016	-
	0254	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0254	05/10/91	0001	NR	N			0.030		0.005	-
	0255	04/24/91	0001	NR	N		<	0.005		0.005	-
	0255	08/24/91	0001	NR	N			0.0048		0.0016	-
	0255	12/13/91	0001	NR	N		<	0.03	I	0.03	-
SELENIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.005		0.005	-
SILICA - SIO2	0249	04/23/90	0001	NR	N	MG/L		36.		2.	-
	0249	10/03/90	0001	NR	N			30.6		0.1	-
	0249	04/24/91	0001	NR	N			34.0		0.1	-
	0251	04/23/90	0001	NR	N			30.		2.	-
	0251	10/05/90	0001	NR	N			19.2		0.1	-
	0251	04/24/91	0001	NR	N			28.4		0.1	-
	0253	05/10/91	0001	NR	N			22.6		0.1	-
	0254	10/03/90	0001	NR	N			40.2		0.1	-
	0254	05/10/91	0001	NR	N			49.6		0.1	-
	0255	04/24/91	0001	NR	N			37.0		0.5	-
SILICA - SIO2 (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		37.		2.	-
SILVER	0249	04/23/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0249	10/03/90	0001	NR	N		<	0.01		0.01	-
	0249	04/24/91	0001	NR	N		<	0.01		0.01	-
	0251	04/23/90	0001	NR	N		<	0.01		0.01	-
	0251	10/05/90	0001	NR	N		<	0.01		0.01	-
	0251	04/24/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N		<	0.0029		0.0029	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N		<	0.01		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
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SAMPLE ID CODES:
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N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SILVER	0255	04/24/91	0001	NR	N	MG/L	<	0.01		0.01	-
	0255	08/24/91	0001	NR	N		<	0.0029		0.0029	-
	0255	12/13/91	0001	NR	N		<	0.01		0.01	-
SILVER (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.01		0.01	-
SODIUM	0249	04/23/90	0001	NR	N	MG/L		436.		0.002	-
	0249	10/03/90	0001	NR	N			372.		0.002	-
	0249	04/24/91	0001	NR	N			428.		5.	-
	0251	04/23/90	0001	NR	N			359.		0.002	-
	0251	10/05/90	0001	NR	N			430.		0.002	-
	0251	04/24/91	0001	NR	N			390.		5.	-
	0253	05/10/91	0001	NR	N			907.		5.	-
	0253	08/25/91	0001	NR	N			570		0.014	-
	0254	10/03/90	0001	NR	N			496.		0.002	-
	0254	05/10/91	0001	NR	N			798.		5.	-
	0255	04/24/91	0001	NR	N			520.		20.	-
	0255	08/24/91	0001	NR	N			270		0.014	-
	0255	12/13/91	0001	NR	N			397.		5.	-
SODIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		417.		0.002	-
SPECIFIC CONDUCTANCE	0249	04/23/90	0001	NR	N	UMHO/CM		4600.		-	-
	0249	06/25/90	N001	NR	N			6200.		-	-
	0249	10/03/90	0001	NR	N			4850.		-	-
	0249	04/24/91	0001	NR	N			5800.		-	-
	0251	04/23/90	0001	NR	N			5000.		-	-
	0251	10/05/90	0001	NR	N			3250.		-	-
	0251	04/24/91	0001	NR	N			4630.		-	-
	0253	05/10/91	0001	NR	N			5600.		-	-
	0253	08/25/91	0001	NR	N			5430.		-	-
	0254	10/03/90	0001	NR	N			5100.		-	-
	0254	05/10/91	0001	NR	N			7440.		-	-
	0255	04/24/91	0001	NR	N			5870.		-	-
	0255	08/24/91	0001	NR	N			5000.		-	-
	0255	12/13/91	0001	NR	N			409		-	-
STRONTIUM	0249	04/23/90	0001	NR	N	MG/L		12.8		0.1	-
	0249	10/03/90	0001	NR	N			9.32		0.01	-
	0249	04/24/91	0001	NR	N			12.7		0.01	-
	0251	04/23/90	0001	NR	N			11.9		0.1	-
	0251	10/05/90	0001	NR	N			12.9		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
STRONTIUM	0251	04/24/91	0001	NR	N	MG/L		13.3		0.01	-
	0253	05/10/91	0001	NR	N			15.1		0.01	-
	0253	08/25/91	0001	NR	N			11		0.01	-
	0254	10/03/90	0001	NR	N			11.4		0.01	-
	0254	05/10/91	0001	NR	N			14.9		0.01	-
	0255	04/24/91	0001	NR	N			14.6		0.05	-
	0255	08/24/91	0001	NR	N			11		0.01	-
	0255	12/13/91	0001	NR	N			12.6		0.01	-
STRONTIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		13.1		0.1	-
SULFATE	0249	04/23/90	0001	NR	N	MG/L		3370.		0.1	-
	0249	10/03/90	0001	NR	N			3320.		0.1	-
	0249	04/24/91	0001	NR	N			3380.		10.	-
	0251	04/23/90	0001	NR	N			1950.		0.1	-
	0251	10/05/90	0001	NR	N			2370.		0.1	-
	0251	04/24/91	0001	NR	N			2040.		10.	-
	0253	05/10/91	0001	NR	N			3520.		10.	-
	0253	08/25/91	0001	NR	N			3200		1.	-
	0254	10/03/90	0001	NR	N			3400.		0.1	-
	0254	05/10/91	0001	NR	N			3040.		10.	-
	0255	04/24/91	0001	NR	N			3470.		10.	-
	0255	08/24/91	0001	NR	N			2900		1.	-
	0255	12/13/91	0001	NR	N			3330.		10.	-
SULFATE (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		3812.5		0.1	-
SULFIDE	0249	10/03/90	0001	NR	N	MG/L	<	0.1		0.1	-
	0249	04/24/91	0001	NR	N			12.9		1.	-
	0251	10/05/90	0001	NR	N			28.4		0.1	-
	0251	04/24/91	0001	NR	N			20.5		1.	-
	0253	05/10/91	0001	NR	N			15.6		1.	-
	0254	10/03/90	0001	NR	N			8.9		0.1	-
	0254	05/10/91	0001	NR	N			14.6		1.	-
	0255	04/24/91	0001	NR	N			14.6		1.	-
TEMPERATURE	0249	06/25/90	N001	NR	N	C - DEGREE		32.		-	-
	0249	10/03/90	0001	NR	N			18.0		-	-
	0249	04/24/91	0001	NR	N			25.3		-	-
	0251	10/05/90	0001	NR	N			16.0		-	-
	0251	04/24/91	0001	NR	N			16.5		-	-
	0253	05/10/91	0001	NR	N			14.4		-	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
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TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
TEMPERATURE	0253	08/25/91	0001	NR	N	C - DEGREE		22.9		-	-
	0254	10/03/90	0001	NR	N			17.1		-	-
	0254	05/10/91	0001	NR	N			13.9		-	-
	0255	04/24/91	0001	NR	N			22.2		-	-
	0255	08/24/91	0001	NR	N			21.9		-	-
	0255	12/13/91	0001	NR	N			9.8		-	-
THALLIUM	0249	04/23/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0249	04/24/91	0001	NR	N		<	0.01		0.01	-
	0251	04/23/90	0001	NR	N		<	0.01		0.01	-
	0251	04/24/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N		<	0.01		0.01	-
	0255	04/24/91	0001	NR	N		<	0.01		0.01	-
THALLIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L	<	0.01		0.01	-
THORIUM-230	0249	10/03/90	0001	NR	N	PCI/L		0.2	c	0.5	0.3
	0249	04/24/91	0001	NR	N			0.1		1.	0.2
	0251	10/05/90	0001	NR	N		<	0.4	d	0.1	0.4
	0251	04/24/91	0001	NR	N			0.1		1.	0.2
	0253	05/10/91	0001	NR	N			0.1		1.	0.1
	0254	10/03/90	0001	NR	N			0.3	c	0.6	0.3
	0254	05/10/91	0001	NR	N			0.0		1.	0.1
	0255	04/24/91	0001	NR	N			0.1		1.	0.2
TIN	0249	04/23/90	0001	NR	N	MG/L		0.066		0.005	-
	0249	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0249	04/24/91	0001	NR	N		<	0.03	I	0.03	-
	0251	04/23/90	0001	NR	N			0.054		0.005	-
	0251	10/05/90	0001	NR	N		<	0.05	Ic	0.05	-
	0251	04/24/91	0001	NR	N		<	0.03	I	0.03	-
	0253	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0253	08/25/91	0001	NR	N		<	0.0050		0.005	-
	0254	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0254	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0255	04/24/91	0001	NR	N		<	0.03	I	0.03	-
	0255	08/24/91	0001	NR	N		<	0.0050		0.005	-
TIN (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.009		0.005	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT
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FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
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TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
TOTAL DISSOLVED SOLIDS	0249	04/23/90	0001	NR	N	MG/L		2980.		10.	-
	0249	10/03/90	0001	NR	N			5880.		10.	-
	0249	04/24/91	0001	NR	N			5920.		10.	-
	0251	04/23/90	0001	NR	N			3520.		10.	-
	0251	10/05/90	0001	NR	N			4080.		10.	-
	0251	04/24/91	0001	NR	N			4290.		10.	-
	0253	05/10/91	0001	NR	N			5870.		10.	-
	0253	08/25/91	0001	NR	N			5000		10.	-
	0254	10/03/90	0001	NR	N			6900.		10.	-
	0254	05/10/91	0001	NR	N			5020.		10.	-
	0255	04/24/91	0001	NR	N			6020.		10.	-
	0255	08/24/91	0001	NR	N			4900		10.	-
	0255	12/13/91	0001	NR	N			5700.		10.	-
TOTAL DISSOLVED SOLIDS (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		5640.		10.	-
TOTAL KJELDAHL NITROGEN	0249	10/03/90	0001	NR	N	MG/L		26.		1.	-
	0249	04/24/91	0001	NR	N			23.		1.	-
	0251	10/05/90	0001	NR	N		<	1.		1.	-
	0251	04/24/91	0001	NR	N		<	1.		1.	-
	0253	05/10/91	0001	NR	N		<	1.		1.	-
	0254	10/03/90	0001	NR	N		<	1.		1.	-
	0254	05/10/91	0001	NR	N		<	1.		1.	-
	0255	04/24/91	0001	NR	N			3.		1.	-
TOTAL ORGANIC CARBON	0249	10/03/90	0001	NR	N	MG/L		40.		1.	-
	0249	04/24/91	0001	NR	N			5.		1.	-
	0251	10/05/90	0001	NR	N			6.		1.	-
	0251	04/24/91	0001	NR	N			8.		1.	-
	0253	05/10/91	0001	NR	N			3.		1.	-
	0254	10/03/90	0001	NR	N			35.		1.	-
	0254	05/10/91	0001	NR	N			7.		1.	-
	0255	04/24/91	0001	NR	N			7.		1.	-
URANIUM	0249	04/23/90	0001	NR	N	MG/L		0.730		0.003	-
	0249	10/03/90	0001	NR	N			0.806		0.001	-
	0249	04/24/91	0001	NR	N			0.483		0.001	-
	0251	04/23/90	0001	NR	N			0.468		0.003	-
	0251	10/05/90	0001	NR	N			0.178		0.001	-
	0251	04/24/91	0001	NR	N			0.407		0.001	-
	0253	05/10/91	0001	NR	N			0.208		0.001	-
	0253	08/25/91	0001	NR	N			0.358		0.0003	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.7 - SEEP WATER QUALITY DATA BY PARAMETER: NORTH ARROYO SEEPS
SITE: HAT01 MEXICAN HAT
04/23/90 TO 12/13/91
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
URANIUM	0254	10/03/90	0001	NR	N	MG/L		0.784		0.001	-
	0254	05/10/91	0001	NR	N			0.772		0.001	-
	0255	04/24/91	0001	NR	N			0.628		0.001	-
	0255	08/24/91	0001	NR	N			0.568		0.0003	-
	0255	12/13/91	0001	NR	N			0.748		0.001	-
URANIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.718		0.003	-
VANADIUM	0249	04/23/90	0001	NR	N	MG/L		0.01		0.01	-
	0249	10/03/90	0001	NR	N		<	0.01		0.01	-
	0249	04/24/91	0001	NR	N		<	0.01		0.01	-
	0251	04/23/90	0001	NR	N			0.02		0.01	-
	0251	10/05/90	0001	NR	N			0.03		0.01	-
	0251	04/24/91	0001	NR	N			0.02		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N			0.027		0.0051	-
	0254	10/03/90	0001	NR	N			0.07		0.01	-
	0254	05/10/91	0001	NR	N			0.08		0.01	-
	0255	04/24/91	0001	NR	N		<	0.01		0.01	-
	0255	08/24/91	0001	NR	N			0.0075		0.0051	-
	0255	12/13/91	0001	NR	N			0.01		0.01	-
VANADIUM (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.02		0.01	-
ZINC	0249	04/23/90	0001	NR	N	MG/L	<	0.005		0.005	-
	0249	10/03/90	0001	NR	N		<	0.01	Ic	0.01	-
	0249	04/24/91	0001	NR	N		<	0.03	I	0.03	-
	0251	04/23/90	0001	NR	N		<	0.005		0.005	-
	0251	10/05/90	0001	NR	N		<	0.03	Ic	0.03	-
	0251	04/24/91	0001	NR	N		<	0.03	I	0.03	-
	0253	05/10/91	0001	NR	N		<	0.005		0.005	-
	0253	08/25/91	0001	NR	N			0.051		0.0026	-
	0254	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0254	05/10/91	0001	NR	N			0.009		0.005	-
	0255	04/24/91	0001	NR	N		<	0.03	I	0.03	-
	0255	08/24/91	0001	NR	N			0.0092		0.0026	-
	0255	12/13/91	0001	NR	N		<	0.03	I	0.03	-
ZINC (TOTAL)	0249	06/25/90	N001	NR	N	MG/L		0.092		0.005	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

DATA FILE NAME: M:\DART\HAT01\GWQ10003.DAT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ALKALINITY	0248	04/23/90	N001	NR	N	MG/L CACO3		292.		-	-
	0248	10/03/90	0001	NR	N			272.		-	-
	0248	04/25/91	0001	NR	N			296.		-	-
	0248	08/24/91	0001	NR	N			256.		-	-
	0248	12/13/91	0001	NR	N			274		-	-
	0253	05/10/91	0001	NR	N			275.		-	-
	0253	08/25/91	0001	NR	N			292.		-	-
	0254	10/03/90	0001	NR	N			452.		-	-
	0254	05/10/91	0001	NR	N			473.		-	-
	0261	06/25/90	N001	NR	N			274.		-	-
	0261	10/03/90	0001	NR	N			189.		-	-
	0261	05/11/91	0001	NR	N			185.		-	-
	0261	12/14/91	0001	NR	N			289		-	-
	0922	06/01/88	0001	NR	N			293.		-	-
	0922	08/30/88	0001	NR	N			340.		-	-
	0922	06/25/90	N001	NR	N			490.		-	-
	0922	10/03/90	0001	NR	N			334.		-	-
	0922	04/25/91	0001	NR	N			331.		-	-
	0922	08/24/91	0001	NR	N			284.		-	-
	0922	12/14/91	0001	NR	N			486		-	-
	0923	06/01/88	0001	NR	N			211.		-	-
	0923	04/25/91	0001	NR	N			216.		-	-
	0924	08/30/88	0001	NR	N			223.		-	-
ALUMINUM	0248	10/03/90	0001	NR	N	MG/L	<	0.05		0.05	-
	0248	04/25/91	0001	NR	N		<	0.05		0.05	-
	0248	08/24/91	0001	NR	N			0.079		0.0067	-
	0248	12/13/91	0001	NR	N		<	0.05		0.05	-
	0253	05/10/91	0001	NR	N		<	0.05		0.05	-
	0253	08/25/91	0001	NR	N			0.072		0.0067	-
	0254	10/03/90	0001	NR	N		<	0.05		0.05	-
	0254	05/10/91	0001	NR	N		<	0.05		0.05	-
	0261	10/03/90	0001	NR	N		<	0.05		0.05	-
	0261	05/11/91	0001	NR	N		<	0.05		0.05	-
	0261	12/14/91	0001	NR	N		<	0.05		0.05	-
	0922	06/01/88	0001	NR	N		<	0.1		0.1	-
	0922	08/30/88	0001	NR	N			0.2		0.1	-
	0922	10/03/90	0001	NR	N		<	0.05		0.05	-
	0922	04/25/91	0001	NR	N		<	0.05		0.05	-
	0922	08/24/91	0001	NR	N			0.11		0.0067	-
	0922	12/14/91	0001	NR	N		<	0.05		0.05	-
	0923	06/01/88	0001	NR	N		<	0.1		0.1	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ALUMINUM	0923	04/25/91	0001	NR	N	MG/L	<	0.05		0.05	-
	0924	08/30/88	0001	NR	N			0.2		0.1	-
ALUMINUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.1		0.1	-
	0248	06/25/90	N001	NR	N			0.9		0.1	-
	0261	06/25/90	N001	NR	N			17.0		0.1	-
	0922	06/25/90	N001	NR	N			1.4		0.1	-
AMMONIUM	0248	10/03/90	0001	NR	N	MG/L		0.12		0.1	-
	0248	04/25/91	0001	NR	N			0.15		0.1	-
	0253	05/10/91	0001	NR	N			0.14		0.1	-
	0254	10/03/90	0001	NR	N			3.17		0.1	-
	0254	05/10/91	0001	NR	N			3.44		0.1	-
	0261	10/03/90	0001	NR	N		<	0.1		0.1	-
	0261	05/11/91	0001	NR	N		<	0.1		0.1	-
	0922	06/01/88	0001	NR	N			0.2		0.1	-
	0922	08/30/88	0001	NR	N			0.6		0.1	-
	0922	10/03/90	0001	NR	N			1.1		0.1	-
	0922	04/25/91	0001	NR	N			0.37		0.1	-
	0923	06/01/88	0001	NR	N			0.2		0.1	-
	0923	04/25/91	0001	NR	N			0.17		0.1	-
	0924	08/30/88	0001	NR	N		<	0.1		0.1	-
AMMONIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.1		0.1	-
	0248	06/25/90	N001	NR	N		<	0.1		0.1	-
	0922	06/25/90	N001	NR	N			1.0		0.1	-
ANTIMONY	0248	10/03/90	0001	NR	N	MG/L	<	0.006	Ic	0.006	-
	0248	04/25/91	0001	NR	N		<	0.003		0.003	-
	0248	08/24/91	0001	NR	N		<	0.020		0.02	-
	0248	12/13/91	0001	NR	N		<	0.003		0.003	-
	0253	05/10/91	0001	NR	N		<	0.003		0.003	-
	0253	08/25/91	0001	NR	N			0.042		0.02	-
	0254	10/03/90	0001	NR	N			0.006		0.003	-
	0254	05/10/91	0001	NR	N		<	0.003		0.003	-
	0261	10/03/90	0001	NR	N		<	0.006	Ic	0.006	-
	0261	05/11/91	0001	NR	N		<	0.003		0.003	-
	0261	12/14/91	0001	NR	N		<	0.003		0.003	-
	0922	10/03/90	0001	NR	N		<	0.006	Ic	0.006	-
	0922	04/25/91	0001	NR	N		<	0.003		0.003	-
	0922	08/24/91	0001	NR	N		<	0.020		0.02	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ANTIMONY	0922	12/14/91	0001	NR	N	MG/L	<	0.003		0.003	-
	0923	04/25/91	0001	NR	N		<	0.003		0.003	-
ANTIMONY (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.030		0.003	-
	0248	06/25/90	N001	NR	N			0.007		0.003	-
	0261	06/25/90	N001	NR	N		<	0.003		0.003	-
	0922	06/25/90	N001	NR	N		<	0.003		0.003	-
ARSENIC	0248	10/03/90	0001	NR	N	MG/L	<	0.05	Ic	0.05	-
	0248	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0248	08/24/91	0001	NR	N		<	0.0020		0.002	-
	0248	12/13/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0253	08/25/91	0001	NR	N			0.0034		0.002	-
	0254	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0254	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0261	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0261	05/11/91	0001	NR	N		<	0.03	I	0.03	-
	0261	12/14/91	0001	NR	N		<	0.01		0.01	-
	0922	06/01/88	0001	NR	N		<	0.01		0.01	-
	0922	08/30/88	0001	NR	N			0.02		0.01	-
	0922	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0922	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0922	08/24/91	0001	NR	N			0.0033		0.002	-
	0922	12/14/91	0001	NR	N		<	0.01		0.01	-
	0923	06/01/88	0001	NR	N		<	0.01		0.01	-
	0923	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0924	08/30/88	0001	NR	N			0.02		0.01	-
ARSENIC (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.01		0.01	-
	0248	06/25/90	N001	NR	N		<	0.01		0.01	-
	0261	06/25/90	N001	NR	N			0.02		0.01	-
	0922	06/25/90	N001	NR	N		<	0.01		0.01	-
BARIUM	0248	10/03/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0248	04/25/91	0001	NR	N		<	0.01		0.01	-
	0248	08/24/91	0001	NR	N		<	0.0022		0.0022	-
	0248	12/13/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N			0.01		0.01	-
	0253	08/25/91	0001	NR	N		<	0.0022		0.0022	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
BARIUM	0254	05/10/91	0001	NR	N	MG/L		0.01		0.01	-
	0261	10/03/90	0001	NR	N			0.02		0.01	-
	0261	05/11/91	0001	NR	N			0.01		0.01	-
	0261	12/14/91	0001	NR	N			0.01		0.01	-
	0922	06/01/88	0001	NR	N		<	0.1		0.1	-
	0922	10/03/90	0001	NR	N		<	0.01		0.01	-
	0922	04/25/91	0001	NR	N			0.01		0.01	-
	0922	08/24/91	0001	NR	N		<	0.0022		0.0022	-
	0922	12/14/91	0001	NR	N		<	0.01		0.01	-
	0923	06/01/88	0001	NR	N		<	0.1		0.1	-
	0923	04/25/91	0001	NR	N			0.03		0.01	-
BARIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.1		0.1	-
	0248	06/25/90	N001	NR	N		<	0.1		0.1	-
	0261	06/25/90	N001	NR	N			0.2		0.1	-
	0922	06/25/90	N001	NR	N		<	0.1		0.1	-
BERYLLIUM	0248	04/25/91	0001	NR	N	MG/L	<	0.005		0.005	-
	0253	05/10/91	0001	NR	N		<	0.005		0.005	-
	0254	05/10/91	0001	NR	N		<	0.005		0.005	-
	0261	05/11/91	0001	NR	N		<	0.005		0.005	-
	0922	04/25/91	0001	NR	N		<	0.005		0.005	-
	0923	04/25/91	0001	NR	N		<	0.005		0.005	-
BERYLLIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.01		0.01	-
	0248	06/25/90	N001	NR	N		<	0.01		0.01	-
	0261	06/25/90	N001	NR	N		<	0.01		0.01	-
	0922	06/25/90	N001	NR	N		<	0.01		0.01	-
BORON	0248	10/03/90	0001	NR	N	MG/L		1.17		0.05	-
	0248	04/25/91	0001	NR	N			1.27		0.05	-
	0253	05/10/91	0001	NR	N			0.81		0.05	-
	0254	10/03/90	0001	NR	N			0.88		0.05	-
	0254	05/10/91	0001	NR	N			1.20		0.05	-
	0261	10/03/90	0001	NR	N			0.28		0.05	-
	0261	05/11/91	0001	NR	N			0.40		0.05	-
	0922	10/03/90	0001	NR	N			0.69		0.05	-
	0922	04/25/91	0001	NR	N			0.80		0.05	-
	0923	04/25/91	0001	NR	N			0.78		0.05	-
BORON (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		1.1		0.1	-
	0248	06/25/90	N001	NR	N			1.2		0.1	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
BORON (TOTAL)	0261	06/25/90	N001	NR	N	MG/L		0.5		0.1	-
	0922	06/25/90	N001	NR	N			0.9		0.1	-
BROMIDE	0248	10/03/90	0001	NR	N	MG/L		0.4		0.1	-
	0248	04/25/91	0001	NR	N			0.5		0.1	-
	0253	05/10/91	0001	NR	N			1.1		0.1	-
	0254	10/03/90	0001	NR	N		<	0.5	Ic	0.5	-
	0254	05/10/91	0001	NR	N		<	1.0	I	1.	-
	0261	10/03/90	0001	NR	N			0.5		0.1	-
	0261	05/11/91	0001	NR	N			0.6		0.1	-
	0922	06/01/88	0001	NR	N		<	2.0		2.	-
	0922	10/03/90	0001	NR	N			0.5		0.1	-
	0922	04/25/91	0001	NR	N			0.9		0.1	-
	0923	06/01/88	0001	NR	N		<	2.0		2.	-
	0923	04/25/91	0001	NR	N			0.7		0.1	-
CADMIUM	0248	10/03/90	0001	NR	N	MG/L	<	0.001		0.001	-
	0248	04/25/91	0001	NR	N		<	0.001		0.001	-
	0248	08/24/91	0001	NR	N		<	0.0046		0.0046	-
	0248	12/13/91	0001	NR	N		<	0.001		0.001	-
	0253	05/10/91	0001	NR	N			0.001		0.001	-
	0253	08/25/91	0001	NR	N		<	0.0046		0.0046	-
	0254	10/03/90	0001	NR	N		<	0.001		0.001	-
	0254	05/10/91	0001	NR	N			0.001		0.001	-
	0261	10/03/90	0001	NR	N		<	0.001		0.001	-
	0261	05/11/91	0001	NR	N		<	0.001		0.001	-
	0261	12/14/91	0001	NR	N		<	0.001		0.001	-
	0922	06/01/88	0001	NR	N		<	0.001		0.001	-
	0922	10/03/90	0001	NR	N		<	0.001		0.001	-
	0922	04/25/91	0001	NR	N		<	0.001		0.001	-
	0922	08/24/91	0001	NR	N		<	0.0046		0.0046	-
	0922	12/14/91	0001	NR	N		<	0.001		0.001	-
	0923	06/01/88	0001	NR	N		<	0.001		0.001	-
	0923	04/25/91	0001	NR	N		<	0.001		0.001	-
CADMIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.001		0.001	-
	0248	06/25/90	N001	NR	N			0.002		0.001	-
	0261	06/25/90	N001	NR	N			0.001		0.001	-
	0922	06/25/90	N001	NR	N			0.001		0.001	-
CALCIUM	0248	10/03/90	0001	NR	N	MG/L		500.		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
CALCIUM	0248	04/25/91	0001	NR	N	MG/L		525.		2.	-
	0248	08/24/91	0001	NR	N			420		0.009	-
	0248	12/13/91	0001	NR	N			419.		0.5	-
	0253	05/10/91	0001	NR	N			595.		2.	-
	0253	08/25/91	0001	NR	N			440		0.009	-
	0254	10/03/90	0001	NR	N			656.		0.01	-
	0254	05/10/91	0001	NR	N			650.		2.	-
	0261	10/03/90	0001	NR	N			520.		0.01	-
	0261	05/11/91	0001	NR	N			745.		2.	-
	0261	12/14/91	0001	NR	N			481.		0.5	-
	0922	06/01/88	0001	NR	N			540.		0.01	-
	0922	08/30/88	0001	NR	N			504.		0.01	-
	0922	10/03/90	0001	NR	N			530.		0.01	-
	0922	04/25/91	0001	NR	N			590.		2.	-
	0922	08/24/91	0001	NR	N			530		0.009	-
	0922	12/14/91	0001	NR	N			454.		0.5	-
	0923	06/01/88	0001	NR	N			530.		0.01	-
	0923	04/25/91	0001	NR	N			640.		2.	-
	0924	08/30/88	0001	NR	N			435.		0.01	-
CALCIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		528.		0.01	-
	0248	06/25/90	N001	NR	N			460.		0.01	-
	0261	06/25/90	N001	NR	N			590.		0.01	-
	0922	06/25/90	N001	NR	N			481.		0.01	-
CHLORIDE	0248	10/03/90	0001	NR	N	MG/L		143.		1.	-
	0248	04/25/91	0001	NR	N			12.		0.5	-
	0248	08/24/91	0001	NR	N			140		0.5	-
	0248	12/13/91	0001	NR	N			130.		1.	-
	0253	05/10/91	0001	NR	N			185.		1.	-
	0253	08/25/91	0001	NR	N			190		0.5	-
	0254	10/03/90	0001	NR	N			113.		1.	-
	0254	05/10/91	0001	NR	N			164.		1.	-
	0261	10/03/90	0001	NR	N			176.		1.	-
	0261	05/11/91	0001	NR	N			162.		1.	-
	0261	12/14/91	0001	NR	N			181.		1.	-
	0922	06/01/88	0001	NR	N			150.		1.	-
	0922	08/30/88	0001	NR	N			141.		1.	-
	0922	10/03/90	0001	NR	N			129.		1.	-
	0922	04/25/91	0001	NR	N			158.		1.	-
	0922	08/24/91	0001	NR	N			180		0.5	-
	0922	12/14/91	0001	NR	N			135.		1.	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
CHLORIDE	0923	06/01/88	0001	NR	N	MG/L		170.		1.	-
	0923	04/25/91	0001	NR	N			246.		1.	-
	0924	08/30/88	0001	NR	N			154.		1.	-
CHLORIDE (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		183.		1.	-
	0248	06/25/90	N001	NR	N			150.		1.	-
	0261	06/25/90	N001	NR	N			183.		1.	-
	0922	06/25/90	N001	NR	N			150.		1.	-
CHROMIUM	0248	10/03/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0248	04/25/91	0001	NR	N		<	0.01		0.01	-
	0248	08/24/91	0001	NR	N		<	0.0032		0.0032	-
	0248	12/13/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N		<	0.0032		0.0032	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N		<	0.01		0.01	-
	0261	10/03/90	0001	NR	N		<	0.01		0.01	-
	0261	05/11/91	0001	NR	N		<	0.01		0.01	-
	0261	12/14/91	0001	NR	N		<	0.01		0.01	-
	0922	06/01/88	0001	NR	N		<	0.01		0.01	-
	0922	08/30/88	0001	NR	N			0.12		0.01	-
	0922	10/03/90	0001	NR	N		<	0.01		0.01	-
	0922	04/25/91	0001	NR	N		<	0.01		0.01	-
	0922	08/24/91	0001	NR	N		<	0.0032		0.0032	-
	0922	12/14/91	0001	NR	N		<	0.01		0.01	-
	0923	06/01/88	0001	NR	N		<	0.01		0.01	-
	0923	04/25/91	0001	NR	N		<	0.01		0.01	-
	0924	08/30/88	0001	NR	N			0.11		0.01	-
CHROMIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.01		0.01	-
	0248	06/25/90	N001	NR	N		<	0.01		0.01	-
	0261	06/25/90	N001	NR	N			0.01		0.01	-
	0922	06/25/90	N001	NR	N		<	0.01		0.01	-
COBALT	0248	10/03/90	0001	NR	N	MG/L	<	0.03		0.03	-
	0248	04/25/91	0001	NR	N		<	0.03		0.03	-
	0248	12/13/91	0001	NR	N		<	0.03		0.03	-
	0253	05/10/91	0001	NR	N		<	0.03		0.03	-
	0254	10/03/90	0001	NR	N			0.04		0.03	-
	0254	05/10/91	0001	NR	N		<	0.03		0.03	-
	0261	10/03/90	0001	NR	N		<	0.03		0.03	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
COBALT	0261	05/11/91	0001	NR	N	MG/L	<	0.03		0.03	-
	0261	12/14/91	0001	NR	N		<	0.03		0.03	-
	0922	10/03/90	0001	NR	N		<	0.03		0.03	-
	0922	04/25/91	0001	NR	N		<	0.03		0.03	-
	0922	12/14/91	0001	NR	N		<	0.03		0.03	-
	0923	04/25/91	0001	NR	N		<	0.03		0.03	-
COBALT (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.01		0.05	-
	0248	06/25/90	N001	NR	N		<	0.05		0.05	-
	0261	06/25/90	N001	NR	N		<	0.05		0.05	-
	0922	06/25/90	N001	NR	N		<	0.05		0.05	-
COPPER	0248	10/03/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0248	04/25/91	0001	NR	N		<	0.01		0.01	-
	0248	08/24/91	0001	NR	N			0.0064		0.0005	-
	0248	12/13/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N			0.028		0.0005	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N			0.02		0.01	-
	0261	10/03/90	0001	NR	N		<	0.01		0.01	-
	0261	05/11/91	0001	NR	N		<	0.01		0.01	-
	0261	12/14/91	0001	NR	N		<	0.01		0.01	-
	0922	10/03/90	0001	NR	N		<	0.01		0.01	-
	0922	04/25/91	0001	NR	N		<	0.01		0.01	-
	0922	08/24/91	0001	NR	N			0.033		0.0005	-
	0922	12/14/91	0001	NR	N		<	0.01		0.01	-
	0923	04/25/91	0001	NR	N		<	0.01		0.01	-
COPPER (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.02		0.02	-
	0248	06/25/90	N001	NR	N		<	0.02		0.02	-
	0261	06/25/90	N001	NR	N			0.03		0.02	-
	0922	06/25/90	N001	NR	N			0.03		0.02	-
CYANIDE	0248	10/03/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0261	10/03/90	0001	NR	N		<	0.01		0.01	-
	0922	10/03/90	0001	NR	N		<	0.01		0.01	-
FLUORIDE	0248	10/03/90	0001	NR	N	MG/L		0.4		0.1	-
	0248	04/25/91	0001	NR	N			0.4		0.1	-
	0248	08/24/91	0001	NR	N			0.34		0.1	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
FLUORIDE	0253	05/10/91	0001	NR	N	MG/L		0.6		0.1	-
	0253	08/25/91	0001	NR	N			0.68		0.1	-
	0254	10/03/90	0001	NR	N			0.5		0.1	-
	0254	05/10/91	0001	NR	N			0.5		0.1	-
	0261	10/03/90	0001	NR	N			0.5		0.1	-
	0261	05/11/91	0001	NR	N			0.4		0.1	-
	0922	06/01/88	0001	NR	N			0.5		0.1	-
	0922	08/30/88	0001	NR	N			0.4		0.1	-
	0922	10/03/90	0001	NR	N			0.7		0.1	-
	0922	04/25/91	0001	NR	N			0.6		0.1	-
	0922	08/24/91	0001	NR	N			0.49		0.1	-
	0923	06/01/88	0001	NR	N			0.5		0.1	-
	0923	04/25/91	0001	NR	N			0.8		0.1	-
	0924	08/30/88	0001	NR	N			0.6		0.1	-
FLUORIDE (TOTAL)	0248	06/25/90	N001	NR	N	MG/L		0.3		0.1	-
	0261	06/25/90	N001	NR	N			0.4		0.1	-
	0922	06/25/90	N001	NR	N			0.4		0.1	-
GROSS ALPHA	0248	10/03/90	0001	NR	N	PCI/L		449.		1.	84.6
	0248	04/25/91	0001	NR	N			422.		1.	79.1
	0248	08/24/91	0001	NR	N			360		1.	70
	0248	12/13/91	0001	NR	N			419.		1.	67.9
	0253	05/10/91	0001	NR	N			218.		1.	63.5
	0253	08/25/91	0001	NR	N			180		1.	50
	0254	10/03/90	0001	NR	N			332.		1.	69.0
	0254	05/10/91	0001	NR	N			796.		1.	131.
	0261	10/03/90	0001	NR	N		<	40.2	b	1.	40.2
	0261	05/11/91	0001	NR	N			29.6		1.	33.1
	0261	12/14/91	0001	NR	N			77.4		1.	40.4
	0922	08/30/88	0001	NR	N			120.		0.2	50.
	0922	10/03/90	0001	NR	N			241.		1.	67.8
	0922	04/25/91	0001	NR	N			118.		1.	53.5
	0922	08/24/91	0001	NR	N			130		1.	50
	0922	12/14/91	0001	NR	N			231.		1.	60.8
	0922	11/18/92	0001	NR	N			129.	#	49.1	46.5
	0923	04/25/91	0001	NR	N			35.0		1.	60.6
	0923	11/18/92	0001	NR	N			11.4	#	42.4	27.1
	0924	08/30/88	0001	NR	N			97.		0.2	35.
GROSS ALPHA (TOTAL)	0922	11/18/92	N001	NR	N	PCI/L		111.	#	49.1	44.4

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
- THE DATA HAS NOT YET UNDERGONE QUALITY CONTROL TESTS.
b - CHANGED PARAMETER VALUE

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
GROSS ALPHA (TOTAL)	0923	11/18/92	N001	NR	N	PCI/L		20.1	#	37.5	25.5
GROSS BETA	0248	10/03/90	0001	NR	N	PCI/L		197.		0.5	29.7
	0248	04/25/91	0001	NR	N			216.		0.5	34.4
	0248	08/24/91	0001	NR	N			160		0.5	30
	0248	12/13/91	0001	NR	N			144.		0.5	26.8
	0253	05/10/91	0001	NR	N			85.1		0.5	28.8
	0253	08/25/91	0001	NR	N			96		0.5	24
	0254	10/03/90	0001	NR	N			246.		0.5	33.7
	0254	05/10/91	0001	NR	N			291.		0.5	50.3
	0261	10/03/90	0001	NR	N			46.3		0.5	22.0
	0261	05/11/91	0001	NR	N			29.0		0.5	19.8
	0261	12/14/91	0001	NR	N			62.7		0.5	23.5
	0922	08/30/88	0001	NR	N			81.		1.	23.
	0922	10/03/90	0001	NR	N			135.		0.5	26.8
	0922	04/25/91	0001	NR	N			106.		0.5	29.7
	0922	08/24/91	0001	NR	N			120		0.5	30
	0922	12/14/91	0001	NR	N			133.		0.5	34.9
	0922	11/18/92	0001	NR	N			65.4	#	38.3	26.2
	0923	04/25/91	0001	NR	N			29.2		0.5	43.1
	0923	11/18/92	0001	NR	N			22.0	#	30.8	19.5
	0924	08/30/88	0001	NR	N			93.		1.	20.
GROSS BETA (TOTAL)	0922	11/18/92	N001	NR	N	PCI/L		76.1	#	38.3	26.7
	0923	11/18/92	N001	NR	N			25.9	#	32.3	20.7
IRON	0248	10/03/90	0001	NR	N	MG/L	<	0.03		0.03	-
	0248	04/25/91	0001	NR	N		<	0.03		0.03	-
	0248	08/24/91	0001	NR	N		<	0.0053		0.0053	-
	0248	12/13/91	0001	NR	N		<	0.03		0.03	-
	0253	05/10/91	0001	NR	N		<	0.03		0.03	-
	0253	08/25/91	0001	NR	N		<	0.0053		0.0053	-
	0254	10/03/90	0001	NR	N		<	0.03		0.03	-
	0254	05/10/91	0001	NR	N		<	0.03		0.03	-
	0261	10/03/90	0001	NR	N		<	0.03		0.03	-
	0261	05/11/91	0001	NR	N		<	0.03		0.03	-
	0261	12/14/91	0001	NR	N		<	0.03		0.03	-
	0922	06/01/88	0001	NR	N		<	0.03		0.03	-
	0922	08/30/88	0001	NR	N			0.08		0.03	-
	0922	10/03/90	0001	NR	N		<	0.03		0.03	-
	0922	04/25/91	0001	NR	N		<	0.03		0.03	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
- THE DATA HAS NOT YET UNDERGONE QUALITY CONTROL TESTS.

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
IRON	0922	08/24/91	0001	NR	N	MG/L	<	0.0053		0.0053	-
	0922	12/14/91	0001	NR	N		<	0.03		0.03	-
	0923	06/01/88	0001	NR	N		<	0.03		0.03	-
	0923	04/25/91	0001	NR	N		<	0.03		0.03	-
	0924	08/30/88	0001	NR	N			0.07		0.03	-
IRON (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.16		0.03	-
	0248	06/25/90	N001	NR	N			0.66		0.03	-
	0261	06/25/90	N001	NR	N			9.37		0.03	-
	0922	06/25/90	N001	NR	N			1.05		0.03	-
LEAD	0248	10/03/90	0001	NR	N	MG/L	<	0.03	Ic	0.03	-
	0248	04/25/91	0001	NR	N		<	0.005		0.005	-
	0248	08/24/91	0001	NR	N		<	0.0085	I	0.0085	-
	0248	12/13/91	0001	NR	N		<	0.005		0.005	-
	0253	05/10/91	0001	NR	N		<	0.005		0.005	-
	0253	08/25/91	0001	NR	N		<	0.0017		0.0017	-
	0254	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0254	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0261	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0261	05/11/91	0001	NR	N		<	0.005		0.005	-
	0261	12/14/91	0001	NR	N		<	0.005		0.005	-
	0922	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0922	04/25/91	0001	NR	N		<	0.005		0.005	-
	0922	08/24/91	0001	NR	N		<	0.0085	I	0.0085	-
	0922	12/14/91	0001	NR	N		<	0.005		0.005	-
	0923	04/25/91	0001	NR	N		<	0.005		0.005	-
LEAD (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.01		0.01	-
	0248	06/25/90	N001	NR	N			0.02		0.01	-
	0261	06/25/90	N001	NR	N			0.01		0.01	-
	0922	06/25/90	N001	NR	N			0.02		0.01	-
LEAD-210	0248	10/03/90	0001	NR	N	PCI/L		0.9		1.5	2.7
	0254	10/03/90	0001	NR	N		<	2.5	b	1.5	2.5
	0261	10/03/90	0001	NR	N			1.0		1.5	2.5
	0922	10/03/90	0001	NR	N		<	1.5	b	1.5	1.5
MAGNESIUM	0248	10/03/90	0001	NR	N	MG/L		296.		0.001	-
	0248	04/25/91	0001	NR	N			289.		0.5	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
b - CHANGED PARAMETER VALUE
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MAGNESIUM	0248	08/24/91	0001	NR	N	MG/L		240		0.014	-
	0248	12/13/91	0001	NR	N			236.		0.5	-
	0253	05/10/91	0001	NR	N			371.		0.5	-
	0253	08/25/91	0001	NR	N			240		0.014	-
	0254	10/03/90	0001	NR	N			570.		0.001	-
	0254	05/10/91	0001	NR	N			880.		2.	-
	0261	10/03/90	0001	NR	N			44.		0.001	-
	0261	05/11/91	0001	NR	N			234.		0.5	-
	0261	12/14/91	0001	NR	N			217.		0.5	-
	0922	06/01/88	0001	NR	N			264.		0.001	-
	0922	08/30/88	0001	NR	N			235.		0.001	-
	0922	10/03/90	0001	NR	N			315.		0.001	-
	0922	04/25/91	0001	NR	N			367.		0.5	-
	0922	08/24/91	0001	NR	N			330		0.014	-
	0922	12/14/91	0001	NR	N			275.		0.5	-
	0923	06/01/88	0001	NR	N			273.		0.001	-
	0923	04/25/91	0001	NR	N			426.		0.5	-
	0924	08/30/88	0001	NR	N			169.		0.001	-
MAGNESIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		280.		0.001	-
	0248	06/25/90	N001	NR	N			270.		0.001	-
	0261	06/25/90	N001	NR	N			243.		0.001	-
	0922	06/25/90	N001	NR	N			286.		0.001	-
MANGANESE	0248	10/03/90	0001	NR	N	MG/L	<	0.02	Ic	0.02	-
	0248	04/25/91	0001	NR	N		<	0.05	I	0.05	-
	0248	08/24/91	0001	NR	N		<	0.0019		0.0019	-
	0248	12/13/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.05	I	0.05	-
	0253	08/25/91	0001	NR	N			0.028		0.0019	-
	0254	10/03/90	0001	NR	N			1.59		0.01	-
	0254	05/10/91	0001	NR	N			0.48		0.01	-
	0261	10/03/90	0001	NR	N			0.10		0.01	-
	0261	05/11/91	0001	NR	N		<	0.01		0.01	-
	0261	12/14/91	0001	NR	N			0.05		0.01	-
	0922	06/01/88	0001	NR	N		<	0.01		0.01	-
	0922	08/30/88	0001	NR	N			0.03		0.01	-
	0922	10/03/90	0001	NR	N			0.08		0.01	-
	0922	04/25/91	0001	NR	N		<	0.01		0.01	-
	0922	08/24/91	0001	NR	N			0.0081		0.0019	-
	0922	12/14/91	0001	NR	N		<	0.01		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
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TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PVI	PARAMETER VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MANGANESE	0923	06/01/88	0001	NR	N	MG/L	<	0.01		0.01	-
	0923	04/25/91	0001	NR	N			0.16		0.01	-
	0924	08/30/88	0001	NR	N			0.21		0.01	-
MANGANESE (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.02		0.01	-
	0248	06/25/90	N001	NR	N			0.04		0.01	-
	0261	06/25/90	N001	NR	N			0.76		0.01	-
	0922	06/25/90	N001	NR	N			0.18		0.01	-
MERCURY	0248	10/03/90	0001	NR	N	MG/L	<	0.0002		0.0002	-
	0248	08/24/91	0001	NR	N		<	0.00010		0.0001	-
	0248	12/13/91	0001	NR	N		<	0.0002		0.0002	-
	0253	08/25/91	0001	NR	N		<	0.00010		0.0001	-
	0254	10/03/90	0001	NR	N		<	0.0002		0.0002	-
	0261	10/03/90	0001	NR	N		<	0.0002		0.0002	-
	0261	12/14/91	0001	NR	N		<	0.0002		0.0002	-
	0922	06/01/88	0001	NR	N		<	0.0002		0.0002	-
	0922	10/03/90	0001	NR	N		<	0.0002		0.0002	-
	0922	08/24/91	0001	NR	N		<	0.00010		0.0001	-
	0922	12/14/91	0001	NR	N		<	0.0002		0.0002	-
	0923	06/01/88	0001	NR	N		<	0.0002		0.0002	-
MERCURY (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.0002		0.0002	-
	0248	06/25/90	N001	NR	N		<	0.0002		0.0002	-
	0261	06/25/90	N001	NR	N		<	0.0002		0.0002	-
	0922	06/25/90	N001	NR	N		<	0.0002		0.0002	-
MOLYBDENUM	0248	10/03/90	0001	NR	N	MG/L		0.03		0.01	-
	0248	04/25/91	0001	NR	N			0.04		0.01	-
	0248	08/24/91	0001	NR	N			0.041		0.0048	-
	0248	12/13/91	0001	NR	N			0.02		0.01	-
	0253	05/10/91	0001	NR	N			0.08		0.01	-
	0253	08/25/91	0001	NR	N			0.12		0.0048	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N			0.01		0.01	-
	0261	10/03/90	0001	NR	N			0.01		0.01	-
	0261	05/11/91	0001	NR	N			0.01		0.01	-
	0261	12/14/91	0001	NR	N			0.02		0.01	-
	0922	06/01/88	0001	NR	N			0.02		0.01	-
	0922	08/30/88	0001	NR	N			0.08		0.01	-
	0922	10/03/90	0001	NR	N			0.01		0.01	-
	0922	04/25/91	0001	NR	N			0.02		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MOLYBDENUM	0922	08/24/91	0001	NR	N	MG/L		0.024		0.0048	-
	0922	12/14/91	0001	NR	N		<	0.01		0.01	-
	0923	06/01/88	0001	NR	N			0.08		0.01	-
	0923	04/25/91	0001	NR	N			0.04		0.01	-
	0924	08/30/88	0001	NR	N			0.18		0.01	-
MOLYBDENUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.03		0.01	-
	0248	06/25/90	N001	NR	N			0.03		0.01	-
	0261	06/25/90	N001	NR	N			0.02		0.01	-
	0922	06/25/90	N001	NR	N			0.03		0.01	-
NET GROSS ALPHA *	0248	10/03/90	0001	NR	N	PCI/L		106.00		-	-
	0248	04/25/91	0001	NR	N			148.29		-	-
	0248	08/24/91	0001	NR	N			12.20		-	-
	0248	12/13/91	0001	NR	N			19.06		-	-
	0253	05/10/91	0001	NR	N			75.31		-	-
	0253	08/25/91	0001	NR	N			-65.59		-	-
	0254	10/03/90	0001	NR	N			-205.82		-	-
	0254	05/10/91	0001	NR	N			266.41		-	-
	0261	10/03/90	0001	NR	N			-15.28		-	-
	0261	05/11/91	0001	NR	N			20.00		-	-
	0261	12/14/91	0001	NR	N			45.84		-	-
	0922	08/30/88	0001	NR	N			-63.85		-	-
	0922	10/03/90	0001	NR	N			37.26		-	-
	0922	04/25/91	0001	NR	N			-27.43		-	-
	0922	08/24/91	0001	NR	N			-115.59		-	-
	0922	12/14/91	0001	NR	N			-66.72		-	-
	0922	11/18/92	0001	NR	N			-28.78		-	-
	0923	04/25/91	0001	NR	N			20.59		-	-
	0923	11/18/92	0001	NR	N			-3.69		-	-
	0924	08/30/88	0001	NR	N			-63.52		-	-
NET GROSS ALPHA (TOTAL) **	0922	11/18/92	N001	NR	N	PCI/L		-45.41		-	-
	0923	11/18/92	N001	NR	N			3.64		-	-
NICKEL	0248	10/03/90	0001	NR	N	MG/L	<	0.04		0.04	-
	0248	04/25/91	0001	NR	N		<	0.04		0.04	-
	0248	08/24/91	0001	NR	N			0.027		0.0061	-

* NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** NET GROSS ALPHA (TOTAL) (TOTAL GROSS ALPHA - TOTAL URANIUM)

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
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TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
NICKEL	0248	12/13/91	0001	NR	N	MG/L	<	0.04		0.04	-
	0253	05/10/91	0001	NR	N			0.04		0.04	-
	0253	08/25/91	0001	NR	N			0.029		0.0061	-
	0254	10/03/90	0001	NR	N			0.21		0.04	-
	0254	05/10/91	0001	NR	N			0.29		0.04	-
	0261	10/03/90	0001	NR	N		<	0.04		0.04	-
	0261	05/11/91	0001	NR	N		<	0.04		0.04	-
	0261	12/14/91	0001	NR	N		<	0.04		0.04	-
	0922	06/01/88	0001	NR	N		<	0.04		0.04	-
	0922	08/30/88	0001	NR	N			0.08		0.04	-
	0922	10/03/90	0001	NR	N			0.05		0.04	-
	0922	04/25/91	0001	NR	N			0.04		0.04	-
	0922	08/24/91	0001	NR	N			0.034		0.0061	-
	0922	12/14/91	0001	NR	N		<	0.04		0.04	-
	0923	06/01/88	0001	NR	N		<	0.04		0.04	-
	0923	04/25/91	0001	NR	N		<	0.04		0.04	-
	0924	08/30/88	0001	NR	N			0.07		0.04	-
NICKEL (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.04		0.04	-
	0248	06/25/90	N001	NR	N			0.04		0.04	-
	0261	06/25/90	N001	NR	N		<	0.04		0.04	-
	0922	06/25/90	N001	NR	N			0.06		0.04	-
NITRATE	0248	10/03/90	0001	NR	N	MG/L		50.2		1.	-
	0248	04/25/91	0001	NR	N			55.3		1.	-
	0248	08/24/91	0001	NR	N			49		0.22	-
	0248	12/13/91	0001	NR	N			45.6		4.	-
	0253	05/10/91	0001	NR	N			36.7		1.	-
	0253	08/25/91	0001	NR	N			16		0.22	-
	0254	10/03/90	0001	NR	N			994.		1.	-
	0254	05/10/91	0001	NR	N			753.		1.	-
	0261	08/24/90	0001	NR	N			3.0		1.	-
	0261	10/03/90	0001	NR	N		<	1.0		1.	-
	0261	05/11/91	0001	NR	N			8.9		1.	-
	0261	12/14/91	0001	NR	N		<	1.0		1.	-
	0922	06/01/88	0001	NR	N			21.8		1.	-
	0922	08/30/88	0001	NR	N			10.		1.	-
	0922	10/03/90	0001	NR	N			338.		1.	-
	0922	04/25/91	0001	NR	N			37.6		1.	-
	0922	08/24/91	0001	NR	N			49		0.22	-
	0922	12/14/91	0001	NR	N			85.4		5.	-
	0923	06/01/88	0001	NR	N			13.7		1.	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

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FLOW RELATIONSHIP CODE:
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SAMPLE ID CODES:
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N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
NITRATE	0923	04/25/91	0001	NR	N	MG/L		1.5		1.	-
	0924	08/30/88	0001	NR	N			5.5		1.	-
NITRATE (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		4.7		1.	-
	0248	06/25/90	N001	NR	N			45.		1.	-
	0922	06/25/90	N001	NR	N			7.8		1.	-
NITRITE AND NITRATE	0248	10/03/90	0001	NR	N	MG/L		11.4		1.	-
	0248	04/25/91	0001	NR	N			12.5		0.05	-
	0253	05/10/91	0001	NR	N			8.28		0.05	-
	0254	10/03/90	0001	NR	N			225.		1.	-
	0254	05/10/91	0001	NR	N			176.		0.05	-
	0261	10/03/90	0001	NR	N			0.08	c	0.08	-
	0261	05/11/91	0001	NR	N			2.04		0.05	-
	0922	06/01/88	0001	NR	N			5.0		1.	-
	0922	08/30/88	0001	NR	N			2.2		1.	-
	0922	10/03/90	0001	NR	N			76.4		1.	-
	0922	04/25/91	0001	NR	N			8.48		0.05	-
	0923	06/01/88	0001	NR	N			3.2		1.	-
	0923	04/25/91	0001	NR	N			0.35		0.05	-
	0924	08/30/88	0001	NR	N			1.2		1.	-
NITRITE AND NITRATE (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		10.6		1.	-
PH	0248	04/23/90	N001	NR	N	SU		7.96		-	-
	0248	06/25/90	N001	NR	N			7.88		-	-
	0248	10/03/90	0001	NR	N			8.59		-	-
	0248	04/25/91	0001	NR	N			8.09		-	-
	0248	08/24/91	0001	NR	N			8.00		-	-
	0248	12/13/91	0001	NR	N			8.14		-	-
	0253	05/10/91	0001	NR	N			7.52		-	-
	0253	08/25/91	0001	NR	N			7.73		-	-
	0254	10/03/90	0001	NR	N			7.96		-	-
	0254	05/10/91	0001	NR	N			7.94		-	-
	0261	06/25/90	N001	NR	N			7.59		-	-
	0261	10/03/90	0001	NR	N			7.76		-	-
	0261	05/11/91	0001	NR	N			7.98		-	-
	0261	12/14/91	0001	NR	N			7.80		-	-
	0922	06/01/88	0001	NR	N			7.02		-	-
	0922	08/30/88	0001	NR	N			6.92		-	-
	0922	06/25/90	N001	NR	N			6.70		-	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
PH	0922	10/03/90	0001	NR	N	SU		6.74		-	-
	0922	04/25/91	0001	NR	N			7.48		-	-
	0922	08/24/91	0001	NR	N			7.93		-	-
	0922	12/14/91	0001	NR	N			6.93		-	-
	0923	06/01/88	0001	NR	N			7.19		-	-
	0923	04/25/91	0001	NR	N			8.20		-	-
	0924	08/30/88	0001	NR	N			7.87		-	-
PHOSPHATE	0248	10/03/90	0001	NR	N	MG/L		0.1		0.1	-
	0254	10/03/90	0001	NR	N			0.1		0.1	-
	0261	10/03/90	0001	NR	N			0.1		0.1	-
	0922	06/01/88	0001	NR	N		<	0.1		0.1	-
	0922	10/03/90	0001	NR	N			0.1		0.1	-
	0923	06/01/88	0001	NR	N		<	0.1		0.1	-
PHOSPHATE (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.1		0.1	-
	0248	06/25/90	N001	NR	N		<	0.1		0.1	-
	0261	06/25/90	N001	NR	N		<	0.1		0.1	-
	0922	06/25/90	N001	NR	N		<	0.1		0.1	-
POLONIUM-210	0248	10/03/90	0001	NR	N	PCI/L	<	0.3	d	0.1	0.3
	0254	10/03/90	0001	NR	N			0.1	c	0.3	0.2
	0261	10/03/90	0001	NR	N			0.5	c	0.8	0.3
	0922	10/03/90	0001	NR	N			0.1	c	0.3	0.2
POTASSIUM	0248	10/03/90	0001	NR	N	MG/L		10.7		0.01	-
	0248	04/25/91	0001	NR	N			12.		5.	-
	0248	08/24/91	0001	NR	N			13		0.0005	-
	0248	12/13/91	0001	NR	N			9.1		0.01	-
	0253	05/10/91	0001	NR	N			9.		5.	-
	0253	08/25/91	0001	NR	N			14		0.0005	-
	0254	10/03/90	0001	NR	N			19.		0.01	-
	0254	05/10/91	0001	NR	N			28.		5.	-
	0261	10/03/90	0001	NR	N			15.		0.01	-
	0261	05/11/91	0001	NR	N			13.		5.	-
	0261	12/14/91	0001	NR	N			12.		5.	-
	0922	06/01/88	0001	NR	N			11.2		0.01	-
	0922	08/30/88	0001	NR	N			14.3		0.01	-
	0922	10/03/90	0001	NR	N			13.		0.01	-
	0922	04/25/91	0001	NR	N			10.		5.	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
c - CHANGED DETECTION LIMIT
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
POTASSIUM	0922	08/24/91	0001	NR	N	MG/L		16		0.0005	-
	0922	12/14/91	0001	NR	N			2.5		0.01	-
	0923	06/01/88	0001	NR	N			10.5		0.01	-
	0923	04/25/91	0001	NR	N			17.		5.	-
	0924	08/30/88	0001	NR	N			11.6		0.01	-
POTASSIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		14.0		0.01	-
	0248	06/25/90	N001	NR	N			14.2		0.01	-
	0261	06/25/90	N001	NR	N			25.7		0.01	-
	0922	06/25/90	N001	NR	N			15.6		0.01	-
RADIUM-226	0248	10/03/90	0001	NR	N	PCI/L	<	0.1	d	0.1	0.1
	0248	04/25/91	0001	NR	N			0.0		1.	0.2
	0248	08/24/91	0001	NR	N			0.1		1.	0.2
	0248	12/13/91	0001	NR	N			0.2		1.	0.2
	0253	05/10/91	0001	NR	N			0.2		1.	0.3
	0253	08/25/91	0001	NR	N			0.0		1.	0.1
	0254	10/03/90	0001	NR	N			0.1	c	0.3	0.2
	0254	05/10/91	0001	NR	N			0.3		1.	0.3
	0261	10/03/90	0001	NR	N		<	1.2	b	1.	1.2
	0261	05/11/91	0001	NR	N			0.1		1.	0.3
	0261	12/14/91	0001	NR	N			0.0		1.	0.1
	0922	06/01/88	0001	NR	N			0.6		1.	0.4
	0922	08/30/88	0001	NR	N			0.1	c	0.2	0.1
	0922	10/03/90	0001	NR	N			0.1	c	0.3	0.2
	0922	04/25/91	0001	NR	N			0.1		1.	0.2
	0922	08/24/91	0001	NR	N			0.1		1.	0.1
	0922	12/14/91	0001	NR	N			0.3		1.	0.2
	0922	11/18/92	0001	NR	N			0.2	#	0.3	0.2
	0923	06/01/88	0001	NR	N			0.9		1.	0.5
	0923	04/25/91	0001	NR	N			0.2		1.	0.3
	0923	11/18/92	0001	NR	N			0.1	#	0.3	0.2
	0924	08/30/88	0001	NR	N			0.1	c	0.2	0.1
RADIUM-226 (TOTAL)	0248	04/23/90	N001	NR	N	PCI/L	<	0.2	d	0.1	0.2
	0248	06/25/90	N001	NR	N		<	0.1	d	0.1	0.1
	0261	06/25/90	N001	NR	N			0.8		1.	0.6
	0922	06/25/90	N001	NR	N			1.6		1.	0.7

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
- THE DATA HAS NOT YET UNDERGONE QUALITY CONTROL TESTS.
b - CHANGED PARAMETER VALUE
c - CHANGED DETECTION LIMIT
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
RADIUM-226 (TOTAL)	0922	11/18/92	N001	NR	N	PCI/L	0.1	#	0.3	0.2
	0923	11/18/92	N001	NR	N		0.0	#	0.3	0.2
RADIUM-226 + RADIUM-228	0248	10/03/90	0001	NR	N	PCI/L	0.85		-	-
	0248	04/25/91	0001	NR	N		0.00		-	-
	0248	08/24/91	0001	NR	N		0.10		-	-
	0248	12/13/91	0001	NR	N		0.20		-	-
	0253	05/10/91	0001	NR	N		3.90		-	-
	0253	08/25/91	0001	NR	N		0.10		-	-
	0254	10/03/90	0001	NR	N		1.10		-	-
	0254	05/10/91	0001	NR	N		7.40		-	-
	0261	10/03/90	0001	NR	N		1.50		-	-
	0261	05/11/91	0001	NR	N		6.10		-	-
	0261	12/14/91	0001	NR	N		2.10		-	-
	0922	06/01/88	0001	NR	N		1.10		-	-
	0922	08/30/88	0001	NR	N		0.40		-	-
	0922	10/03/90	0001	NR	N		0.60		-	-
	0922	04/25/91	0001	NR	N		0.10		-	-
	0922	08/24/91	0001	NR	N		0.10		-	-
	0922	12/14/91	0001	NR	N		0.90		-	-
	0922	11/18/92	0001	NR	N		4.90		-	-
	0923	06/01/88	0001	NR	N		1.40		-	-
	0923	04/25/91	0001	NR	N		8.00		-	-
	0923	11/18/92	0001	NR	N		1.10		-	-
	0924	08/30/88	0001	NR	N		0.50		-	-
RADIUM-226 + RADIUM-228 TOTAL	0248	04/23/90	N001	NR	N	PCI/L	0.55		-	-
	0248	06/25/90	N001	NR	N		0.25		-	-
	0261	06/25/90	N001	NR	N		2.20		-	-
	0922	06/25/90	N001	NR	N		2.40		-	-
	0922	11/18/92	N001	NR	N		1.20		-	-
	0923	11/18/92	N001	NR	N		2.60		-	-
RADIUM-228	0248	10/03/90	0001	NR	N	PCI/L	0.8		1.	1.4
	0248	04/25/91	0001	NR	N		0.0		1.	2.2
	0248	08/24/91	0001	NR	N		0.0		1.	0.9
	0248	12/13/91	0001	NR	N		0.0		1.	2.1
	0253	05/10/91	0001	NR	N		3.7		1.	2.5
	0253	08/25/91	0001	NR	N		0.1		1.	1.3
	0254	10/03/90	0001	NR	N		1.0		1.	1.6
	0254	05/10/91	0001	NR	N		7.1		1.	2.7

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
- THE DATA HAS NOT YET UNDERGONE QUALITY CONTROL TESTS.

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PVI	PARAMETER VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
RADIUM-228	0261	10/03/90	0001	NR	N	PCI/L		1.0		1.	1.6
	0261	05/11/91	0001	NR	N			6.0		1.	2.6
	0261	12/14/91	0001	NR	N			2.1		1.	2.6
	0922	06/01/88	0001	NR	N		<	1.1	b	1.	1.1
	0922	08/30/88	0001	NR	N			0.3		1.	0.8
	0922	10/03/90	0001	NR	N		<	1.2	b	1.	1.2
	0922	04/25/91	0001	NR	N			0.0		1.	2.3
	0922	08/24/91	0001	NR	N			0.0		1.	0.9
	0922	12/14/91	0001	NR	N			0.6		1.	2.4
	0922	11/18/92	0001	NR	N			4.7	#	1.3	1.2
	0923	06/01/88	0001	NR	N		<	1.2	b	1.	1.2
	0923	04/25/91	0001	NR	N			7.8		1.	2.7
	0923	11/18/92	0001	NR	N			1.0	#	2.1	1.3
	0924	08/30/88	0001	NR	N			0.4		1.	0.9
RADIUM-228 (TOTAL)	0248	04/23/90	N001	NR	N	PCI/L	<	0.8	b	1.	0.8
	0248	06/25/90	N001	NR	N			0.2		1.	0.9
	0261	06/25/90	N001	NR	N			1.4		1.	2.6
	0922	06/25/90	N001	NR	N			0.8		1.	0.8
	0922	11/18/92	N001	NR	N			1.1	#	2.1	1.4
	0923	11/18/92	N001	NR	N			2.6	#	1.6	1.2
SELENIUM	0248	10/03/90	0001	NR	N	MG/L		0.160		0.005	-
	0248	04/25/91	0001	NR	N			0.310		0.005	-
	0248	08/24/91	0001	NR	N			0.0052		0.0016	-
	0248	12/13/91	0001	NR	N			0.27		0.05	-
	0253	05/10/91	0001	NR	N			0.025		0.005	-
	0253	08/25/91	0001	NR	N			0.0090		0.0016	-
	0254	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0254	05/10/91	0001	NR	N			0.030		0.005	-
	0261	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0261	05/11/91	0001	NR	N		<	0.03	I	0.03	-
	0261	12/14/91	0001	NR	N		<	0.03	I	0.03	-
	0922	06/01/88	0001	NR	N		<	0.005		0.005	-
	0922	10/03/90	0001	NR	N			0.025		0.005	-
	0922	04/25/91	0001	NR	N			0.032		0.005	-
	0922	08/24/91	0001	NR	N			0.013		0.0016	-
	0922	12/14/91	0001	NR	N		<	0.03	I	0.03	-
	0923	06/01/88	0001	NR	N		<	0.005		0.005	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
- THE DATA HAS NOT YET UNDERGONE QUALITY CONTROL TESTS.
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
b - CHANGED PARAMETER VALUE
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SELENIUM	0923	04/25/91	0001	NR	N	MG/L		0.029		0.005	-
SELENIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.029		0.005	-
	0248	06/25/90	N001	NR	N			0.079		0.005	-
	0261	06/25/90	N001	NR	N		<	0.005		0.005	-
	0922	06/25/90	N001	NR	N			0.012		0.005	-
SILICA - SIO2	0248	10/03/90	0001	NR	N	MG/L		25.0		0.1	-
	0248	04/25/91	0001	NR	N			27.7		0.1	-
	0253	05/10/91	0001	NR	N			22.6		0.1	-
	0254	10/03/90	0001	NR	N			40.2		0.1	-
	0254	05/10/91	0001	NR	N			49.6		0.1	-
	0261	10/03/90	0001	NR	N			15.5		0.1	-
	0261	05/11/91	0001	NR	N			16.8		0.1	-
	0922	06/01/88	0001	NR	N			21.2		2.	-
	0922	08/30/88	0001	NR	N			25.		2.	-
	0922	10/03/90	0001	NR	N			25.0		0.1	-
	0922	04/25/91	0001	NR	N			24.4		0.1	-
	0923	06/01/88	0001	NR	N			19.2		2.	-
	0923	04/25/91	0001	NR	N			24.4		0.1	-
	0924	08/30/88	0001	NR	N			19.		2.	-
SILICA - SIO2 (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		25.		2.	-
	0248	06/25/90	N001	NR	N			28.		2.	-
	0261	06/25/90	N001	NR	N			46.		2.	-
	0922	06/25/90	N001	NR	N			30.		2.	-
SILVER	0248	10/03/90	0001	NR	N	MG/L	<	0.01		0.01	-
	0248	04/25/91	0001	NR	N		<	0.01		0.01	-
	0248	08/24/91	0001	NR	N		<	0.0029		0.0029	-
	0248	12/13/91	0001	NR	N		<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N		<	0.0029		0.0029	-
	0254	10/03/90	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N		<	0.01		0.01	-
	0261	10/03/90	0001	NR	N		<	0.01		0.01	-
	0261	05/11/91	0001	NR	N		<	0.01		0.01	-
	0261	12/14/91	0001	NR	N		<	0.01		0.01	-
	0922	06/01/88	0001	NR	N		<	0.01		0.01	-
	0922	10/03/90	0001	NR	N		<	0.01		0.01	-
	0922	04/25/91	0001	NR	N		<	0.01		0.01	-
	0922	08/24/91	0001	NR	N		<	0.0029		0.0029	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SILVER	0922	12/14/91	0001	NR	N	MG/L	<	0.01		0.01	-
	0923	06/01/88	0001	NR	N		<	0.01		0.01	-
	0923	04/25/91	0001	NR	N		<	0.01		0.01	-
SILVER (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.01		0.01	-
	0248	06/25/90	N001	NR	N		<	0.01		0.01	-
	0261	06/25/90	N001	NR	N		<	0.01		0.01	-
	0922	06/25/90	N001	NR	N		<	0.01		0.01	-
SODIUM	0248	10/03/90	0001	NR	N	MG/L		780.		0.002	-
	0248	04/25/91	0001	NR	N			756.		5.	-
	0248	08/24/91	0001	NR	N			590		0.014	-
	0248	12/13/91	0001	NR	N			578.		5.	-
	0253	05/10/91	0001	NR	N			907.		5.	-
	0253	08/25/91	0001	NR	N			570		0.014	-
	0254	10/03/90	0001	NR	N			496.		0.002	-
	0254	05/10/91	0001	NR	N			798.		5.	-
	0261	10/03/90	0001	NR	N			740.		0.002	-
	0261	05/11/91	0001	NR	N			711.		5.	-
	0261	12/14/91	0001	NR	N			661.		5.	-
	0922	06/01/88	0001	NR	N			720.		0.002	-
	0922	08/30/88	0001	NR	N			607.		0.002	-
	0922	10/03/90	0001	NR	N			670.		0.002	-
	0922	04/25/91	0001	NR	N			852.		5.	-
	0922	08/24/91	0001	NR	N			580		0.014	-
	0922	12/14/91	0001	NR	N			555.		5.	-
	0923	06/01/88	0001	NR	N			750.		0.002	-
	0923	04/25/91	0001	NR	N			1520.		20.	-
	0924	08/30/88	0001	NR	N			480.		0.002	-
SODIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		685.		0.002	-
	0248	06/25/90	N001	NR	N			728.		0.002	-
	0261	06/25/90	N001	NR	N			757.		0.002	-
	0922	06/25/90	N001	NR	N			587.		0.002	-
SPECIFIC CONDUCTANCE	0248	04/23/90	N001	NR	N	UMHO/CM		4506.		-	-
	0248	06/25/90	N001	NR	N			6200.		-	-
	0248	10/03/90	0001	NR	N			9100.		-	-
	0248	04/25/91	0001	NR	N			5580.		-	-
	0248	08/24/91	0001	NR	N			5910.		-	-
	0248	12/13/91	0001	NR	N			289		-	-
	0253	05/10/91	0001	NR	N			5600.		-	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SPECIFIC CONDUCTANCE	0253	08/25/91	0001	NR	N	UMHO/CM	5430.		-	-
	0254	10/03/90	0001	NR	N		5100.		-	-
	0254	05/10/91	0001	NR	N		7440.		-	-
	0261	06/25/90	N001	NR	N		7800.		-	-
	0261	10/03/90	0001	NR	N		4500.		-	-
	0261	05/11/91	0001	NR	N		5060.		-	-
	0261	12/14/91	0001	NR	N		2970		-	-
	0922	06/01/88	0001	NR	N		3925.		-	-
	0922	08/30/88	0001	NR	N		4600.		-	-
	0922	06/25/90	N001	NR	N		6500.		-	-
	0922	10/03/90	0001	NR	N		4700.		-	-
	0922	04/25/91	0001	NR	N		5860.		-	-
	0922	08/24/91	0001	NR	N		5260.		-	-
	0922	12/14/91	0001	NR	N		335		-	-
	0923	06/01/88	0001	NR	N		4100.		-	-
	0923	04/25/91	0001	NR	N		9530.		-	-
	0924	08/30/88	0001	NR	N		4250.		-	-
STRONTIUM	0248	10/03/90	0001	NR	N	MG/L	9.94		0.01	-
	0248	04/25/91	0001	NR	N		10.8		0.01	-
	0248	08/24/91	0001	NR	N		10		0.01	-
	0248	12/13/91	0001	NR	N		8.87		0.01	-
	0253	05/10/91	0001	NR	N		15.1		0.01	-
	0253	08/25/91	0001	NR	N		11		0.01	-
	0254	10/03/90	0001	NR	N		11.4		0.01	-
	0254	05/10/91	0001	NR	N		14.9		0.01	-
	0261	10/03/90	0001	NR	N		11.0		0.01	-
	0261	05/11/91	0001	NR	N		11.9		0.01	-
	0261	12/14/91	0001	NR	N		10.4		0.01	-
	0922	10/03/90	0001	NR	N		11.4		0.01	-
	0922	04/25/91	0001	NR	N		12.9		0.01	-
	0922	08/24/91	0001	NR	N		11		0.01	-
	0922	12/14/91	0001	NR	N		10.2		0.01	-
	0923	04/25/91	0001	NR	N		13.8		0.01	-
STRONTIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	9.29		0.1	-
	0248	06/25/90	N001	NR	N		9.84		0.1	-
	0261	06/25/90	N001	NR	N		12.0		0.1	-
	0922	06/25/90	N001	NR	N		10.6		0.1	-
SULFATE	0248	10/03/90	0001	NR	N	MG/L	3500.		0.1	-
	0248	04/25/91	0001	NR	N		3320.		10.	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SULFATE	0248	08/24/91	0001	NR	N	MG/L		3700		1.	-
	0248	12/13/91	0001	NR	N			3140.		10.	-
	0253	05/10/91	0001	NR	N			3520.		10.	-
	0253	08/25/91	0001	NR	N			3200		1.	-
	0254	10/03/90	0001	NR	N			3400.		0.1	-
	0254	05/10/91	0001	NR	N			3040.		10.	-
	0261	10/03/90	0001	NR	N			3280.		0.1	-
	0261	05/11/91	0001	NR	N			3060.		10.	-
	0261	12/14/91	0001	NR	N			3050.		10.	-
	0922	06/01/88	0001	NR	N			3160.		0.1	-
	0922	08/30/88	0001	NR	N			3070.		0.1	-
	0922	10/03/90	0001	NR	N			3420.		0.1	-
	0922	04/25/91	0001	NR	N			3470.		10.	-
	0922	08/24/91	0001	NR	N			3800		1.	-
	0922	12/14/91	0001	NR	N			3170.		10.	-
	0923	06/01/88	0001	NR	N			3330.		0.1	-
	0923	04/25/91	0001	NR	N			4840.		10.	-
	0924	08/30/88	0001	NR	N			2570.		0.1	-
SULFATE (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		3260.		0.1	-
	0248	06/25/90	N001	NR	N			3604.7		0.1	-
	0261	06/25/90	N001	NR	N			3652.1		0.1	-
	0922	06/25/90	N001	NR	N			3907.2		0.1	-
SULFIDE	0248	10/03/90	0001	NR	N	MG/L		0.4		0.1	-
	0248	04/25/91	0001	NR	N			22.4		1.	-
	0253	05/10/91	0001	NR	N			15.6		1.	-
	0254	10/03/90	0001	NR	N			8.9		0.1	-
	0254	05/10/91	0001	NR	N			14.6		1.	-
	0261	10/03/90	0001	NR	N		<	0.1		0.1	-
	0261	05/11/91	0001	NR	N			4.44		1.	-
	0922	06/01/88	0001	NR	N			0.2		0.1	-
	0922	10/03/90	0001	NR	N		<	0.1		0.1	-
	0922	04/25/91	0001	NR	N			26.9		1.	-
	0923	06/01/88	0001	NR	N		<	0.1		0.1	-
	0923	04/25/91	0001	NR	N			4.6		1.	-
TEMPERATURE	0248	04/23/90	N001	NR	N	C - DEGREE		21.		-	-
	0248	06/25/90	N001	NR	N			32.0		-	-
	0248	10/03/90	0001	NR	N			20.1		-	-
	0248	04/25/91	0001	NR	N			17.7		-	-
	0248	08/24/91	0001	NR	N			20.8		-	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
TEMPERATURE	0248	12/13/91	0001	NR	N	C - DEGREE		1.4		-	-
	0253	05/10/91	0001	NR	N			14.4		-	-
	0253	08/25/91	0001	NR	N			22.9		-	-
	0254	10/03/90	0001	NR	N			17.1		-	-
	0254	05/10/91	0001	NR	N			13.9		-	-
	0261	06/25/90	N001	NR	N			37.0		-	-
	0261	10/03/90	0001	NR	N			17.5		-	-
	0261	05/11/91	0001	NR	N			9.3		-	-
	0261	12/14/91	0001	NR	N			1.9		-	-
	0922	06/01/88	0001	NR	N			16.5		-	-
	0922	08/30/88	0001	NR	N			21.		-	-
	0922	06/25/90	N001	NR	N			33.0		-	-
	0922	10/03/90	0001	NR	N			18.		-	-
	0922	04/25/91	0001	NR	N			18.7		-	-
	0922	08/24/91	0001	NR	N			22.3		-	-
	0922	12/14/91	0001	NR	N			3.8		-	-
	0923	06/01/88	0001	NR	N			18.0		-	-
	0923	04/25/91	0001	NR	N			25.9		-	-
	0924	08/30/88	0001	NR	N			22.0		-	-
THALLIUM	0248	04/25/91	0001	NR	N	MG/L	<	0.01		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0254	05/10/91	0001	NR	N		<	0.01		0.01	-
	0261	05/11/91	0001	NR	N		<	0.01		0.01	-
	0922	04/25/91	0001	NR	N		<	0.01		0.01	-
	0923	04/25/91	0001	NR	N		<	0.01		0.01	-
THALLIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L	<	0.01		0.01	-
	0248	06/25/90	N001	NR	N		<	0.01		0.01	-
	0261	06/25/90	N001	NR	N		<	0.01		0.01	-
	0922	06/25/90	N001	NR	N		<	0.01		0.01	-
THORIUM-230	0248	10/03/90	0001	NR	N	PCI/L		0.4	c	0.8	0.4
	0248	04/25/91	0001	NR	N			0.1		1.	0.2
	0253	05/10/91	0001	NR	N			0.1		1.	0.1
	0254	10/03/90	0001	NR	N			0.3	c	0.6	0.3
	0254	05/10/91	0001	NR	N			0.0		1.	0.1
	0261	10/03/90	0001	NR	N		<	0.3	d	0.1	0.3
	0261	05/11/91	0001	NR	N			0.03		1.	0.2
	0922	06/01/88	0001	NR	N			0.5		1.	0.6

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
c - CHANGED DETECTION LIMIT
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
THORIUM-230	0922	08/30/88	0001	NR	N	PCI/L		0.3	c	0.8	0.5
	0922	10/03/90	0001	NR	N			0.2	c	0.6	0.4
	0922	04/25/91	0001	NR	N			0.1		1.	0.2
	0923	06/01/88	0001	NR	N			0.4		1.	0.6
	0923	04/25/91	0001	NR	N			0.0		1.	0.1
	0924	08/30/88	0001	NR	N		<	0.4	d	0.1	0.4
TIN	0248	10/03/90	0001	NR	N	MG/L	<	0.05	Ic	0.05	-
	0248	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0248	08/24/91	0001	NR	N		<	0.0050		0.005	-
	0253	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0253	08/25/91	0001	NR	N		<	0.0050		0.005	-
	0254	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0254	05/10/91	0001	NR	N		<	0.03	I	0.03	-
	0261	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0261	05/11/91	0001	NR	N		<	0.03	I	0.03	-
	0922	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0922	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0922	08/24/91	0001	NR	N		<	0.0050		0.005	-
	0923	04/25/91	0001	NR	N		<	0.03	I	0.03	-
TIN (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.069		0.005	-
	0248	06/25/90	N001	NR	N			0.006		0.005	-
	0261	06/25/90	N001	NR	N			0.023		0.005	-
	0922	06/25/90	N001	NR	N			0.010		0.005	-
TOTAL DISSOLVED SOLIDS	0248	10/03/90	0001	NR	N	MG/L		5780.		10.	-
	0248	04/25/91	0001	NR	N			5670.		10.	-
	0248	08/24/91	0001	NR	N			5600		10.	-
	0248	12/13/91	0001	NR	N			5220.		10.	-
	0253	05/10/91	0001	NR	N			5870.		10.	-
	0253	08/25/91	0001	NR	N			5000		10.	-
	0254	10/03/90	0001	NR	N			6900.		10.	-
	0254	05/10/91	0001	NR	N			5020.		10.	-
	0261	10/03/90	0001	NR	N			5330.		10.	-
	0261	05/11/91	0001	NR	N			5030.		10.	-
	0261	12/14/91	0001	NR	N			4860.		10.	-
	0922	06/01/88	0001	NR	N			5490.		10.	-
	0922	08/30/88	0001	NR	N			5230.		10.	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
TOTAL DISSOLVED SOLIDS	0922	10/03/90	0001	NR	N	MG/L		5670.		10.	-
	0922	04/25/91	0001	NR	N			6140.		10.	-
	0922	08/24/91	0001	NR	N			5800		10.	-
	0922	12/14/91	0001	NR	N			5550.		10.	-
	0923	06/01/88	0001	NR	N			5310.		10.	-
	0923	04/25/91	0001	NR	N			7780.		10.	-
	0924	08/30/88	0001	NR	N			4310.		10.	-
TOTAL DISSOLVED SOLIDS (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		5050.		10.	-
	0248	06/25/90	N001	NR	N			5170.		10.	-
	0261	06/25/90	N001	NR	N			5220.		10.	-
	0922	06/25/90	N001	NR	N			5540.		10.	-
TOTAL KJELDAHL NITROGEN	0248	10/03/90	0001	NR	N	MG/L	<	1.		1.	-
	0248	04/25/91	0001	NR	N		<	1.		1.	-
	0253	05/10/91	0001	NR	N		<	1.		1.	-
	0254	10/03/90	0001	NR	N		<	1.		1.	-
	0254	05/10/91	0001	NR	N		<	1.		1.	-
	0261	10/03/90	0001	NR	N		<	1.		1.	-
	0261	05/11/91	0001	NR	N		<	1.		1.	-
	0922	10/03/90	0001	NR	N		<	1.		1.	-
	0922	04/25/91	0001	NR	N			1.		1.	-
	0923	04/25/91	0001	NR	N			2.		1.	-
TOTAL ORGANIC CARBON	0248	10/03/90	0001	NR	N	MG/L		6.		1.	-
	0248	04/25/91	0001	NR	N			3.		1.	-
	0253	05/10/91	0001	NR	N			3.		1.	-
	0254	10/03/90	0001	NR	N			35.		1.	-
	0254	05/10/91	0001	NR	N			7.		1.	-
	0261	10/03/90	0001	NR	N			8.		1.	-
	0261	05/11/91	0001	NR	N			6.		1.	-
	0922	10/03/90	0001	NR	N			11.		1.	-
	0922	04/25/91	0001	NR	N			4.		1.	-
	0923	04/25/91	0001	NR	N			6.		1.	-
URANIUM	0248	10/03/90	0001	NR	N	MG/L		0.500		0.001	-
	0248	04/25/91	0001	NR	N			0.399		0.001	-
	0248	08/24/91	0001	NR	N			0.507		0.0003	-
	0248	12/13/91	0001	NR	N			0.583		0.001	-
	0253	05/10/91	0001	NR	N			0.208		0.001	-
	0253	08/25/91	0001	NR	N			0.358		0.0003	-
	0254	10/03/90	0001	NR	N			0.784		0.001	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
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TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
URANIUM	0254	05/10/91	0001	NR	N	MG/L		0.772		0.001	-
	0261	10/03/90	0001	NR	N			0.023		0.001	-
	0261	05/11/91	0001	NR	N			0.014		0.001	-
	0261	12/14/91	0001	NR	N			0.046		0.001	-
	0922	06/01/88	0001	NR	N			0.22		0.003	-
	0922	08/30/88	0001	NR	N			0.268		0.003	-
	0922	10/03/90	0001	NR	N			0.297		0.001	-
	0922	04/25/91	0001	NR	N			0.212		0.001	-
	0922	08/24/91	0001	NR	N			0.358		0.0003	-
	0922	12/14/91	0001	NR	N			0.434		0.001	-
	0922	11/18/92	0001	NR	N			0.230	#	0.001	-
	0923	06/01/88	0001	NR	N			0.020		0.003	-
	0923	04/25/91	0001	NR	N			0.021		0.001	-
	0923	11/18/92	0001	NR	N			0.022	#	0.001	-
	0924	08/30/88	0001	NR	N			0.234		0.003	-
URANIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.460		0.003	-
	0248	06/25/90	N001	NR	N			0.538		0.003	-
	0261	06/25/90	N001	NR	N			0.021		0.003	-
	0922	06/25/90	N001	NR	N			0.367		0.003	-
	0922	11/18/92	N001	NR	N			0.228	#	0.001	-
	0923	11/18/92	N001	NR	N			0.024	#	0.001	-
VANADIUM	0248	10/03/90	0001	NR	N	MG/L		0.04		0.01	-
	0248	04/25/91	0001	NR	N			0.05		0.01	-
	0248	08/24/91	0001	NR	N			0.036		0.0051	-
	0248	12/13/91	0001	NR	N			0.02		0.01	-
	0253	05/10/91	0001	NR	N		<	0.01		0.01	-
	0253	08/25/91	0001	NR	N			0.027		0.0051	-
	0254	10/03/90	0001	NR	N			0.07		0.01	-
	0254	05/10/91	0001	NR	N			0.08		0.01	-
	0261	10/03/90	0001	NR	N			0.02		0.01	-
	0261	05/11/91	0001	NR	N		<	0.01		0.01	-
	0261	12/14/91	0001	NR	N			0.01		0.01	-
	0922	06/01/88	0001	NR	N			0.02		0.01	-
	0922	08/30/88	0001	NR	N			0.09		0.01	-
	0922	10/03/90	0001	NR	N			0.04		0.01	-
	0922	04/25/91	0001	NR	N		<	0.01		0.01	-
	0922	08/24/91	0001	NR	N			0.033		0.0051	-
	0922	12/14/91	0001	NR	N			0.02		0.01	-
	0923	06/01/88	0001	NR	N			0.03		0.01	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
- THE DATA HAS NOT YET UNDERGONE QUALITY CONTROL TESTS.

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.8 - SEEP WATER QUALITY DATA BY PARAMETER: GYPSUM CREEK SEEPS
SITE: HAT01 MEXICAN HAT
06/01/88 TO 11/18/92
REPORT DATE: 02/18/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
VANADIUM	0923	04/25/91	0001	NR	N	MG/L		0.05		0.01	-
	0924	08/30/88	0001	NR	N			0.09		0.01	-
VANADIUM (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.04		0.01	-
	0248	06/25/90	N001	NR	N			0.06		0.01	-
	0261	06/25/90	N001	NR	N			0.05		0.01	-
	0922	06/25/90	N001	NR	N			0.05		0.01	-
ZINC	0248	10/03/90	0001	NR	N	MG/L	<	0.01	Ic	0.01	-
	0248	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0248	08/24/91	0001	NR	N			0.0082		0.0026	-
	0248	12/13/91	0001	NR	N		<	0.005		0.005	-
	0253	05/10/91	0001	NR	N		<	0.005		0.005	-
	0253	08/25/91	0001	NR	N			0.051		0.0026	-
	0254	10/03/90	0001	NR	N		<	0.05	Ic	0.05	-
	0254	05/10/91	0001	NR	N			0.009		0.005	-
	0261	10/03/90	0001	NR	N		<	0.005		0.005	-
	0261	05/11/91	0001	NR	N			0.006		0.005	-
	0261	12/14/91	0001	NR	N		<	0.005		0.005	-
	0922	06/01/88	0001	NR	N			0.020		0.005	-
	0922	08/30/88	0001	NR	N		<	0.005		0.005	-
	0922	10/03/90	0001	NR	N		<	0.03	Ic	0.03	-
	0922	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0922	08/24/91	0001	NR	N			0.012		0.0026	-
	0922	12/14/91	0001	NR	N		<	0.01	I	0.01	-
	0923	06/01/88	0001	NR	N		<	0.005		0.005	-
	0923	04/25/91	0001	NR	N		<	0.03	I	0.03	-
	0924	08/30/88	0001	NR	N		<	0.005		0.005	-
ZINC (TOTAL)	0248	04/23/90	N001	NR	N	MG/L		0.022		0.005	-
	0248	06/25/90	N001	NR	N			0.090		0.005	-
	0261	06/25/90	N001	NR	N			0.120		0.005	-
	0922	06/25/90	N001	NR	N			0.061		0.005	-

FORMATION OF COMPLETION CODE:
NR - NO RECOVERY OF DATA FOR CLASSIFYING

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
c - CHANGED DETECTION LIMIT

DATA FILE NAME: M:\DART\HAT01\GWQ10006.DAT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

Table D.7.9 Sulfur and oxygen isotope data for sulfate minerals and dissolved sulfate in seeps and tailings pore fluids at the Mexican Hat site, Utah

	$\delta 34_S$ (± 0.3°/oo)	$\delta 18_O$ (± 0.8°/oo)
Fluid samples:		
San Juan River	-2.6	5.7
Lysimeter 241	5.8	3.0
Lysimeter 242	7.8	2.2
Lysimeter 243	8.1	4.9
Lysimeter 244	6.7	3.0
North Arroyo Seep SP-1 (251)	5.7	10.6
North Arroyo Seep SP-2 (249)	6.8	5.2
Gypsum Creek Seep GS-1 (248)	9.9	11.0
Gypsum Creek Seep 922	10.5	--
Honaker Trail Monitor Well 930	15.1	
Gypsum Creek Seep 924	10.0	
Solid Samples:		
Bedded Gypsum in West Wall of Gypsum Creek (across from 262)	14.6	14.7
Gypsum Creek Efflorescence in West Wall (across from 262)	11.3	10.2
Gypsum Creek Dry Seep (262)	5.3	3.4
Gypsum Creek Seep GS-1 (248)	11.3	11.4

Note:

$$\delta^{34}S = \frac{(^{34}S/^{32}S)_{sample} - (^{34}S/^{32}S)_{standard}}{(^{34}S/^{32}S)_{standard}} \times 1000$$

$$\delta^{18}O = \frac{(^{18}O/^{16}O)_{sample} - (^{18}O/^{16}O)_{standard}}{(^{18}O/^{16}O)_{standard}} \times 1000$$

$\delta^{34}S$ standard = Canyon Diablo Troilite

$\delta^{18}O$ standard = Standard Mean Ocean Water

Table D.7.10 Hydrogen and oxygen isotope data for selected water samples in the vicinity of Mexican Hat site, Utah

	δD ($\pm$ 0.3°/oo)	$\delta 18_0$ ($\pm$ 0.8°/oo)
Fluid samples:		
San Juan River	-87	-11.8
Lysimeter 241	-88	-12.0
Lysimeter 242	-88	-12.7
Lysimeter 243	-91	-12.4
Lysimeter 244	-86	-11.6
SP-1	-86	-11.7
SP-2	-87	-10.9
SP-2	-86	-10.9

Notes:

$$\delta D = \frac{(^2H/^1H)_{sample} - (^2H/^1H)_{standard}}{(^2H/^1H)_{standard}} \times 1000$$

$$\delta^{18}O = \frac{(^{18}O/^{16}O)_{sample} - (^{18}O/^{16}O)_{standard}}{(^{18}O/^{16}O)_{standard}} \times 1000$$

δD standard and $\delta^{18}O$ standard = Standard Mean Ocean Water

Table D.7.11 Rate schedule for water users of the Halchita water supply system

Quantity per month (gallons)	Cost (per 1000 gallons)
First 3000	$1.50
More than 3000	2.45

Ref. Nelson, 1985.

TABLE D.7.12 - MONITOR WELL INFORMATION
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/10/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	GROUND ELEVATION (FT MSL)	BOREHOLE DEPTH (FT) *	CASING STICKUP (FT)	CASING ELEVATION (FT MSL)	CASING DEPTH (FT) *	CASING + DIAMETER (INCHES)	SCREEN * BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	FLOW CODE	FORMATION OF COMPLETION
0601	54980.4	88017.7	4881.51	24.00	2.92	4884.43	27.00	2.000	15.00	10.0	U	SR
0602	56377.4	88661.2	4861.53	35.00	2.49	4864.02	34.00	2.000	22.00	10.0	N	AL
0603	57812.7	89036.9	4846.64	55.00	1.92	4848.56	57.00	2.000	45.00	10.0	C	AL
0604	58397.0	89424.6	4837.30	30.00	1.79	4839.09	32.00	2.000	15.00	15.0	C	AL
0605	58707.6	90066.7	4831.42	32.00	2.54	4833.96	34.00	2.000	17.00	15.0	D	AL
0606	59034.2	88634.0	4860.44	47.00	2.87	4863.31	50.00	2.000	35.00	10.0	D	AL
0607	59657.2	87519.2	4869.41	30.00	1.85	4871.26	30.00	2.000	12.50	10.0	D	SR
0608	58685.7	87189.4	4901.08	120.00	2.03	4903.11	122.00	2.000	100.00	20.0	O	DC
0609	59052.1	87652.9	4878.30	15.00	1.87	4880.17	16.00	2.000	9.00	5.0	O	SR
0610	56338.8	88611.6	4860.83	87.00	0.98	4861.81	87.00	2.000	65.00	20.0	N	SR
0611	57811.0	89017.5	4846.35	185.00	2.00	4848.35	185.00	2.000	155.00	20.0	N	DC
0612	58437.2	85614.8	5000.09	215.00	1.65	5001.74	217.50	2.000	170.00	20.0	N	DC
0613	56377.8	88643.7	4860.81	160.00	2.01	4862.82	162.00	2.000	140.00	20.0	N	DC
0614	60940.5	87832.6	4854.28	84.50	1.38	4855.66	72.00	2.000	50.00	20.0	D	SR
0615	57794.4	88980.7	4847.50	89.00	1.79	4849.29	100.00	2.000	68.00	20.0	C	SR
0616	56747.3	87987.6	4869.00	-	0.92	4869.92	8.00	-	-	-	N	AL
0617	52090.6	87094.4	4907.96	-	1.00	4908.96	-	-	-	-	N	AL
0618	58868.3	87016.1	4920.00	153.00	1.02	4921.02	153.00	12.000	-	-	O	DC
0619	58876.5	87587.9	4886.52	154.00	0.90	4887.42	154.00	12.000	-	-	O	DC
0625	58272.5	89803.1	4838.80	89.00	1.29	4840.09	89.00	12.000	-	-	C	DC
0650	64970.2	89923.8	4790.15	99.50	3.14	4793.29	102.50	4.000	80.50	20.0	D	AL
0651	63788.9	92734.3	4781.46	82.00	3.05	4784.51	85.00	4.000	23.00	60.0	D	AL
0652	62581.5	93759.3	4800.69	56.00	3.15	4803.84	59.00	4.000	37.00	20.0	D	AL
0653	61249.3	89596.3	4832.14	78.00	2.80	4834.94	80.00	4.000	58.00	20.0	D	AL
0654	59351.4	91063.4	4824.41	79.00	2.60	4827.01	82.00	4.000	60.00	20.0	C	AL
0655	59754.6	88624.1	4857.73	60.00	2.66	4860.39	63.00	4.000	41.00	20.0	D	AL
0656	59545.2	89175.1	4852.07	62.00	2.54	4854.61	65.00	4.000	43.00	20.0	D	AL
0657	59266.0	87596.5	4881.18	138.00	2.03	4883.21	141.00	4.000	124.00	15.0	O	DC
0658	54763.4	88857.0	4876.19	165.00	2.63	4878.82	160.00	4.000	138.00	20.0	N	SR
0659	59069.8	88670.3	4860.84	109.00	2.79	4863.63	112.00	4.000	90.00	20.0	D	SR
0660	61303.4	89584.3	4831.38	155.00	2.78	4834.16	158.00	4.000	136.00	20.0	D	SR
0661	56366.1	85447.7	5057.34	218.00	2.65	5059.99	215.00	4.000	193.00	20.0	N	DC
0662	59236.5	87577.5	4877.07	70.00	2.74	4879.81	73.00	4.000	41.00	30.0	D	AL
0663	59069.6	88593.5	4861.56	217.00	2.85	4864.41	222.00	4.000	180.00	40.0	D	DC
0664	61255.9	89537.0	4832.84	233.00	2.92	4835.76	236.00	4.000	214.00	20.0	D	DC
0668	60171.4	88287.0	4864.27	218.00	2.44	4866.71	217.50	4.000	182.50	20.0	D	DC
0669	60146.3	88247.8	4863.19	56.00	2.59	4865.78	59.00	4.000	37.00	20.0	D	AL

* DEPTH GIVEN IN FEET BELOW GROUND SURFACE

\+ CASING DIAMETER = INSIDE DIAMETER

FORMATION OF COMPLETION CODE:
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION
AL - ALLUVIUM
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION

FLOW RELATIONSHIP CODE:
U - UPGRADIENT
N - UNKNOWN
C - CROSS GRADIENT
D - DOWN GRADIENT
O - ON-SITE

DATA FILE: M:\DART\MON01\MWI10000.DAT

FIELDS DISPLAYED WITH A DASH INDICATE THE DATA IS UNAVAILABLE

Table D.7.13 Summary of hydraulic conductivities calculated from slug tests and one aquifer test

		Hydraulic conductivity (K) - ft/sec				
Well ID	Formation	Bouwer-Rice	Hvorslev	Ferris-Knowles	CBP	Mean K
601	SR	5.5E-6	---	---	---	5.5E-6
602	AL	4.3E-6	3.3E-6	---	---	3.8E-6
604	AL	1.7E-5	---	---	---	1.7E-5
605	AL	3.6E-5	4.6E-5	---	---	4.1E-5
610	DC	2.2E-6	2.7E-6	9.5E-7	3.1E-6	2.2E-6
612	DC	---	---	1.8E-6	2.9E-6	2.4E-6
651[a]	AL	---	---	---	---	2.2E-4
653	AL	3.3E-5	4.5E-5	---	---	3.9E-5
655	AL	3.9E-6	4.6E-6	---	---	4.3E-6
656	AL	2.8E-5	3.2E-5	---	---	3.0E-5
657	DC	---	---	1.1E-6	4.1E-6	2.6E-6
658	SR	1.4E-5	---	4.9E-6	2.3E-5	1.4E-5
659	SR	1.2E-5	---	4.5E-6	2.1E-5	1.3E-5
660	SR	9.4E-5	---	7.2E-5	---	8.3E-5
661	DC	---	---	---	2.1E-6	2.1E-6
662	AL	2.0E-5	2.9E-5	---	---	2.5E-5
663	DC	---	---	2.1E-7	3.2E-7	2.7E-7
664	DC	---	---	3.2E-5	6.0E-6	1.9E-5
668	DC	---	---	4.4E-7	1.7E-6	1.1E-6
669	AL	5.4E-6	9.5E-6	---	---	7.5E-6

AL - Alluvium.
DC - DeChelly member of the Cutler Formation.
SR - Shinarump member of the Cutler Formation.
CBP - Cooper-Bredehoeft-Papadopulos method.

[a]Aquifer test.

TABLE D.7.14 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
ALLUVIUM MONITOR WELL 602
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY	MG/L CACO3	7	202.0000	219.0000	216.0000	212.5714	7.0677	0.0332	0.0	204.1754	220.9674	NORMAL	
ALUMINUM	MG/L	5	** 0.0500	0.7000	0.0500	NA	NA	NA	60.0	** 0.0500	0.7000	NONPARAMETRIC	2,5
AMMONIUM	MG/L	6	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2,6
ANTIMONY	MG/L	5	** 0.0030	0.0040	** 0.0030	NA	NA	NA	80.0	** 0.0030	0.0040	NONPARAMETRIC	2,5
ARSENIC	MG/L	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6
BARIUM	MG/L	5	0.0500	0.3000	0.0500	NA	NA	NA	40.0	0.0500	0.3000	NONPARAMETRIC	2,5
BERYLLIUM	MG/L	2	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
BORON	MG/L	4	** 0.0500	0.8000	+ 0.1250	NA	NA	NA	50.0	** 0.0500	0.8000	NONPARAMETRIC	2,4
BROMIDE	MG/L	2	0.2000	1.0000	+ 0.6000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.14 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
ALLUVIUM MONITOR WELL 602
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CADMIUM	MG/L	6	** 0.0005	0.0050	+ 0.0005	NA	NA	NA	83.3	** 0.0005	0.0050	NONPARAMETRIC	2,6
CALCIUM	MG/L	6	27.4000	29.4000	+ 28.3000	28.3500	0.6745	0.0238	0.0	27.4234	29.2766	NORMAL	
CHLORIDE	MG/L	6	15.0000	17.0000	+ 15.2500	15.5667	0.7916	0.0509	0.0	14.4792	16.6542	NORMAL	
CHROMIUM	MG/L	5	** 0.0100	0.0200	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.0200	NONPARAMETRIC	2,5
COBALT	MG/L	4	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	** 0.0300	** 0.0300	NONPARAMETRIC	2,4
COPPER	MG/L	4	** 0.0100	0.0100	+ 0.0100	NA	NA	NA	100.0	** 0.0100	0.0100	NONPARAMETRIC	2,4
CYANIDE	MG/L	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
DISSOLVED OXYGEN	MG/L	1	2.2000	2.2000	2.2000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
FLUORIDE	MG/L	4	0.1000	0.4000	+ 0.2500	0.2500	0.1291	0.5164	0.0	** 0.1000	0.5431	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.14 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
ALLUVIUM MONITOR WELL 602
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
GROSS ALPHA	PCI/L	5	0.4000	11.2000	7.6000	6.2800	4.1913	0.6674	0.0	** 0.2000	13.3034	NORMAL	
GROSS BETA	PCI/L	5	** 0.5000	20.0000	3.1000	NA	NA	NA	0.0	** 0.5000	20.0000	NONPARAMETRIC	9,5
IRON	MG/L	5	** 0.0300	0.0800	** 0.0300	NA	NA	NA	80.0	** 0.0300	0.0800	NONPARAMETRIC	2,5
LEAD	MG/L	4	** 0.0050	0.0050	+ 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
LEAD-210	PCI/L	2	** 1.5000	5.8000	+ 3.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
MAGNESIUM	MG/L	6	17.9000	19.5000	+ 18.3000	18.5667	0.7146	0.0385	0.0	17.5850	19.5484	NORMAL	
MANGANESE	MG/L	5	** 0.0100	0.0200	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.0200	NONPARAMETRIC	2,5
MERCURY	MG/L	3	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
MOLYBDENUM	MG/L	6	** 0.0100	0.1100	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.1100	NONPARAMETRIC	2,6

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.14 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
ALLUVIUM MONITOR WELL 602
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NET GROSS ALPHA ***	PCI/L	5	0.0600	7.7700	5.2800	4.0720	3.1429	0.7718	0.0	-1.1945	9.3385	NORMAL	
NICKEL	MG/L	4	** 0.0400	0.1300	** 0.0400	NA	NA	NA	75.0	** 0.0400	0.1300	NONPARAMETRIC	2,4
NITRATE	MG/L	6	2.7000	8.8600	+ 7.7000	6.5767	2.5458	0.3871	0.0	3.0794	10.0739	NORMAL	
NITRITE	MG/L	2	** 0.1000	0.9900	+ 0.5200	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
NITRITE AND NITRATE	MG/L	2	1.6800	2.3000	+ 1.9900	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
PH	SU	7	7.5000	8.0100	7.8300	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE	MG/L	3	** 0.1000	0.6000	** 0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
POLONIUM-210	PCI/L	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
POTASSIUM	MG/L	6	1.8000	2.1900	+ 2.0150	2.0150	0.1638	0.0813	0.0	1.7900	2.2400	NORMAL	

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.14 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
ALLUVIUM MONITOR WELL 602
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
RADIUM-226	PCI/L	5	** 0.7000	1.0000	0.7000	** 0.7000	0.2387	0.3511	0.0	** 0.7000	1.0801	NORMAL	
RADIUM-226 + RADIUM-228	PCI/L	5	0.6000	2.2000	1.0000	1.1000	0.6403	0.5821	0.0	0.0270	2.1730	NORMAL	
RADIUM-228	PCI/L	5	** 1.0000	1.2000	** 1.0000	NA	NA	NA	20.0	** 1.0000	1.2000	NONPARAMETRIC	2,5
REDOX POTENTIAL	mVOLTS	1	458.0000	458.0000	458.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SELENIUM	MG/L	5	** 0.0050	0.0060	** 0.0050	NA	NA	NA	60.0	** 0.0050	0.0060	NONPARAMETRIC	2,5
SILICA - SIO2	MG/L	4	10.0000	14.0000	+ 13.3000	12.6500	1.8138	0.1434	0.0	8.5317	16.7683	NORMAL	
SILVER	MG/L	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
SODIUM	MG/L	6	93.4000	112.0000	+ 103.0000	102.9667	7.1905	0.0698	0.0	93.0887	112.8446	NORMAL	
SPECIFIC CONDUCTANCE	UMHO/CM	7	460.0000	722.0000	568.0000	575.0000	103.3263	0.1797	0.0	452.2543	697.7457	NORMAL	

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1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.14 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
ALLUVIUM MONITOR WELL 602
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
STRONTIUM	MG/L	4	0.0500	0.2800	+ 0.1600	NA	NA	NA	50.0	0.0500	0.2800	NONPARAMETRIC	2,4
SULFATE	MG/L	6	110.0000	164.0000	+ 137.5000	137.5000	18.4689	0.1343	0.0	112.1283	162.8717	NORMAL	
SULFIDE	MG/L	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
TEMPERATURE	C - DEGREE	7	13.5000	17.0000	14.8000	15.1143	1.3247	0.0876	0.0	13.5406	16.6879	NORMAL	
THALLIUM	MG/L	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
THORIUM-230	PCI/L	3	** 1.0000	6.3000	1.0000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
TIN	MG/L	4	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
TOTAL DISSOLVED SOLIDS	MG/L	6	420.0000	449.0000	+ 438.5000	437.1667	10.0283	0.0229	0.0	423.3902	450.9431	NORMAL	
TOTAL ORGANIC CARBON	MG/L	5	** 1.0000	61.2000	1.3000	NA	NA	NA	40.0	** 1.0000	61.2000	NONPARAMETRIC	2,5

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1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.14 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, ALLUVIUM MONITOR WELL 602
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
TOTAL ORGANIC HALOGENS	MG/L	1	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
URANIUM	MG/L	6	** 0.0010	0.0050	+ 0.0034	NA	NA	NA	16.7	** 0.0010	0.0050	NONPARAMETRIC	2,6
VANADIUM	MG/L	5	** 0.0100	0.7000	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.7000	NONPARAMETRIC	2,5
ZINC	MG/L	5	** 0.0050	0.0300	** 0.0050	NA	NA	NA	80.0	** 0.0050	0.0300	NONPARAMETRIC	2,5

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
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6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

INPUT DATA FILENAME: M:\DART\MON01\GWQ10008.DAT

TABLE D.7.15 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, SHINARUMP MONITOR WELLS (601, 610, AND 658)
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY	MG/L CACO3	8	202.0000	280.0000	+ 214.5000	225.0000	27.1924	0.1209	0.0	196.1773	253.8227	NORMAL	
ALUMINUM	MG/L	8	** 0.0500	0.8000	+ 0.2500	0.3369	0.2822	0.8378	12.5	** 0.0500	0.6360	NORMAL	
AMMONIUM	MG/L	8	** 0.1000	0.2600	** 0.1000	NA	NA	NA	75.0	** 0.1000	0.2600	NONPARAMETRIC	2
ANTIMONY	MG/L	7	** 0.0030	0.0050	0.0030	NA	NA	NA	42.9	** 0.0030	0.0050	NONPARAMETRIC	2
ARSENIC	MG/L	8	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
BARIUM	MG/L	7	0.0400	0.2000	0.0500	NA	NA	NA	42.9	0.0400	0.2000	NONPARAMETRIC	2
BERYLLIUM	MG/L	1	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
BORON	MG/L	7	0.0500	0.4000	0.3000	0.2429	0.1694	0.6975	14.3	** 0.0500	0.4441	NORMAL	
BROMIDE	MG/L	3	** 0.1000	1.0000	1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
CADMIUM	MG/L	8	** 0.0005	0.0005	+ 0.0005	NA	NA	NA	100.0	** 0.0005	0.0005	NONPARAMETRIC	2

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TABLE D.7.15 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, SHINARUMP MONITOR WELLS (601, 610, AND 658)
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CALCIUM	MG/L	8	3.0000	29.9000	+ 26.7000	21.0138	11.4095	0.5430	0.0	8.9203	33.1072	NORMAL	
CHLORIDE	MG/L	8	7.0000	15.2000	+ 13.5000	12.4125	3.1050	0.2502	0.0	9.1213	15.7037	NORMAL	
CHROMIUM	MG/L	8	** 0.0100	0.0400	+ 0.0125	NA	NA	NA	50.0	** 0.0100	0.0400	NONPARAMETRIC	2
COBALT	MG/L	7	** 0.0300	0.0600	** 0.0300	NA	NA	NA	85.7	** 0.0300	0.0600	NONPARAMETRIC	2
COPPER	MG/L	6	** 0.0100	0.0100	+ 0.0100	NA	NA	NA	100.0	** 0.0100	0.0100	NONPARAMETRIC	2,6
CYANIDE	MG/L	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5
DISSOLVED OXYGEN	MG/L	1	0.7000	0.7000	0.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
FLUORIDE	MG/L	6	0.2000	0.8000	+ 0.3500	0.4167	0.2563	0.6150	0.0	** 0.1000	0.7687	NORMAL	
GROSS ALPHA	PCI/L	8	** 0.2000	22.0000	+ 2.3000	NA	NA	NA	0.0	** 0.2000	22.0000	NONPARAMETRIC	9

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TABLE D.7.15 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
SHINARUMP MONITOR WELLS (601, 610, AND 658)
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
GROSS BETA	PCI/L	8	1.6000	11.0000	+ 3.8000	4.8000	3.2706	0.6814	0.0	1.3333	8.2667	NORMAL	
IRON	MG/L	8	** 0.0300	0.3300	+ 0.0600	NA	NA	NA	37.5	** 0.0300	0.3300	NONPARAMETRIC	2
LEAD	MG/L	7	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2
LEAD-210	PCI/L	5	** 1.2000	3.7000	** 1.2000	** 1.2000	4.1783	NA	0.0	** 1.2000	6.1084	LOGNORMAL	7,8
MAGNESIUM	MG/L	8	1.6800	20.3000	+ 18.0000	15.7225	5.8792	0.3739	0.0	9.4908	21.9542	NORMAL	
MANGANESE	MG/L	8	** 0.0100	0.1000	+ 0.0200	NA	NA	NA	37.5	** 0.0100	0.1000	NONPARAMETRIC	2
MERCURY	MG/L	5	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,5
MOLYBDENUM	MG/L	8	** 0.0100	0.2200	+ 0.0600	NA	NA	NA	37.5	** 0.0100	0.2200	NONPARAMETRIC	2
NET GROSS ALPHA ***	PCI/L	8	-3.5200	17.0600	+ 1.0650	NA	NA	NA	0.0	-3.5200	17.0600	NONPARAMETRIC	9

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
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7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.
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TABLE D.7.15 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, SHINARUMP MONITOR WELLS (601, 610, AND 658)
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NICKEL	MG/L	7	** 0.0400	0.1100	** 0.0400	NA	NA	NA	57.1	** 0.0400	0.1100	NONPARAMETRIC	2
NITRATE	MG/L	8	** 1.0000	13.2900	+ 4.7000	5.2188	4.2585	0.8160	12.5	** 1.0000	9.7325	NORMAL	
NITRITE	MG/L	5	** 0.1000	0.9900	** 0.1000	NA	NA	NA	60.0	** 0.1000	0.9900	NONPARAMETRIC	2,5
NITRITE AND NITRATE	MG/L	3	1.2200	3.3000	2.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
PH	SU	9	7.1400	8.4000	7.7900	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE	MG/L	5	** 0.1000	0.3000	0.2000	NA	NA	NA	40.0	** 0.1000	0.3000	NONPARAMETRIC	2,5
POLONIUM-210	PCI/L	5	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	60.0	** 1.0000	** 1.0000	NONPARAMETRIC	2,5
POTASSIUM	MG/L	8	0.9300	3.8900	+ 2.0700	2.1338	0.8731	0.4092	0.0	1.2083	3.0592	NORMAL	
RADIUM-226	PCI/L	7	** 0.3000	8.6000	** 0.3000	NA	NA	NA	0.0	** 0.3000	8.6000	NONPARAMETRIC	9

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RADIUM-226 + RADIUM-228	PCI/L	7	0.1000	8.8000	0.7000	0.9561	4.3815	NA	0.0	0.1653	5.5299	LOGNORMAL	7,8
RADIUM-228	PCI/L	7	** 1.0000	1.3000	** 1.0000	NA	NA	NA	14.3	** 1.0000	1.3000	NONPARAMETRIC	9
REDOX POTENTIAL	mVOLTS	1	434.5000	434.5000	434.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SELENIUM	MG/L	7	** 0.0050	0.0070	** 0.0050	NA	NA	NA	85.7	** 0.0050	0.0070	NONPARAMETRIC	2
SILICA - SIO2	MG/L	6	9.0000	14.0000	+ 10.5000	11.0000	2.0976	0.1907	0.0	8.1184	13.8816	NORMAL	
SILVER	MG/L	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6
SODIUM	MG/L	8	73.7000	119.0000	+ 93.4000	94.8375	12.5933	0.1328	0.0	81.4892	108.1858	NORMAL	
SPECIFIC CONDUCTANCE	UMHO/CM	9	400.0000	750.0000	450.0000	520.1111	129.3111	0.2486	0.0	395.2828	644.9394	NORMAL	
STRONTIUM	MG/L	8	0.0500	0.2800	+ 0.0500	NA	NA	NA	62.5	0.0500	0.2800	NONPARAMETRIC	2

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TABLE D.7.15 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, SHINARUMP MONITOR WELLS (601, 610, AND 658)
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SULFATE	MG/L	8	53.1000	131.0000	+ 100.5000	96.2625	31.2658	0.3248	0.0	63.1222	129.4028	NORMAL	
SULFIDE	MG/L	5	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2,5
TEMPERATURE	C - DEGREE	9	13.0000	20.0000	16.0000	16.0333	1.9326	0.1205	0.0	14.1677	17.8990	NORMAL	
THALLIUM	MG/L	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
THORIUM-230	PCI/L	6	** 0.1000	0.5000	+ 0.1500	NA	NA	NA	50.0	** 0.1000	0.5000	NONPARAMETRIC	2,6
TIN	MG/L	6	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,6
TOTAL DISSOLVED SOLIDS	MG/L	8	328.0000	436.0000	+ 388.0000	388.6250	38.9246	0.1002	0.0	347.3667	429.8833	NORMAL	
TOTAL ORGANIC CARBON	MG/L	7	** 1.0000	51.0000	43.0000	32.3571	21.7844	0.6732	14.3	6.4785	58.2357	NORMAL	
TOTAL ORGANIC HALOGENS	MG/L	2	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1

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1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.15 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
SHINARUMP MONITOR WELLS (601, 610, AND 658)
SITE: MON01 MONUMENT VALLEY
04/18/85 TO 11/22/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS													
# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
URANIUM	MG/L										
8	** 0.0010	0.0081	+ 0.0028	NA	NA	NA	25.0	** 0.0010	0.0081	NONPARAMETRIC	2
VANADIUM	MG/L										
8	** 0.0100	0.6000	+ 0.1025	NA	NA	NA	50.0	** 0.0100	0.6000	NONPARAMETRIC	2
ZINC	MG/L										
8	** 0.0050	0.0560	** 0.0050	NA	NA	NA	75.0	** 0.0050	0.0560	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.

INPUT DATA FILENAME: M:\DART\MON01\GWQ10009.DAT

TABLE D.7.16 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
DECHELLY MONITOR WELLS (612, 613, 661)
SITE: MON01 MONUMENT VALLEY
04/19/85 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY	MG/L CACO3	14	77.0000	198.0000	+ 181.0000	163.6429	38.9588	0.2381	0.0	136.0506	191.2351	NORMAL	
ALUMINUM	MG/L	12	** 0.0500	0.8000	+ 0.1750	NA	NA	NA	50.0	** 0.0500	0.7000	NONPARAMETRIC	2
AMMONIUM	MG/L	13	** 0.1000	0.1000	** 0.1000	NA	NA	NA	92.3	** 0.1000	** 0.1000	NONPARAMETRIC	2
ANTIMONY	MG/L	11	** 0.0030	0.0070	** 0.0030	NA	NA	NA	81.8	** 0.0030	0.0040	NONPARAMETRIC	2
ARSENIC	MG/L	13	** 0.0060	0.0060	** 0.0060	NA	NA	NA	92.3	** 0.0060	** 0.0060	NONPARAMETRIC	2
BARIUM	MG/L	11	0.0400	0.3000	0.0500	NA	NA	NA	54.5	0.0400	0.2000	NONPARAMETRIC	2
BERYLLIUM	MG/L	5	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,5
BORON	MG/L	11	** 0.0500	0.4000	0.0500	NA	NA	NA	54.5	0.0500	0.4000	NONPARAMETRIC	2
BROMIDE	MG/L	4	** 0.1000	1.0000	+ 0.5250	NA	NA	NA	100.0	** 0.1000	1.0000	NONPARAMETRIC	2,4
CADMIUM	MG/L	13	** 0.0010	0.0040	** 0.0010	NA	NA	NA	92.3	** 0.0010	** 0.0010	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.16 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT,
DECHELLY MONITOR WELLS (612, 613, 661)
SITE: MON01 MONUMENT VALLEY
04/19/85 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CALCIUM	MG/L	13	6.3400	28.6000	16.3000	17.8646	6.2747	0.3512	0.0	13.1989	22.5304	NORMAL	
CHLORIDE	MG/L	13	4.0000	10.0000	8.0000	7.2077	2.1006	0.2914	0.0	5.6458	8.7696	NORMAL	
CHROMIUM	MG/L	12	** 0.0100	0.0400	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.0300	NONPARAMETRIC	2
COBALT	MG/L	11	** 0.0300	0.0600	** 0.0300	NA	NA	NA	90.9	** 0.0300	** 0.0300	NONPARAMETRIC	2
COPPER	MG/L	10	** 0.0100	0.0100	+ 0.0100	NA	NA	NA	100.0	0.0100	0.0100	NONPARAMETRIC	2
CYANIDE	MG/L	7	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
FLUORIDE	MG/L	10	0.2000	0.6000	+ 0.4000	0.3600	0.1174	0.3261	0.0	0.2553	0.4647	NORMAL	
GROSS ALPHA	PCI/L	10	** 0.2000	10.0000	+ 3.8500	NA	NA	NA	0.0	1.0000	6.1000	NONPARAMETRIC	9
GROSS BETA	PCI/L	10	1.5000	9.0000	+ 4.8000	5.3600	2.4254	0.4525	0.0	3.1963	7.5237	NORMAL	
IRON	MG/L	12	** 0.0300	0.1000	** 0.0300	NA	NA	NA	75.0	** 0.0300	0.0700	NONPARAMETRIC	2

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.16 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, DECHELLY MONITOR WELLS (612, 613, 661)
SITE: MON01 MONUMENT VALLEY
04/19/85 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
LEAD	MG/L	11	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	0.0050	0.0050	NONPARAMETRIC	2
LEAD-210	PCI/L	5	** 1.2000	1.2000	** 1.2000	NA	NA	NA	60.0	** 1.2000	1.2000	NONPARAMETRIC	2,5
MAGNESIUM	MG/L	13	8.3700	31.9000	28.0000	24.1669	7.1410	0.2955	0.0	18.8570	29.4768	NORMAL	
MANGANESE	MG/L	12	** 0.0100	0.0500	** 0.0100	NA	NA	NA	83.3	** 0.0100	0.0300	NONPARAMETRIC	2
MERCURY	MG/L	8	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2
MOLYBDENUM	MG/L	13	** 0.0100	0.1800	0.0100	NA	NA	NA	46.2	** 0.0100	0.1100	NONPARAMETRIC	2
NET GROSS ALPHA ***	PCI/L	10	-2.7400	3.4100	+ 1.5400	NA	NA	NA	0.0	-0.8500	3.1400	NONPARAMETRIC	9
NICKEL	MG/L	11	** 0.0400	0.1100	** 0.0400	NA	NA	NA	63.6	** 0.0400	0.1000	NONPARAMETRIC	2
NITRATE	MG/L	13	** 1.0000	22.0000	4.6000	6.0554	5.6025	0.9252	7.7	1.8895	10.2213	NORMAL	

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
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2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.16 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, DECHELLY MONITOR WELLS (612, 613, 661)
SITE: MON01 MONUMENT VALLEY
04/19/85 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NITRITE	MG/L	4	** 0.1000	1.6500	** 0.1000	NA	NA	NA	75.0	** 0.1000	1.6500	NONPARAMETRIC	2,4
NITRITE AND NITRATE	MG/L	3	1.0600	2.5000	1.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
PH	SU	14	7.3700	9.3600	+ 8.0050	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE	MG/L	8	** 0.1000	0.3000	** 0.1000	NA	NA	NA	87.5	** 0.1000	0.3000	NONPARAMETRIC	2
POLONIUM-210	PCI/L	5	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	40.0	** 0.9000	** 0.9000	NONPARAMETRIC	2,5
POTASSIUM	MG/L	13	1.8200	5.2900	2.9900	3.2138	1.1302	0.3517	0.0	2.3735	4.0542	NORMAL	
RADIUM-226	PCI/L	11	** 0.1000	0.3000	** 0.1000	NA	NA	NA	27.3	** 0.1000	0.3000	NONPARAMETRIC	2
RADIUM-226 + RADIUM-228	PCI/L	11	0.0000	1.7000	0.7000	NA	NA	NA	0.0	0.2500	0.9000	NONPARAMETRIC	9
RADIUM-228	PCI/L	11	** 0.9000	1.7000	** 0.9000	NA	NA	NA	27.3	** 0.9000	** 0.9000	NONPARAMETRIC	2

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.16 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, DECHELLY MONITOR WELLS (612, 613, 661)
SITE: MON01 MONUMENT VALLEY
04/19/85 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SELENIUM	MG/L	12	** 0.0050	0.0050	** 0.0050	NA	NA	NA	91.7	** 0.0050	** 0.0050	NONPARAMETRIC	2
SILICA - SIO2	MG/L	10	5.0000	11.0000	+ 10.0000	9.6400	1.8470	0.1916	0.0	7.9923	11.2877	NORMAL	
SILVER	MG/L	10	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
SODIUM	MG/L	13	7.6200	51.7000	49.0000	36.3169	18.6251	0.5129	0.0	22.4677	50.1661	NORMAL	
SPECIFIC CONDUCTANCE	UMHO/CM	14	110.0000	550.0000	+ 365.0000	350.2143	125.2850	0.3577	0.0	261.4821	438.9464	NORMAL	
STRONTIUM	MG/L	10	0.0500	0.3600	+ 0.1250	NA	NA	NA	50.0	0.0500	0.3600	NONPARAMETRIC	2
SULFATE	MG/L	13	13.2000	64.0000	53.5000	42.9769	21.7183	0.5053	0.0	26.8277	59.1261	NORMAL	
SULFIDE	MG/L	7	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2
TEMPERATURE	C - DEGREE	14	13.7000	22.0000	+ 16.7000	16.7429	2.0512	0.1225	0.0	15.2901	18.1956	NORMAL	
THALLIUM	MG/L	5	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,5

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.16 - GROUNDWATER QUALITY STATISTICS BY PARAMETER: UPGRADIENT, DECHELLY MONITOR WELLS (612, 613, 661)
SITE: MON01 MONUMENT VALLEY
04/19/85 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME	UNITS	# OF SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
THORIUM-230	PCI/L	7	** 0.1000	1.1000	0.3000	NA	NA	NA	28.6	** 0.1000	1.1000	NONPARAMETRIC	2
TIN	MG/L	10	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2
TOTAL DISSOLVED SOLIDS	MG/L	13	118.0000	321.0000	271.0000	237.8462	62.6430	0.2634	0.0	191.2664	284.4259	NORMAL	
TOTAL ORGANIC CARBON	MG/L	8	** 1.0000	53.0000	+ 33.5000	28.0875	18.7975	0.6692	12.5	8.1630	48.0120	NORMAL	
TOTAL ORGANIC HALOGENS	MG/L	1	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
URANIUM	MG/L	13	0.0012	0.0096	0.0040	0.0044	0.0024	0.5515	0.0	0.0026	0.0062	NORMAL	
VANADIUM	MG/L	12	** 0.0100	0.8000	** 0.0100	NA	NA	NA	58.3	** 0.0100	0.7000	NONPARAMETRIC	2
ZINC	MG/L	12	** 0.0050	0.0160	+ 0.0055	NA	NA	NA	50.0	** 0.0050	0.0100	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.

INPUT DATA FILENAME: M:\DART\MON01\GWQ10010.DAT

TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ALKALINITY	0804	04/27/86	0001	TA	O	MG/L CACO3		35.		-	-
	0805	04/27/86	0001	TA	O			44.		-	-
	0814	04/27/86	0001	TA	O			2.		-	-
	0816	04/27/86	0001	TA	O			0.		-	-
ALUMINUM	0804	10/28/85	0001	TA	O	MG/L		0.3		0.1	-
	0804	04/27/86	0001	TA	O			0.9		0.1	-
	0805	10/28/85	0001	TA	O			0.4		0.1	-
	0805	04/27/86	0001	TA	O			0.6		0.1	-
	0814	04/27/86	0001	TA	O			1.2		0.1	-
	0815	10/28/85	0001	TA	O			0.4		0.1	-
	0815	04/27/86	0001	TA	O			5.5		0.1	-
	0816	10/28/85	0001	TA	O			0.3		0.1	-
	0816	04/27/86	0001	TA	O			3.9		0.1	-
	0817	10/28/85	0001	TA	O			0.4		0.1	-
AMMONIUM	0804	10/28/85	0001	TA	O	MG/L		47.		0.1	-
	0804	04/27/86	0001	TA	O			17.		0.1	-
	0805	10/28/85	0001	TA	O			12.		0.1	-
	0815	10/28/85	0001	TA	O			1.5		0.1	-
	0816	10/28/85	0001	TA	O			200.		0.1	-
	0817	10/28/85	0001	TA	O			1200.		0.1	-
ANTIMONY	0804	10/28/85	0001	TA	O	MG/L	<	0.003		0.003	-
	0804	04/27/86	0001	TA	O		<	0.003		0.003	-
	0805	10/28/85	0001	TA	O		<	0.003		0.003	-
	0805	04/27/86	0001	TA	O		<	0.003		0.003	-
	0814	04/27/86	0001	TA	O		<	0.003		0.003	-
	0815	10/28/85	0001	TA	O		<	0.003		0.003	-
	0815	04/27/86	0001	TA	O		<	0.003		0.003	-
	0816	10/28/85	0001	TA	O		<	0.003		0.003	-
	0816	04/27/86	0001	TA	O		<	0.003		0.003	-
	0817	10/28/85	0001	TA	O		<	0.003		0.003	-
ARSENIC	0804	10/28/85	0001	TA	O	MG/L	<	0.01		0.01	-
	0804	04/27/86	0001	TA	O		<	0.01		0.01	-
	0805	10/28/85	0001	TA	O		<	0.01		0.01	-
	0805	04/27/86	0001	TA	O		<	0.01		0.01	-
	0814	10/28/85	0001	TA	O		<	0.01		0.01	-
	0814	04/27/86	0001	TA	O		<	0.01		0.01	-
	0815	10/28/85	0001	TA	O		<	0.01		0.01	-

MATERIAL OF SAMPLING CODE:
TA - URANIUM MILL TAILINGS

FLOW RELATIONSHIP CODE:
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ARSENIC	0815	04/27/86	0001	TA	O	MG/L	<	0.01		0.01	-
	0816	10/28/85	0001	TA	O		<	0.01		0.01	-
	0816	04/27/86	0001	TA	O		<	0.01		0.01	-
	0817	10/28/85	0001	TA	O		<	0.01		0.01	-
BARIUM	0804	10/28/85	0001	TA	O	MG/L		0.3		0.1	-
	0804	04/27/86	0001	TA	O			0.1		0.1	-
	0805	10/28/85	0001	TA	O			0.5		0.1	-
	0805	04/27/86	0001	TA	O			0.2		0.1	-
	0814	04/27/86	0001	TA	O		<	0.1		0.1	-
	0815	10/28/85	0001	TA	O			0.3		0.1	-
	0815	04/27/86	0001	TA	O			0.1		0.1	-
	0816	10/28/85	0001	TA	O			0.3		0.1	-
	0816	04/27/86	0001	TA	O			0.1		0.1	-
	0817	10/28/85	0001	TA	O			0.3		0.1	-
BORON	0804	04/27/86	0001	TA	O	MG/L	<	0.1		0.1	-
	0805	04/27/86	0001	TA	O		<	0.1		0.1	-
	0814	04/27/86	0001	TA	O		<	0.1		0.1	-
	0815	04/27/86	0001	TA	O		<	0.1		0.1	-
	0816	04/27/86	0001	TA	O		<	0.1		0.1	-
CADMIUM	0804	10/28/85	0001	TA	O	MG/L	<	0.001		0.001	-
	0804	04/27/86	0001	TA	O		<	0.001		0.001	-
	0805	10/28/85	0001	TA	O		<	0.001		0.001	-
	0805	04/27/86	0001	TA	O		<	0.001		0.001	-
	0814	04/27/86	0001	TA	O		<	0.001		0.001	-
	0815	10/28/85	0001	TA	O		<	0.001		0.001	-
	0815	04/27/86	0001	TA	O		<	0.001		0.001	-
	0816	10/28/85	0001	TA	O		<	0.001		0.001	-
	0816	04/27/86	0001	TA	O		<	0.001		0.001	-
	0817	10/28/85	0001	TA	O		<	0.001		0.001	-
CALCIUM	0804	10/28/85	0001	TA	O	MG/L		36.9		0.01	-
	0804	04/27/86	0001	TA	O			39.4		0.01	-
	0805	10/28/85	0001	TA	O			425.		0.01	-
	0805	04/27/86	0001	TA	O			198.		0.01	-
	0814	10/28/85	0001	TA	O			585.		0.01	-
	0814	04/27/86	0001	TA	O			534.		0.01	-
	0815	10/28/85	0001	TA	O			544.		0.01	-
	0815	04/27/86	0001	TA	O			510.		0.01	-

MATERIAL OF SAMPLING CODE:
TA - URANIUM MILL TAILINGS

FLOW RELATIONSHIP CODE:
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
CALCIUM	0816	10/28/85	0001	TA	O	MG/L		626.		0.01	-
	0816	04/27/86	0001	TA	O			457.		0.01	-
	0817	10/28/85	0001	TA	O			555.		0.01	-
CHLORIDE	0804	10/28/85	0001	TA	O	MG/L		26.		1.	-
	0804	04/27/86	0001	TA	O			33.		1.	-
	0805	10/28/85	0001	TA	O			41.		1.	-
	0805	04/27/86	0001	TA	O			45.		1.	-
	0814	10/28/85	0001	TA	O			5.		1.	-
	0815	10/28/85	0001	TA	O			7.		1.	-
	0816	10/28/85	0001	TA	O			15.		1.	-
	0817	10/28/85	0001	TA	O			20.		1.	-
CHROMIUM	0804	10/28/85	0001	TA	O	MG/L		0.02		0.01	-
	0804	04/27/86	0001	TA	O		<	0.01		0.01	-
	0805	10/28/85	0001	TA	O			0.03		0.01	-
	0805	04/27/86	0001	TA	O			0.03		0.01	-
	0814	04/27/86	0001	TA	O			0.03		0.01	-
	0815	10/28/85	0001	TA	O			0.02		0.01	-
	0815	04/27/86	0001	TA	O			0.05		0.01	-
	0816	10/28/85	0001	TA	O			0.04		0.01	-
	0816	04/27/86	0001	TA	O			0.05		0.01	-
	0817	10/28/85	0001	TA	O			0.02		0.01	-
COBALT	0804	10/28/85	0001	TA	O	MG/L	<	0.05		0.05	-
	0804	04/27/86	0001	TA	O			0.07		0.05	-
	0805	10/28/85	0001	TA	O			0.05		0.05	-
	0805	04/27/86	0001	TA	O			0.11		0.05	-
	0814	04/27/86	0001	TA	O			0.34		0.05	-
	0815	10/28/85	0001	TA	O			0.61		0.05	-
	0815	04/27/86	0001	TA	O			0.87		0.05	-
	0816	10/28/85	0001	TA	O			0.65		0.05	-
	0816	04/27/86	0001	TA	O			1.41		0.05	-
	0817	10/28/85	0001	TA	O			0.99		0.05	-
COPPER	0804	10/28/85	0001	TA	O	MG/L	<	0.02		0.02	-
	0804	04/27/86	0001	TA	O			0.03		0.02	-
	0805	10/28/85	0001	TA	O			0.04		0.02	-
	0805	04/27/86	0001	TA	O			0.04		0.02	-
	0814	04/27/86	0001	TA	O			0.04		0.02	-
	0815	10/28/85	0001	TA	O			0.04		0.02	-

MATERIAL OF SAMPLING CODE:
TA - URANIUM MILL TAILINGS

FLOW RELATIONSHIP CODE:
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
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TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
COPPER	0815	04/27/86	0001	TA	O	MG/L		0.11		0.02	-
	0816	10/28/85	0001	TA	O			0.03		0.02	-
	0816	04/27/86	0001	TA	O			0.14		0.02	-
	0817	10/28/85	0001	TA	O			0.04		0.02	-
FLUORIDE	0804	04/27/86	0001	TA	O	MG/L		1.7		0.1	-
IRON	0804	10/28/85	0001	TA	O	MG/L		0.03		0.03	-
	0804	04/27/86	0001	TA	O		<	0.03		0.03	-
	0805	10/28/85	0001	TA	O			0.04		0.03	-
	0805	04/27/86	0001	TA	O			0.04		0.03	-
	0814	04/27/86	0001	TA	O			0.1		0.03	-
	0815	10/28/85	0001	TA	O			0.03		0.03	-
	0815	04/27/86	0001	TA	O			0.11		0.03	-
	0816	10/28/85	0001	TA	O			0.29		0.03	-
	0816	04/27/86	0001	TA	O			0.16		0.03	-
	0817	10/28/85	0001	TA	O			1.86		0.03	-
LEAD	0804	04/27/86	0001	TA	O	MG/L	<	0.01		0.01	-
	0805	04/27/86	0001	TA	O		<	0.01		0.01	-
	0814	04/27/86	0001	TA	O		<	0.01		0.01	-
	0815	04/27/86	0001	TA	O		<	0.01		0.01	-
	0816	04/27/86	0001	TA	O		<	0.01		0.01	-
MAGNESIUM	0804	10/28/85	0001	TA	O	MG/L		18.3		0.001	-
	0804	04/27/86	0001	TA	O			17.6		0.001	-
	0805	10/28/85	0001	TA	O			135.		0.001	-
	0805	04/27/86	0001	TA	O			90.		0.001	-
	0814	10/28/85	0001	TA	O			3.94		0.001	-
	0814	04/27/86	0001	TA	O			3.02		0.001	-
	0815	10/28/85	0001	TA	O			6.3		0.001	-
	0815	04/27/86	0001	TA	O			5.26		0.001	-
	0816	10/28/85	0001	TA	O			31.8		0.001	-
	0816	04/27/86	0001	TA	O			35.		0.001	-
	0817	10/28/85	0001	TA	O			78.3		0.001	-
MANGANESE	0804	10/28/85	0001	TA	O	MG/L		0.37		0.01	-
	0804	04/27/86	0001	TA	O			0.17		0.01	-
	0805	10/28/85	0001	TA	O			0.67		0.01	-
	0805	04/27/86	0001	TA	O			0.77		0.01	-
	0814	04/27/86	0001	TA	O			0.92		0.01	-

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TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MANGANESE	0815	10/28/85	0001	TA	O	MG/L		2.25		0.01	-
	0815	04/27/86	0001	TA	O			2.82		0.01	-
	0816	10/28/85	0001	TA	O			2.77		0.01	-
	0816	04/27/86	0001	TA	O			3.94		0.01	-
	0817	10/28/85	0001	TA	O			2.97		0.01	-
MERCURY	0804	10/28/85	0001	TA	O	MG/L	<	0.0002		0.0002	-
	0805	10/28/85	0001	TA	O		<	0.0002		0.0002	-
	0814	10/28/85	0001	TA	O		<	0.0002		0.0002	-
	0815	10/28/85	0001	TA	O		<	0.0002		0.0002	-
	0816	10/28/85	0001	TA	O		<	0.0002		0.0002	-
	0817	10/28/85	0001	TA	O		<	0.0002		0.0002	-
MOLYBDENUM	0804	10/28/85	0001	TA	O	MG/L		0.17		0.01	-
	0804	04/27/86	0001	TA	O			0.21		0.01	-
	0805	10/28/85	0001	TA	O			0.2		0.01	-
	0805	04/27/86	0001	TA	O			0.24		0.01	-
	0814	04/27/86	0001	TA	O			0.23		0.01	-
	0815	10/28/85	0001	TA	O			0.25		0.01	-
	0815	04/27/86	0001	TA	O			0.19		0.01	-
	0816	10/28/85	0001	TA	O			0.26		0.01	-
	0816	04/27/86	0001	TA	O			0.15		0.01	-
	0817	10/28/85	0001	TA	O			0.32		0.01	-
NICKEL	0804	10/28/85	0001	TA	O	MG/L		0.06		0.04	-
	0804	04/27/86	0001	TA	O			0.05		0.04	-
	0805	10/28/85	0001	TA	O			0.15		0.04	-
	0805	04/27/86	0001	TA	O			0.09		0.04	-
	0814	04/27/86	0001	TA	O			0.31		0.04	-
	0815	10/28/85	0001	TA	O			0.54		0.04	-
	0815	04/27/86	0001	TA	O			0.57		0.04	-
	0816	10/28/85	0001	TA	O			0.53		0.04	-
	0816	04/27/86	0001	TA	O			0.66		0.04	-
	0817	10/28/85	0001	TA	O			1.1		0.04	-
NITRATE	0804	10/28/85	0001	TA	O	MG/L		25.		1.	-
	0804	04/27/86	0001	TA	O			32.		1.	-
	0805	10/28/85	0001	TA	O			570.		1.	-
	0805	04/27/86	0001	TA	O			83.		1.	-
	0814	10/28/85	0001	TA	O			14.		1.	-
	0815	10/28/85	0001	TA	O			18.		1.	-

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SAMPLE ID CODES:
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TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
NITRATE	0816	10/28/85	0001	TA	O	MG/L		27.		1.	-
	0817	10/28/85	0001	TA	O			530.		1.	-
PH	0804	10/28/85	0001	TA	O	SU		7.63		-	-
	0804	04/27/86	0001	TA	O			6.72		-	-
	0805	10/28/85	0001	TA	O			7.24		-	-
	0805	04/27/86	0001	TA	O			7.19		-	-
	0814	10/28/85	0001	TA	O			6.64		-	-
	0814	04/27/86	0001	TA	O			5.82		-	-
	0815	10/28/85	0001	TA	O			6.23		-	-
	0815	04/27/86	0001	TA	O			4.56		-	-
	0816	10/28/85	0001	TA	O			6.32		-	-
	0816	04/27/86	0001	TA	O			4.3		-	-
	0817	10/28/85	0001	TA	O			6.16		-	-
POTASSIUM	0804	10/28/85	0001	TA	O	MG/L		4.81		0.01	-
	0804	04/27/86	0001	TA	O			3.27		0.01	-
	0805	10/28/85	0001	TA	O			5.21		0.01	-
	0805	04/27/86	0001	TA	O			3.25		0.01	-
	0814	10/28/85	0001	TA	O			3.79		0.01	-
	0814	04/27/86	0001	TA	O			2.24		0.01	-
	0815	10/28/85	0001	TA	O			3.83		0.01	-
	0815	04/27/86	0001	TA	O			3.13		0.01	-
	0816	10/28/85	0001	TA	O			8.91		0.01	-
	0816	04/27/86	0001	TA	O			6.07		0.01	-
	0817	10/28/85	0001	TA	O			21.9		0.01	-
RADIUM-226	0804	10/28/85	0001	TA	O	PCI/L		2.9		1.	2.1
	0805	10/28/85	0001	TA	O			4.7		1.	2.1
	0815	10/28/85	0001	TA	O			8.1		1.	3.3
	0816	10/28/85	0001	TA	O			13.		1.	4.
	0817	10/28/85	0001	TA	O			3.8		1.	2.3
SELENIUM	0804	10/28/85	0001	TA	O	MG/L	<	0.005		0.005	-
	0804	04/27/86	0001	TA	O		<	0.005		0.005	-
	0805	10/28/85	0001	TA	O		<	0.005		0.005	-
	0805	04/27/86	0001	TA	O		<	0.005		0.005	-
	0814	10/28/85	0001	TA	O		<	0.005		0.005	-
	0814	04/27/86	0001	TA	O		<	0.005		0.005	-
	0815	10/28/85	0001	TA	O		<	0.005		0.005	-
	0815	04/27/86	0001	TA	O		<	0.005		0.005	-

MATERIAL OF SAMPLING CODE:
TA - URANIUM MILL TAILINGS

FLOW RELATIONSHIP CODE:
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SAMPLE ID CODES:
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TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SELENIUM	0816	10/28/85	0001	TA	O	MG/L	<	0.005		0.005	-
	0816	04/27/86	0001	TA	O		<	0.005		0.005	-
	0817	10/28/85	0001	TA	O		<	0.005		0.005	-
SILVER	0804	10/28/85	0001	TA	O	MG/L	<	0.01		0.01	-
	0804	04/27/86	0001	TA	O		<	0.01		0.01	-
	0805	10/28/85	0001	TA	O		<	0.01		0.01	-
	0805	04/27/86	0001	TA	O		<	0.01		0.01	-
	0814	04/27/86	0001	TA	O		<	0.01		0.01	-
	0815	10/28/85	0001	TA	O		<	0.01		0.01	-
	0815	04/27/86	0001	TA	O		<	0.01		0.01	-
	0816	10/28/85	0001	TA	O		<	0.01		0.01	-
	0816	04/27/86	0001	TA	O		<	0.01		0.01	-
	0817	10/28/85	0001	TA	O		<	0.01		0.01	-
SODIUM	0804	10/28/85	0001	TA	O	MG/L		107.		0.002	-
	0804	04/27/86	0001	TA	O			171.		0.002	-
	0805	10/28/85	0001	TA	O			362.		0.002	-
	0805	04/27/86	0001	TA	O			232.		0.002	-
	0814	10/28/85	0001	TA	O			18.1		0.002	-
	0814	04/27/86	0001	TA	O			3.75		0.002	-
	0815	10/28/85	0001	TA	O			9.51		0.002	-
	0815	04/27/86	0001	TA	O			3.57		0.002	-
	0816	10/28/85	0001	TA	O			22.6		0.002	-
	0816	04/27/86	0001	TA	O			8.36		0.002	-
	0817	10/28/85	0001	TA	O			70.7		0.002	-
SPECIFIC CONDUCTANCE	0804	04/27/86	0001	TA	O	UMHO/CM		435.		-	-
	0805	04/27/86	0001	TA	O			850.		-	-
	0814	04/27/86	0001	TA	O			800.		-	-
	0815	04/27/86	0001	TA	O			850.		-	-
	0816	04/27/86	0001	TA	O			1200.		-	-
STRONTIUM	0804	10/28/85	0001	TA	O	MG/L		0.2		0.1	-
	0804	04/27/86	0001	TA	O			0.1		0.1	-
	0805	10/28/85	0001	TA	O			1.6		0.1	-
	0805	04/27/86	0001	TA	O			1.3		0.1	-
	0814	04/27/86	0001	TA	O			0.7		0.1	-
	0815	10/28/85	0001	TA	O			0.7		0.1	-
	0815	04/27/86	0001	TA	O			0.7		0.1	-
	0816	10/28/85	0001	TA	O			0.7		0.1	-

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FLOW RELATIONSHIP CODE:
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SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PVI	PARAMETER VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
STRONTIUM	0816	04/27/86	0001	TA	O	MG/L		0.7		0.1	-
	0817	10/28/85	0001	TA	O			0.7		0.1	-
SULFATE	0804	10/28/85	0001	TA	O	MG/L		212.		0.1	-
	0804	04/27/86	0001	TA	O			286.		0.1	-
	0805	10/28/85	0001	TA	O			1610.		0.1	-
	0805	04/27/86	0001	TA	O			738.		0.1	-
	0814	10/28/85	0001	TA	O			1420.		0.1	-
	0815	10/28/85	0001	TA	O			1310.		0.1	-
	0816	10/28/85	0001	TA	O			2050.		0.1	-
	0817	10/28/85	0001	TA	O			4510.		0.1	-
TEMPERATURE	0804	04/27/86	0001	TA	O	C - DEGREE		16.		-	-
	0805	04/27/86	0001	TA	O			15.5		-	-
	0814	04/27/86	0001	TA	O			16.		-	-
	0815	04/27/86	0001	TA	O			16.		-	-
	0816	04/27/86	0001	TA	O			16.		-	-
TIN	0804	10/28/85	0001	TA	O	MG/L	<	0.005		0.005	-
	0804	04/27/86	0001	TA	O		<	0.005		0.005	-
	0805	10/28/85	0001	TA	O		<	0.005		0.005	-
	0805	04/27/86	0001	TA	O		<	0.005		0.005	-
	0814	04/27/86	0001	TA	O		<	0.005		0.005	-
	0815	10/28/85	0001	TA	O		<	0.005		0.005	-
	0815	04/27/86	0001	TA	O		<	0.005		0.005	-
	0816	10/28/85	0001	TA	O		<	0.005		0.005	-
	0816	04/27/86	0001	TA	O		<	0.005		0.005	-
	0817	10/28/85	0001	TA	O		<	0.005		0.005	-
TOTAL DISSOLVED SOLIDS	0804	10/28/85	0001	TA	O	MG/L		703.		10.	-
	0805	10/28/85	0001	TA	O			2900.		10.	-
	0814	10/28/85	0001	TA	O			2220.		10.	-
	0815	10/28/85	0001	TA	O			2080.		10.	-
	0816	10/28/85	0001	TA	O			3140.		10.	-
	0817	10/28/85	0001	TA	O			6850.		10.	-
URANIUM	0804	10/28/85	0001	TA	O	MG/L		0.0201		0.003	-
	0804	04/27/86	0001	TA	O			0.0205		0.003	-
	0805	10/28/85	0001	TA	O			0.78		0.003	-
	0805	04/27/86	0001	TA	O			1.08		0.003	-
	0814	10/28/85	0001	TA	O			0.0033		0.003	-

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FLOW RELATIONSHIP CODE:
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

TABLE D.7.17 - LYSIMETER WATER QUALITY DATA BY PARAMETER: ALL LYSIMETERS
(804, 805, 814, 815, 816, 817)
SITE: MON01 MONUMENT VALLEY
10/28/85 TO 04/27/86
REPORT DATE: 02/10/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	MAT. SAMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
URANIUM	0814	04/27/86	0001	TA	O	MG/L		0.0006	c	0.0006	-
	0815	10/28/85	0001	TA	O			0.036		0.003	-
	0815	04/27/86	0001	TA	O			0.0064		0.003	-
	0816	10/28/85	0001	TA	O			0.0753		0.003	-
	0816	04/27/86	0001	TA	O			0.054		0.003	-
	0817	10/28/85	0001	TA	O			0.0008	c	0.0008	-
VANADIUM	0804	10/28/85	0001	TA	O	MG/L		0.3		0.01	-
	0804	04/27/86	0001	TA	O			0.69		0.01	-
	0805	10/28/85	0001	TA	O			0.62		0.01	-
	0805	04/27/86	0001	TA	O			0.91		0.01	-
	0814	04/27/86	0001	TA	O			1.08		0.01	-
	0815	10/28/85	0001	TA	O			0.48		0.01	-
	0815	04/27/86	0001	TA	O			0.89		0.01	-
	0816	10/28/85	0001	TA	O			0.26		0.01	-
	0816	04/27/86	0001	TA	O			0.97		0.01	-
	0817	10/28/85	0001	TA	O		10	0.25		0.01	-
ZINC	0804	10/28/85	0001	TA	O	MG/L		0.06		0.005	-
	0804	04/27/86	0001	TA	O			0.129		0.005	-
	0805	10/28/85	0001	TA	O			0.129		0.005	-
	0805	04/27/86	0001	TA	O			0.107		0.005	-
	0814	04/27/86	0001	TA	O			1.41		0.005	-
	0815	10/28/85	0001	TA	O			1.82		0.005	-
	0815	04/27/86	0001	TA	O			0.912		0.005	-
	0816	10/28/85	0001	TA	O			3.86		0.005	-
	0816	04/27/86	0001	TA	O			0.86		0.005	-
	0817	10/28/85	0001	TA	O			2.09		0.005	-

MATERIAL OF SAMPLING CODE:
TA - URANIUM MILL TAILINGS

FLOW RELATIONSHIP CODE:
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
c - CHANGED DETECTION LIMIT

DATA FILE NAME: M:\DART\MON01\LYS10000.DAT

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY					MG/L CACO3								
0603	7	193.0000	205.0000		200.0000	199.2857	4.3095	0.0216	0.0	194.1663	204.4051	NORMAL	
0604	6	177.0000	204.0000	+	193.5000	192.3333	10.4817	0.0545	0.0	177.9340	206.7327	NORMAL	
0605	10	204.0000	349.0000	+	248.5000	268.2000	50.7079	0.1891	0.0	222.9646	313.4354	NORMAL	
0606	10	289.0000	641.0000	+	329.0000	356.6000	104.6265	0.2934	0.0	263.2649	449.9351	NORMAL	
0650	4	205.0000	219.0000	+	213.0000	212.5000	6.6081	0.0311	0.0	197.4964	227.5036	NORMAL	
0651	10	175.0000	206.0000	+	196.0000	193.9000	8.7235	0.0450	0.0	186.1179	201.6821	NORMAL	
0652	5	190.0000	205.0000		195.0000	195.6000	5.7706	0.0295	0.0	185.9301	205.2699	NORMAL	
0653	9	173.0000	221.0000		201.0000	201.0000	14.1863	0.0706	0.0	187.3055	214.6945	NORMAL	
0654	9	159.0000	193.0000		176.0000	175.0000	10.0623	0.0575	0.0	165.2865	184.7135	NORMAL	
0655	10	299.0000	358.0000	+	328.0000	329.9000	21.5378	0.0653	0.0	310.6866	349.1134	NORMAL	
0656	4	260.0000	263.0000	+	262.5000	262.0000	1.4142	0.0054	0.0	258.7890	265.2110	NORMAL	
0662	6	325.0000	474.0000	+	374.5000	390.3333	61.0169	0.1563	0.0	306.5110	474.1557	NORMAL	
0669	4	218.0000	246.0000	+	226.0000	229.0000	12.3828	0.0541	0.0	200.8849	257.1151	NORMAL	
ALUMINUM					MG/L								
0603	5	** 0.0500	0.7000		0.0500	NA	NA	NA	60.0	** 0.0500	0.7000	NONPARAMETRIC	2,5
0604	5	** 0.0500	0.6000		0.0500	NA	NA	NA	60.0	** 0.0500	0.6000	NONPARAMETRIC	2,5
0605	8	** 0.0500	0.6000	+	0.0500	NA	NA	NA	62.5	** 0.0500	0.6000	NONPARAMETRIC	2
0606	9	** 0.0500	0.7000		0.0500	NA	NA	NA	66.7	** 0.0500	0.7000	NONPARAMETRIC	2
0650	3	** 0.1000	0.3000	**	0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0651	8	** 0.0500	0.3000	+	0.0500	NA	NA	NA	75.0	** 0.0500	0.3000	NONPARAMETRIC	2
0652	4	** 0.0500	0.2000	+	0.1125	NA	NA	NA	50.0	** 0.0500	0.2000	NONPARAMETRIC	2,4
0653	7	** 0.0500	0.4000		0.0500	NA	NA	NA	71.4	** 0.0500	0.4000	NONPARAMETRIC	2
0654	7	** 0.0500	0.2000		0.0500	NA	NA	NA	71.4	** 0.0500	0.2000	NONPARAMETRIC	2
0655	8	** 0.0500	0.3000	+	0.0500	NA	NA	NA	75.0	** 0.0500	0.3000	NONPARAMETRIC	2
0656	3	** 0.1000	0.4000		0.3000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	5	** 0.0500	0.4000		0.0500	NA	NA	NA	80.0	** 0.0500	0.4000	NONPARAMETRIC	2,5
0669	4	** 0.0500	0.4000	+	0.1750	NA	NA	NA	50.0	** 0.0500	0.4000	NONPARAMETRIC	2,4
AMMONIUM					MG/L								
0603	6	** 0.1000	0.6000	**	0.1000	NA	NA	NA	66.7	** 0.1000	0.6000	NONPARAMETRIC	2,6

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
AMMONIUM					MG/L							
0604	5	** 0.1000	0.3000	** 0.1000	NA	NA	NA	60.0	** 0.1000	0.3000	NONPARAMETRIC	2,5
0605	9	** 0.1000	2.2000	0.5000	NA	NA	NA	33.3	** 0.1000	2.2000	NONPARAMETRIC	2
0606	9	210.0000	370.0000	310.0000	301.3333	62.5540	0.2076	0.0	240.9479	361.7188	NORMAL	
0650	4	** 0.1000	0.5000	** 0.1000	NA	NA	NA	75.0	** 0.1000	0.5000	NONPARAMETRIC	2,4
0651	9	** 0.1000	0.2000	** 0.1000	NA	NA	NA	66.7	** 0.1000	0.2000	NONPARAMETRIC	2
0652	4	** 0.1000	0.1000	** 0.1000	NA	NA	NA	75.0	** 0.1000	0.1000	NONPARAMETRIC	2,4
0653	8	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2
0654	8	** 0.1000	0.2000	** 0.1000	NA	NA	NA	62.5	** 0.1000	0.2000	NONPARAMETRIC	2
0655	9	43.4000	460.0000	239.0000	252.6000	115.2761	0.4564	0.0	141.3201	363.8799	NORMAL	
0656	3	91.0000	150.0000	120.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	** 0.1000	0.1000	** 0.1000	NA	NA	NA	80.0	** 0.1000	0.1000	NONPARAMETRIC	2,5
0669	4	** 0.1000	0.4000	** 0.1000	NA	NA	NA	75.0	** 0.1000	0.4000	NONPARAMETRIC	2,4
ANTIMONY					MG/L							
0603	5	** 0.0030	0.0040	** 0.0030	NA	NA	NA	80.0	** 0.0030	0.0040	NONPARAMETRIC	2,5
0604	5	** 0.0030	0.0050	** 0.0030	NA	NA	NA	60.0	** 0.0030	0.0050	NONPARAMETRIC	2,5
0605	6	** 0.0030	0.0060	** 0.0030	NA	NA	NA	66.7	** 0.0030	0.0060	NONPARAMETRIC	2,6
0606	8	** 0.0030	0.0100	** 0.0030	NA	NA	NA	62.5	** 0.0030	0.0100	NONPARAMETRIC	2
0650	2	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	7	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	** 0.0030	** 0.0030	NONPARAMETRIC	2
0652	3	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	6	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	** 0.0030	** 0.0030	NONPARAMETRIC	2,6
0654	6	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	** 0.0030	** 0.0030	NONPARAMETRIC	2,6
0655	7	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	** 0.0030	** 0.0030	NONPARAMETRIC	2
0656	2	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	3	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	3	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
ARSENIC					MG/L							
0603	6	0.0010	0.0050	+ 0.0050	NA	NA	NA	83.3	0.0010	0.0050	NONPARAMETRIC	2,6
0604	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ARSENIC					MG/L							
0605	9	** 0.0100	0.0110	** 0.0100	NA	NA	NA	77.8	** 0.0100	0.0110	NONPARAMETRIC	2
0606	9	** 0.0100	0.0100	** 0.0100	NA	NA	NA	88.9	** 0.0100	0.0100	NONPARAMETRIC	2
0650	4	0.0030	0.0050	+ 0.0050	NA	NA	NA	75.0	0.0030	0.0050	NONPARAMETRIC	2,4
0651	9	0.0020	0.0050	0.0050	NA	NA	NA	88.9	0.0020	0.0050	NONPARAMETRIC	2
0652	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
0653	8	** 0.0100	0.0110	** 0.0100	NA	NA	NA	75.0	** 0.0100	0.0110	NONPARAMETRIC	2
0654	8	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
0655	9	** 0.0100	0.0250	** 0.0100	NA	NA	NA	88.9	** 0.0100	0.0250	NONPARAMETRIC	2
0656	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5
0669	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
BARIUM					MG/L							
0603	5	0.0400	0.4000	0.0500	NA	NA	NA	40.0	0.0400	0.4000	NONPARAMETRIC	2,5
0604	5	0.0400	0.3000	0.0500	NA	NA	NA	40.0	0.0400	0.3000	NONPARAMETRIC	2,5
0605	7	0.0300	0.3000	0.0500	NA	NA	NA	57.1	0.0300	0.3000	NONPARAMETRIC	2
0606	9	0.0300	0.1000	0.0500	NA	NA	NA	66.7	0.0300	0.1000	NONPARAMETRIC	2
0650	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	7	0.0300	0.2000	0.0500	NA	NA	NA	57.1	0.0300	0.2000	NONPARAMETRIC	2
0652	3	0.1300	0.4000	0.1500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	7	0.0300	0.2000	0.0500	NA	NA	NA	42.9	0.0300	0.2000	NONPARAMETRIC	2
0654	6	0.1000	0.2000	+ 0.1750	0.1583	0.0492	0.3105	0.0	0.0908	0.2259	NORMAL	
0655	8	0.0200	0.2000	+ 0.0500	NA	NA	NA	50.0	0.0200	0.2000	NONPARAMETRIC	2
0656	3	** 0.1000	0.2000	0.2000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	4	0.0200	0.2000	+ 0.0400	NA	NA	NA	25.0	0.0200	0.2000	NONPARAMETRIC	2,4
0669	4	0.0200	0.3000	+ 0.0750	NA	NA	NA	25.0	0.0200	0.3000	NONPARAMETRIC	2,4
BERYLLIUM					MG/L							
0603	2	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0604	2	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0605	5	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,5
0606	5	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,5

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS									
LOC.	SAMP	MINIMUM		MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
BERYLLIUM						MG/L									
0650	1	**	0.0100	**	0.0100	** 0.0100	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0651	5	**	0.0050		0.0050	0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,5
0652	1	**	0.0050	**	0.0050	** 0.0050	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0653	4	**	0.0050		0.0050	** 0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,4
0654	5	**	0.0050		0.0050	0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,5
0655	5	**	0.0050		0.0050	0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,5
0656	1	**	0.0100	**	0.0100	** 0.0100	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0662	2	**	0.0050		0.0050	** 0.0050	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0669	1	**	0.0100	**	0.0100	** 0.0100	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
BORON						MG/L									
0603	4	**	0.0500		0.8000	+ 0.1250	NA	NA	NA	50.0	**	0.0500	0.8000	NONPARAMETRIC	2,4
0604	4	**	0.0500		0.8000	+ 0.1750	NA	NA	NA	50.0	**	0.0500	0.8000	NONPARAMETRIC	2,4
0605	8		0.0500		0.4000	+ 0.2000	NA	NA	NA	25.0		0.0500	0.4000	NONPARAMETRIC	2
0606	8		0.1500		3.2000	+ 0.2000	0.3130	2.7905	NA	0.0		0.1055	0.9289	LOGNORMAL	7,8
0650	3	**	0.1000		0.3000	0.1000	NA	NA	NA	33.3		NA	NA	UNKNOWN	1
0651	7		0.0500		0.2000	0.0500	NA	NA	NA	71.4		0.0500	0.2000	NONPARAMETRIC	2
0652	3		0.0500		0.2000	0.0800	NA	NA	NA	33.3		NA	NA	UNKNOWN	1
0653	6	**	0.0500		0.2000	+ 0.0500	NA	NA	NA	83.3	**	0.0500	0.2000	NONPARAMETRIC	2,6
0654	7	**	0.0500		0.1000	0.0500	NA	NA	NA	85.7	**	0.0500	0.1000	NONPARAMETRIC	2
0655	7	**	0.0500		0.1000	0.0500	NA	NA	NA	85.7	**	0.0500	0.1000	NONPARAMETRIC	2
0656	3	**	0.1000		0.1000	** 0.1000	NA	NA	NA	66.7		NA	NA	UNKNOWN	1
0662	4		0.0500		0.4000	+ 0.1750	NA	NA	NA	25.0		0.0500	0.4000	NONPARAMETRIC	2,4
0669	3	**	0.1000		0.1000	0.1000	NA	NA	NA	33.3		NA	NA	UNKNOWN	1
BROMIDE						MG/L									
0603	2		0.1000		1.0000	+ 0.5500	NA	NA	NA	50.0		NA	NA	UNKNOWN	1
0604	2	**	0.1000		1.0000	+ 0.5250	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0605	3	**	0.1000		1.1000	1.0000	NA	NA	NA	66.7		NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS											
LOC.	SAMP	MINIMUM		MAXIMUM		MEDIAN		MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *		DISTRIBUTION TYPE	FOOT NOTE
BROMIDE						MG/L											
0606	3	**	0.1000		1.0000		0.5000	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0651	2	**	0.1000	**	0.1000	**	0.1000	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0652	1		0.1000		0.1000		0.1000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0653	2	**	0.1000		0.2000	+	0.1250	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0654	2	**	0.1000	**	0.1000	**	0.1000	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0655	2	**	0.1000		0.5000	+	0.2750	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0662	1		0.2000		0.2000		0.2000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
CADMIUM						MG/L											
0603	6	**	0.0005		0.0050	+	0.0005	NA	NA	NA	83.3	**	0.0005		0.0050	NONPARAMETRIC	2,6
0604	5	**	0.0005		0.0060		0.0005	NA	NA	NA	80.0	**	0.0005		0.0060	NONPARAMETRIC	2,5
0605	9	**	0.0010		0.0170	**	0.0010	NA	NA	NA	77.8	**	0.0010		0.0170	NONPARAMETRIC	2
0606	9	**	0.0005		0.0020		0.0005	NA	NA	NA	88.9	**	0.0005		0.0020	NONPARAMETRIC	2
0650	4	**	0.0010		0.0040	**	0.0010	NA	NA	NA	75.0	**	0.0010		0.0040	NONPARAMETRIC	2,4
0651	9	**	0.0010		0.0050	**	0.0010	NA	NA	NA	88.9	**	0.0010		0.0050	NONPARAMETRIC	2
0652	4	**	0.0005		0.0005	+	0.0005	NA	NA	NA	100.0	**	0.0005		0.0005	NONPARAMETRIC	2,4
0653	8	**	0.0010		0.0030	**	0.0010	NA	NA	NA	87.5	**	0.0010		0.0030	NONPARAMETRIC	2
0654	8	**	0.0010		0.0020	**	0.0010	NA	NA	NA	87.5	**	0.0010		0.0020	NONPARAMETRIC	2
0655	9	**	0.0005		0.1200		0.0005	NA	NA	NA	77.8	**	0.0005		0.1200	NONPARAMETRIC	2
0656	3	**	0.0010		0.0020	**	0.0010	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
0662	5	**	0.0010	**	0.0010	**	0.0010	NA	NA	NA	100.0	**	0.0010	**	0.0010	NONPARAMETRIC	2,5
0669	4	**	0.0005		0.0005	+	0.0005	NA	NA	NA	100.0	**	0.0005		0.0005	NONPARAMETRIC	2,4
CALCIUM						MG/L											
0603	6		17.9000		21.0000	+	19.4000	19.4500	1.0330	0.0531	0.0		18.0310		20.8690	NORMAL	
0604	5		17.3000		21.0000		20.0000	19.4400	1.4293	0.0735	0.0		17.0448		21.8352	NORMAL	
0605	9		81.3000		162.0000		116.0000	119.3667	25.0875	0.2102	0.0		95.1488		143.5845	NORMAL	
0606	9		211.0000		428.0000		266.0000	282.5556	72.5674	0.2568	0.0		212.5038		352.6073	NORMAL	
0650	4		9.0000		10.6000	+	9.8400	9.8200	0.7167	0.0730	0.0		8.1928		11.4472	NORMAL	
0651	9		9.6100		11.5000		11.0000	10.7122	0.6583	0.0615	0.0		10.0768		11.3477	NORMAL	
0652	4		25.3000		29.6000	+	27.7000	27.5750	1.9414	0.0704	0.0		23.1670		31.9830	NORMAL	

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1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CALCIUM				MG/L								
0653	8	81.8000	251.0000	+ 178.0000	177.2250	58.2846	0.3289	0.0	115.4461	239.0039	NORMAL	
0654	8	32.9000	45.5000	+ 41.9500	40.9500	3.6473	0.0891	0.0	37.0840	44.8160	NORMAL	
0655	9	390.0000	543.0000	433.0000	448.1111	52.1163	0.1163	0.0	397.8015	498.4207	NORMAL	
0656	3	74.7000	116.0000	110.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	114.0000	167.0000	143.0000	140.8000	20.9093	0.1485	0.0	105.7620	175.8380	NORMAL	
0669	4	80.8000	110.0000	+ 83.3000	89.3500	13.8257	0.1547	0.0	57.9587	120.7413	NORMAL	
CHLORIDE				MG/L								
0603	6	11.0000	15.0000	+ 12.2500	12.4167	1.5052	0.1212	0.0	10.3489	14.4845	NORMAL	
0604	5	10.0000	15.0000	11.6000	11.9400	1.8810	0.1575	0.0	8.7881	15.0919	NORMAL	
0605	9	83.0000	259.0000	124.0000	151.4444	57.4415	0.3793	0.0	95.9942	206.8947	NORMAL	
0606	9	15.9000	25.0000	18.0000	18.6000	2.8156	0.1514	0.0	15.8820	21.3180	NORMAL	
0650	4	6.0000	9.0000	+ 7.1500	7.3250	1.5086	0.2060	0.0	3.8998	10.7502	NORMAL	
0651	9	4.0000	13.1000	12.8000	11.3667	2.9770	0.2619	0.0	8.4929	14.2405	NORMAL	
0652	4	14.0000	17.0000	+ 15.3000	15.4000	1.2302	0.0799	0.0	12.6069	18.1931	NORMAL	
0653	8	24.0000	42.0000	+ 34.5000	34.1250	5.7181	0.1676	0.0	28.0641	40.1859	NORMAL	
0654	8	0.5000	6.0000	+ 5.3500	4.5625	1.8677	0.4094	12.5	2.5828	6.5422	NORMAL	
0655	9	26.6000	38.0000	34.0000	33.7333	3.6932	0.1095	0.0	30.1681	37.2985	NORMAL	
0656	3	21.0000	25.0000	23.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	16.8000	20.0000	19.0000	18.6400	1.4792	0.0794	0.0	16.1613	21.1187	NORMAL	
0669	4	12.2000	17.0000	+ 15.5000	15.0500	2.0680	0.1374	0.0	10.3546	19.7454	NORMAL	
CHROMIUM				MG/L								
0603	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5
0604	5	** 0.0100	0.0200	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.0200	NONPARAMETRIC	2,5
0605	8	** 0.0100	0.0400	** 0.0100	NA	NA	NA	75.0	** 0.0100	0.0400	NONPARAMETRIC	2
0606	9	** 0.0100	0.0700	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.0700	NONPARAMETRIC	2
0650	3	** 0.0100	0.0900	0.0200	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0651	8	** 0.0100	0.0500	** 0.0100	NA	NA	NA	75.0	** 0.0100	0.0500	NONPARAMETRIC	2
0652	4	** 0.0100	0.0400	+ 0.0125	NA	NA	NA	50.0	** 0.0100	0.0400	NONPARAMETRIC	2,4
0653	7	** 0.0100	0.0800	** 0.0100	NA	NA	NA	71.4	** 0.0100	0.0800	NONPARAMETRIC	2
0654	7	** 0.0100	0.0700	** 0.0100	NA	NA	NA	71.4	** 0.0100	0.0700	NONPARAMETRIC	2

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TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CHROMIUM					MG/L							
0655	8	** 0.0100	0.0800	** 0.0100	NA	NA	NA	75.0	** 0.0100	0.0800	NONPARAMETRIC	2
0656	3	** 0.0100	0.0900	0.0300	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	5	** 0.0100	0.0800	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.0800	NONPARAMETRIC	2,5
0669	4	** 0.0100	0.0600	+ 0.0125	NA	NA	NA	50.0	** 0.0100	0.0600	NONPARAMETRIC	2,4
COBALT					MG/L							
0603	4	** 0.0300	0.0600	** 0.0300	NA	NA	NA	75.0	** 0.0300	0.0600	NONPARAMETRIC	2,4
0604	4	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	** 0.0300	** 0.0300	NONPARAMETRIC	2,4
0605	8	** 0.0300	0.0600	** 0.0300	NA	NA	NA	87.5	** 0.0300	0.0600	NONPARAMETRIC	2
0606	8	** 0.0300	0.1200	** 0.0300	NA	NA	NA	75.0	** 0.0300	0.1200	NONPARAMETRIC	2
0650	3	** 0.0500	** 0.0500	** 0.0500	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	7	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	** 0.0300	** 0.0300	NONPARAMETRIC	2
0652	3	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	6	** 0.0300	0.1100	** 0.0300	NA	NA	NA	66.7	** 0.0300	0.1100	NONPARAMETRIC	2,6
0654	7	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	** 0.0300	** 0.0300	NONPARAMETRIC	2
0655	7	** 0.0300	0.1300	** 0.0300	NA	NA	NA	85.7	** 0.0300	0.1300	NONPARAMETRIC	2
0656	3	** 0.0500	0.1000	0.0700	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	4	** 0.0300	** 0.0300	** 0.0300	NA	NA	NA	100.0	** 0.0300	** 0.0300	NONPARAMETRIC	2,4
0669	3	** 0.0500	0.0800	** 0.0500	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
COPPER					MG/L							
0603	4	** 0.0100	0.0100	+ 0.0100	NA	NA	NA	100.0	** 0.0100	0.0100	NONPARAMETRIC	2,4
0604	4	** 0.0100	0.0100	+ 0.0100	NA	NA	NA	100.0	** 0.0100	0.0100	NONPARAMETRIC	2,4
0605	7	** 0.0100	0.0100	0.0100	NA	NA	NA	100.0	** 0.0100	0.0100	NONPARAMETRIC	2
0606	8	** 0.0100	0.0300	+ 0.0150	NA	NA	NA	50.0	** 0.0100	0.0300	NONPARAMETRIC	2
0650	2	** 0.0200	** 0.0200	** 0.0200	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	6	** 0.0100	0.0200	+ 0.0100	NA	NA	NA	83.3	** 0.0100	0.0200	NONPARAMETRIC	2,6
0652	2	** 0.0100	0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	6	** 0.0100	0.0400	+ 0.0100	NA	NA	NA	83.3	** 0.0100	0.0400	NONPARAMETRIC	2,6
0654	6	** 0.0100	0.0100	+ 0.0100	NA	NA	NA	100.0	** 0.0100	0.0100	NONPARAMETRIC	2,6
0655	7	** 0.0100	0.0500	0.0100	NA	NA	NA	71.4	** 0.0100	0.0500	NONPARAMETRIC	2

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6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
COPPER					MG/L							
0656	3	** 0.0200	0.0400	0.0300	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	3	** 0.0100	0.0100	0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	3	** 0.0200	0.0400	** 0.0200	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
CYANIDE					MG/L							
0603	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0604	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0605	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
0606	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5
0650	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0652	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
0654	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0655	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
0656	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
DISSOLVED OXYGEN					MG/L							
0603	1	0.0000	0.0000	0.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0604	1	0.4000	0.4000	0.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0605	1	0.0000	0.0000	0.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0606	1	0.7000	0.7000	0.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	1	1.8000	1.8000	1.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0655	1	5.3000	5.3000	5.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	1	9.2000	9.2000	9.2000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
FLUORIDE					MG/L							
0603	4	0.1000	0.7000	+ 0.2000	0.3000	0.2708	0.9027	0.0	** 0.1000	0.9149	NORMAL	
0604	4	0.1000	0.5000	+ 0.2000	0.2500	0.1732	0.6928	0.0	** 0.1000	0.6433	NORMAL	

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TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
FLUORIDE					MG/L								
0605	7	0.2000	0.6000		0.3000	0.3286	0.1254	0.3815	0.0	0.1797	0.4775	NORMAL	
0606	8	0.3000	0.8000	+	0.5500	0.5375	0.1506	0.2802	0.0	0.3779	0.6971	NORMAL	
0650	2	0.4000	1.0000	+	0.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	6	** 0.1000	0.6000	+	0.2000	NA	NA	NA	16.7	** 0.1000	0.6000	NONPARAMETRIC	2,6
0652	2	0.1000	0.8000	+	0.4500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	6	** 0.1000	0.7000	+	0.2000	NA	NA	NA	16.7	** 0.1000	0.7000	NONPARAMETRIC	2,6
0654	6	** 0.1000	0.5000	+	0.2000	NA	NA	NA	16.7	** 0.1000	0.5000	NONPARAMETRIC	2,6
0655	7	** 0.1000	0.2000		0.1000	NA	NA	NA	28.6	** 0.1000	0.2000	NONPARAMETRIC	2
0656	3	** 0.1000	0.2000		0.2000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	3	** 0.1000	0.6000	**	0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0669	3	** 0.1000	0.3000		0.2000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
GROSS ALPHA					PCI/L								
0603	5	** 0.2000	5.9000		4.8000	NA	NA	NA	0.0	** 0.2000	5.9000	NONPARAMETRIC	9,5
0604	4	0.5000	5.0000	+	1.9000	2.3250	1.9449	0.8365	0.0	** 0.2000	6.7408	NORMAL	
0605	6	** 0.2000	38.0000	+	3.0000	NA	NA	NA	16.7	** 0.2000	38.0000	NONPARAMETRIC	2,6
0606	6	** 0.2000	30.0000	+	10.8500	NA	NA	NA	16.7	** 0.2000	30.0000	NONPARAMETRIC	2,6
0650	3	1.0000	3.0000		1.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	6	** 0.2000	17.0000	+	5.9000	NA	NA	NA	0.0	** 0.2000	17.0000	NONPARAMETRIC	9,6
0652	4	1.6000	6.8000	+	4.8500	4.5250	2.1562	0.4765	0.0	** 0.2000	9.4206	NORMAL	
0653	6	** 0.2000	112.0000	+	7.6500	NA	NA	NA	16.7	** 0.2000	112.0000	NONPARAMETRIC	2,6
0654	5	0.2000	3.0000		1.8000	1.6400	1.2198	0.7438	0.0	** 0.2000	3.6841	NORMAL	
0655	6	** 0.2000	120.0000	+	10.5000	NA	NA	NA	0.0	** 0.2000	120.0000	NONPARAMETRIC	9,6
0656	2	** 0.2000	7.0000	+	3.5500	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0662	4	8.5000	27.3000	+	26.5000	22.2000	9.1502	0.4122	0.0	1.4244	42.9756	NORMAL	
0669	3	1.2000	16.0000		14.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
GROSS BETA					PCI/L								
0603	5	2.2000	5.4000		4.2000	3.8800	1.2478	0.3216	0.0	1.7891	5.9709	NORMAL	
0604	4	1.7000	6.7000	+	2.3500	3.2750	2.3472	0.7167	0.0	** 0.5000	8.6042	NORMAL	
0605	6	** 0.5000	22.0000	+	5.3500	NA	NA	NA	0.0	** 0.5000	22.0000	NONPARAMETRIC	9,6

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1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS		MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
GROSS BETA					PCI/L									
0606	6	16.1000	42.0000	+	26.0000	26.1833	9.4953	0.3626	0.0		13.1390	39.2276	NORMAL	
0650	3	2.8000	6.4000		2.9000	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
0651	6	2.0000	8.0000	+	4.7000	5.0000	2.1090	0.4218	0.0		2.1027	7.8973	NORMAL	
0652	4	3.3000	11.0000	+	7.2000	7.1750	3.1479	0.4387	0.0	**	0.5000	14.3223	NORMAL	
0653	6	3.0000	60.8000	+	9.4000	9.2916	2.8614	NA	0.0		2.1921	39.3841	LOGNORMAL	7,8
0654	5	2.6000	7.2000		4.3000	4.5800	1.6544	0.3612	0.0		1.8077	7.3523	NORMAL	
0655	6	24.1000	80.0000	+	49.5000	49.6500	24.1583	0.4866	0.0		16.4624	82.8376	NORMAL	
0656	2	26.0000	35.0000	+	30.5000	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
0662	4	9.7000	13.8000	+	12.0000	11.8750	1.6800	0.1415	0.0		8.0605	15.6895	NORMAL	
0669	3	7.2000	13.0000		8.3000	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
IRON					MG/L									
0603	5	** 0.0300	0.1000	**	0.0300	NA	NA	NA	80.0	**	0.0300	0.1000	NONPARAMETRIC	2,5
0604	5	** 0.0300	0.0900	**	0.0300	NA	NA	NA	80.0	**	0.0300	0.0900	NONPARAMETRIC	2,5
0605	8	** 0.0300	0.2200	+	0.1300	0.1244	0.0658	0.5287	12.5		0.0547	0.1941	NORMAL	
0606	9	** 0.0300	0.1100		0.0600	NA	NA	NA	33.3	**	0.0300	0.1100	NONPARAMETRIC	2
0650	3	** 0.0300	0.2100		0.0400	NA	NA	NA	33.3		NA	NA	UNKNOWN	1
0651	8	** 0.0300	0.0600	**	0.0300	NA	NA	NA	87.5	**	0.0300	0.0600	NONPARAMETRIC	2
0652	4	** 0.0300	0.0600	**	0.0300	NA	NA	NA	75.0	**	0.0300	0.0600	NONPARAMETRIC	2,4
0653	7	** 0.0300	3.5000	**	0.0300	NA	NA	NA	57.1	**	0.0300	3.5000	NONPARAMETRIC	2
0654	7	** 0.0300	0.2000	**	0.0300	NA	NA	NA	57.1	**	0.0300	0.2000	NONPARAMETRIC	2
0655	8	** 0.0300	0.0900	+	0.0750	NA	NA	NA	37.5	**	0.0300	0.0900	NONPARAMETRIC	2
0656	3	** 0.0300	0.0700		0.0400	NA	NA	NA	33.3		NA	NA	UNKNOWN	1
0662	5	** 0.0300	0.0600		0.0300	NA	NA	NA	40.0	**	0.0300	0.0600	NONPARAMETRIC	2,5
0669	4	** 0.0300	0.0400	**	0.0300	NA	NA	NA	75.0	**	0.0300	0.0400	NONPARAMETRIC	2,4
LEAD					MG/L									
0603	4	** 0.0050	0.0050	+	0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,4
0604	4	** 0.0050	0.0050	+	0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,4
0605	7	** 0.0050	0.0050		0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
LEAD					MG/L							
0606	7	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2
0650	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	7	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2
0652	3	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	6	** 0.0050	0.0050	+ 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,6
0654	7	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2
0655	6	** 0.0050	0.0100	+ 0.0050	NA	NA	NA	83.3	** 0.0050	0.0100	NONPARAMETRIC	2,6
0656	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	4	** 0.0050	0.0050	+ 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
0669	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
LEAD-210					PCI/L							
0603	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0604	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0605	2	** 1.3000	** 1.3000	** 1.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0606	3	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0650	1	1.8000	1.8000	1.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	1	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0652	1	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0654	1	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0655	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0656	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	1	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0669	2	** 1.5000	1.6000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
MAGNESIUM					MG/L							
0603	6	13.0000	14.4000	+ 13.5000	13.6167	0.5672	0.0417	0.0	12.8375	14.3958	NORMAL	
0604	5	11.1000	12.2000	11.8000	11.7600	0.4037	0.0343	0.0	11.0835	12.4365	NORMAL	
0605	9	75.2000	175.0000	108.0000	117.0667	33.4168	0.2855	0.0	84.8083	149.3250	NORMAL	
0606	9	113.0000	160.0000	132.0000	132.8889	17.0913	0.1286	0.0	116.3901	149.3877	NORMAL	
0650	4	4.5600	6.5100	+ 6.0900	5.8125	0.8657	0.1489	0.0	3.8469	7.7781	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 - MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL					
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
MAGNESIUM				MG/L								
0651	9	4.9000	5.6100	5.3200	5.2489	0.2555	0.0487	0.0	5.0023	5.4955	NORMAL	
0652	4	12.3000	14.0000	+ 12.4500	12.8000	0.8042	0.0628	0.0	10.9742	14.6258	NORMAL	
0653	8	69.0000	200.0000	+ 146.5000	139.8250	47.3210	0.3384	0.0	89.6670	189.9830	NORMAL	
0654	8	15.9000	20.5000	+ 18.3000	18.1375	1.4172	0.0781	0.0	16.6354	19.6396	NORMAL	
0655	9	295.0000	407.0000	319.0000	333.4444	40.5404	0.1216	0.0	294.3094	372.5795	NORMAL	
0656	3	65.7000	87.1000	83.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	84.6000	105.0000	96.2000	94.5800	8.9990	0.0951	0.0	79.5003	109.6597	NORMAL	
0669	4	62.2000	78.0000	+ 72.0000	71.0500	6.5937	0.0928	0.0	56.0790	86.0210	NORMAL	
MANGANESE				MG/L								
0603	5	** 0.0100	0.0900	0.0100	NA	NA	NA	40.0	** 0.0100	0.0900	NONPARAMETRIC	2,5
0604	5	** 0.0100	0.0300	0.0100	NA	NA	NA	40.0	** 0.0100	0.0300	NONPARAMETRIC	2,5
0605	8	0.0200	0.0600	+ 0.0450	0.0425	0.0149	0.3501	0.0	0.0267	0.0583	NORMAL	
0606	9	0.0900	0.5800	0.1400	0.1989	0.1502	0.7552	0.0	0.0539	0.3439	NORMAL	
0650	3	** 0.0100	0.0500	0.0100	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0651	8	0.0200	0.0700	+ 0.0300	0.0325	0.0158	0.4865	0.0	0.0157	0.0493	NORMAL	
0652	4	** 0.0100	0.0300	** 0.0100	NA	NA	NA	50.0	** 0.0100	0.0300	NONPARAMETRIC	2,4
0653	7	** 0.0100	0.0500	** 0.0100	NA	NA	NA	57.1	** 0.0100	0.0500	NONPARAMETRIC	2
0654	7	0.0400	0.1000	0.0400	0.0514	0.0219	0.4264	0.0	0.0254	0.0775	NORMAL	
0655	8	0.0400	0.1900	+ 0.0800	0.0987	0.0464	0.4701	0.0	0.0495	0.1480	NORMAL	
0656	3	0.0100	0.0500	0.0200	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	** 0.0100	0.0700	** 0.0100	NA	NA	NA	60.0	** 0.0100	0.0700	NONPARAMETRIC	2,5
0669	4	** 0.0100	0.0400	+ 0.0125	NA	NA	NA	50.0	** 0.0100	0.0400	NONPARAMETRIC	2,4
MERCURY				MG/L								
0603	3	** 0.0002	0.0002	** 0.0002	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0604	3	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0605	5	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,5
0606	6	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,6
0650	2	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	4	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,4

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
MERCURY					MG/L							
0652	1	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	4	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,4
0654	4	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,4
0655	5	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,5
0656	3	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	2	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	3	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
MOLYBDENUM					MG/L							
0603	6	** 0.0100	0.1700	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.1700	NONPARAMETRIC	2,6
0604	5	** 0.0100	0.1900	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.1900	NONPARAMETRIC	2,5
0605	9	** 0.0100	0.2700	0.0300	NA	NA	NA	22.2	** 0.0100	0.2700	NONPARAMETRIC	2
0606	9	** 0.0100	0.1300	** 0.0100	NA	NA	NA	55.6	** 0.0100	0.1300	NONPARAMETRIC	2
0650	4	** 0.0100	0.1900	+ 0.0600	NA	NA	NA	25.0	** 0.0100	0.1900	NONPARAMETRIC	2,4
0651	9	** 0.0100	0.1000	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.1000	NONPARAMETRIC	2
0652	4	** 0.0100	0.3100	+ 0.0925	NA	NA	NA	50.0	** 0.0100	0.3100	NONPARAMETRIC	2,4
0653	8	** 0.0100	0.3500	+ 0.0175	NA	NA	NA	50.0	** 0.0100	0.3500	NONPARAMETRIC	2
0654	8	** 0.0100	0.1900	** 0.0100	NA	NA	NA	62.5	** 0.0100	0.1900	NONPARAMETRIC	2
0655	9	** 0.0100	0.2400	** 0.0100	NA	NA	NA	55.6	** 0.0100	0.2400	NONPARAMETRIC	2
0656	3	** 0.0100	0.3400	0.1800	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	5	** 0.0100	0.1400	** 0.0100	NA	NA	NA	60.0	** 0.0100	0.1400	NONPARAMETRIC	2,5
0669	4	** 0.0100	0.1600	+ 0.0575	NA	NA	NA	50.0	** 0.0100	0.1600	NONPARAMETRIC	2,4
NET GROSS ALPHA ***					PCI/L							
0603	5	-0.7600	4.3000	2.8800	NA	NA	NA	0.0	-0.7600	4.3000	NONPARAMETRIC	9,5
0604	4	-0.8700	4.6600	+ -0.4650	NA	NA	NA	0.0	-0.8700	4.6600	NONPARAMETRIC	9,4
0605	6	-8.9200	35.5300	+ -1.9750	NA	NA	NA	0.0	-8.9200	35.5300	NONPARAMETRIC	9,6
0606	6	-15.6800	10.6500	+ 1.6900	NA	NA	NA	0.0	-15.6800	10.6500	NONPARAMETRIC	9,6
0650	3	-0.7800	1.4200	-0.2500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL							
LOC.	SAMP	MINIMUM		MAXIMUM		MEDIAN		MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM		MAXIMUM *		DISTRIBUTION TYPE	FOOT NOTE
NET GROSS ALPHA ***						PCI/L											
0651	6		-0.9600		15.7000	+	5.3850	NA	NA	NA	0.0		-0.9600		15.7000	NONPARAMETRIC	9,6
0652	4		-1.1400		6.4600	+	1.6250	NA	NA	NA	0.0		-1.1400		6.4600	NONPARAMETRIC	9,4
0653	6		-4.0200		105.1400	+	0.0350	NA	NA	NA	0.0		-4.0200		105.1400	NONPARAMETRIC	9,6
0654	5		-0.3500		2.3800		0.2700	NA	NA	NA	0.0		-0.3500		2.3800	NONPARAMETRIC	9,5
0655	6		-16.4600		97.6400	+	-7.3650	NA	NA	NA	0.0		-16.4600		97.6400	NONPARAMETRIC	9,6
0656	2		-6.2800		-1.0300	+	-3.6550	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0662	4		-0.4200		15.6400	+	9.1750	NA	NA	NA	0.0		-0.4200		15.6400	NONPARAMETRIC	9,4
0669	3		-4.9700		5.8500		3.3700	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
NICKEL						MG/L											
0603	4	**	0.0400	**	0.0400	**	0.0400	NA	NA	NA	100.0	**	0.0400	**	0.0400	NONPARAMETRIC	2,4
0604	4	**	0.0400	**	0.0400	**	0.0400	NA	NA	NA	100.0	**	0.0400	**	0.0400	NONPARAMETRIC	2,4
0605	8	**	0.0400		0.0700	**	0.0400	NA	NA	NA	75.0	**	0.0400		0.0700	NONPARAMETRIC	2
0606	8	**	0.0400		0.0700	**	0.0400	NA	NA	NA	75.0	**	0.0400		0.0700	NONPARAMETRIC	2
0650	3	**	0.0400		0.0600		0.0400	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
0651	7	**	0.0400		0.0700	**	0.0400	NA	NA	NA	71.4	**	0.0400		0.0700	NONPARAMETRIC	2
0652	3	**	0.0400		0.0500		0.0400	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
0653	6	**	0.0400		0.1000	**	0.0400	NA	NA	NA	83.3	**	0.0400		0.1000	NONPARAMETRIC	2,6
0654	7	**	0.0400		0.0600	**	0.0400	NA	NA	NA	71.4	**	0.0400		0.0600	NONPARAMETRIC	2
0655	7	**	0.0400		0.1200	**	0.0400	NA	NA	NA	71.4	**	0.0400		0.1200	NONPARAMETRIC	2
0656	3	**	0.0400		0.0800	**	0.0400	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
0662	4	**	0.0400		0.0900	**	0.0400	NA	NA	NA	75.0	**	0.0400		0.0900	NONPARAMETRIC	2,4
0669	3	**	0.0400		0.0700		0.0600	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
NITRATE						MG/L											
0603	6		1.0000		10.6000	+	3.0000	4.0050	3.4855	0.8703	0.0	**	1.0000		8.7933	NORMAL	
0604	5	**	1.0000		5.3000		2.3000	NA	NA	NA	40.0	**	1.0000		5.3000	NONPARAMETRIC	2,5
0605	9	**	0.1000		4.4300		1.0000	NA	NA	NA	33.3	**	0.1000		4.4300	NONPARAMETRIC	2
0606	9		45.0000		1200.0000		1080.0000	993.5556	364.1250	0.3665	0.0		642.0535		1345.0576	NORMAL	

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NITRATE					MG/L							
0650	4	0.5000	5.3000	+ 0.5000	NA	NA	NA	50.0	0.5000	5.3000	NONPARAMETRIC	2,4
0651	9	** 1.0000	8.0000	1.6000	NA	NA	NA	44.4	** 1.0000	8.0000	NONPARAMETRIC	2
0652	4	5.0000	24.0000	+ 20.8500	17.6750	8.6013	0.4866	0.0	** 1.0000	37.2043	NORMAL	
0653	8	5.0000	64.6000	+ 45.0000	37.9375	20.6326	0.5439	0.0	16.0679	59.8071	NORMAL	
0654	8	** 0.1000	4.4000	+ 0.5000	NA	NA	NA	50.0	** 0.1000	4.4000	NONPARAMETRIC	2
0655	9	380.0000	1140.0000	656.0000	712.5556	234.3332	0.3289	0.0	486.3459	938.7652	NORMAL	
0656	3	360.0000	520.0000	460.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	11.0000	98.0000	72.2000	57.8600	39.8765	0.6892	0.0	** 1.0000	124.6815	NORMAL	
0669	4	10.0000	43.0000	+ 26.7500	26.6250	14.5566	0.5467	0.0	** 1.0000	59.6759	NORMAL	
NITRITE					MG/L							
0603	2	** 0.1000	0.3300	+ 0.1900	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0604	2	** 0.1000	0.3300	+ 0.1900	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0605	2	** 0.1000	0.3300	+ 0.1900	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0606	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0650	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0652	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0654	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0655	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0656	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
NITRITE AND NITRATE					MG/L							
0603	2	0.9000	1.1000	+ 1.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0604	2	0.5300	1.1000	+ 0.8150	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0605	3	0.6100	1.1000	1.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0606	3	215.0000	1080.0000	240.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	1	0.9700	0.9700	0.9700	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0652	1	4.8700	4.8700	4.8700	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	2	12.7000	648.0000	+ 330.3500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS								
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NITRITE AND NITRATE					MG/L							
0654	1	0.7900	0.7900	0.7900	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0655	2	108.0000	655.0000	+ 381.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	1	16.3000	16.3000	16.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
PH					SU							
0603	7	7.6200	8.1200	7.8300	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0604	6	7.8100	8.3100	+ 8.1490	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0605	10	7.5500	7.9000	+ 7.6899	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0606	11	6.8600	7.3300	7.1500	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0650	4	8.1600	9.6800	+ 8.4943	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0651	10	7.9300	8.5900	+ 8.2350	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0652	5	7.8600	8.0600	7.9400	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0653	10	7.4700	7.8900	+ 7.5550	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0654	9	7.5400	7.8900	7.7400	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0655	10	7.0400	7.5000	+ 7.1750	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0656	4	7.4400	7.6800	+ 7.5800	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0662	6	6.7600	7.2400	+ 7.0207	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0669	4	7.4200	7.6600	+ 7.5682	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE					MG/L							
0603	3	0.1000	0.6000	0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0604	3	0.1000	0.6000	0.1000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0605	5	0.2000	0.6000	0.4000	0.3800	0.1483	0.3903	0.0	0.1315	0.6285	NORMAL	
0606	6	** 0.1000	0.6000	+ 0.2500	NA	NA	NA	16.7	** 0.1000	0.6000	NONPARAMETRIC	2,6
0650	2	0.4000	0.6000	+ 0.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	4	0.2000	0.6000	+ 0.3500	0.3750	0.1708	0.4554	0.0	** 0.1000	0.7628	NORMAL	
0652	1	0.5000	0.5000	0.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	4	** 0.1000	0.6000	+ 0.3500	NA	NA	NA	25.0	** 0.1000	0.6000	NONPARAMETRIC	2,4
0654	4	** 0.1000	0.6000	+ 0.2000	NA	NA	NA	25.0	** 0.1000	0.6000	NONPARAMETRIC	2,4
0655	5	** 0.1000	1.3000	0.4000	NA	NA	NA	20.0	** 0.1000	1.3000	NONPARAMETRIC	2,5
0656	3	** 0.1000	0.6000	** 0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN		MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
PHOSPHATE					MG/L								
0662	2	** 0.1000	0.1000	** 0.1000		NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0669	3	** 0.1000	0.3000	** 0.1000		NA	NA	NA	66.7	NA	NA	UNKNOWN	1
POLONIUM-210					PCI/L								
0603	2	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0604	2	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0605	2	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0606	3	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0650	1	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	1	1.9000	1.9000	1.9000		NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0652	1	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	2	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0654	1	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0655	2	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0656	2	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0662	1	** 0.8000	** 0.8000	** 0.8000		NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0669	2	** 1.0000	** 1.0000	** 1.0000		NA	NA	NA	100.0	NA	NA	UNKNOWN	1
POTASSIUM					MG/L								
0603	6	2.3000	2.6000	+ 2.5450		2.4983	0.1227	0.0491	0.0	2.3298	2.6669	NORMAL	
0604	5	1.4000	2.0600	1.9000		1.8220	0.2571	0.1411	0.0	1.3911	2.2529	NORMAL	
0605	9	2.7500	3.8000	3.3000		3.2567	0.3214	0.0987	0.0	2.9464	3.5670	NORMAL	
0606	9	11.0000	16.0000	12.9000		13.0444	1.3740	0.1053	0.0	11.7181	14.3708	NORMAL	
0650	4	1.0000	2.4400	+ 1.5050		1.6125	0.7196	0.4463	0.0	** 0.0100	3.2464	NORMAL	
0651	9	1.7600	2.4700	2.1000		2.0311	0.2189	0.1078	0.0	1.8198	2.2425	NORMAL	
0652	4	2.8000	3.1300	+ 3.0900		3.0275	0.1528	0.0505	0.0	2.6805	3.3745	NORMAL	
0653	8	3.2400	4.1900	+ 3.7100		3.7288	0.3484	0.0934	0.0	3.3594	4.0981	NORMAL	
0654	8	2.2000	3.0000	+ 2.5000		2.5225	0.2258	0.0895	0.0	2.2831	2.7619	NORMAL	
0655	9	25.0000	43.4000	32.1000		32.8667	6.9342	0.2110	0.0	26.1729	39.5604	NORMAL	
0656	3	18.3000	29.0000	27.7000		NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	2.8300	4.2500	3.1000		3.4440	0.6514	0.1891	0.0	2.3524	4.5356	NORMAL	
0669	4	2.2000	3.4100	+ 2.7350		2.7700	0.5206	0.1879	0.0	1.5880	3.9520	NORMAL	
RADIUM-226					PCI/L								
0603	5	** 0.5000	1.7000	0.6000		0.9000	0.6964	0.7738	0.0	** 0.5000	2.0670	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
RADIUM-226					PCI/L							
0604	5	** 0.3000	** 0.3000	** 0.3000	NA	NA	NA	0.0	** 0.3000	** 0.3000	NONPARAMETRIC	9,5
0605	7	** 0.1000	0.3000	0.1000	NA	NA	NA	14.3	** 0.1000	0.3000	NONPARAMETRIC	9
0606	9	** 0.3000	1.0000	0.3000	0.3444	0.2789	0.8097	11.1	** 0.3000	0.6137	NORMAL	
0650	2	** 0.3000	0.7000	+ 0.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	7	** 0.1000	0.1000	** 0.1000	NA	NA	NA	57.1	** 0.1000	0.1000	NONPARAMETRIC	2
0652	3	** 0.3000	** 0.3000	** 0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	7	** 0.3000	0.5000	0.3000	NA	NA	NA	0.0	** 0.3000	0.5000	NONPARAMETRIC	9
0654	6	** 0.3000	0.7000	+ 0.3000	0.3333	0.2066	0.6197	0.0	** 0.3000	0.6171	NORMAL	
0655	8	** 0.1000	0.4000	+ 0.1000	0.1563	0.1237	0.7920	12.5	** 0.1000	0.2874	NORMAL	
0656	3	** 0.3000	0.5000	** 0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	4	** 0.4000	** 0.4000	** 0.4000	NA	NA	NA	0.0	** 0.4000	** 0.4000	NONPARAMETRIC	9,4
0669	4	** 0.2000	0.5000	** 0.2000	NA	NA	NA	0.0	** 0.2000	0.5000	NONPARAMETRIC	9,4
RADIUM-226 + RADIUM-228					PCI/L							
0603	5	0.3000	2.6000	1.9000	1.5600	0.9711	0.6225	0.0	-0.0673	3.1873	NORMAL	
0604	5	0.2000	0.7000	0.6000	0.4600	0.2408	0.5235	0.0	0.0564	0.8636	NORMAL	
0605	7	0.0000	1.5000	0.5500	NA	NA	NA	0.0	0.0000	1.5000	NONPARAMETRIC	9
0606	9	0.6000	15.5000	1.0000	1.5129	2.7071	NA	0.0	0.5785	3.9566	LOGNORMAL	7,8
0650	2	0.6000	0.9000	+ 0.7500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	7	0.3500	2.1000	0.5500	0.7714	0.6116	0.7928	0.0	0.0449	1.4980	NORMAL	
0652	3	0.6000	1.3000	0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	7	0.6000	6.1000	1.6000	2.0286	1.9483	0.9604	0.0	-0.2858	4.3430	NORMAL	
0654	6	0.5000	2.1000	+ 0.8000	1.0500	0.5753	0.5479	0.0	0.2596	1.8404	NORMAL	
0655	8	0.3000	2.7000	+ 0.7000	0.9938	0.8020	0.8070	0.0	0.1437	1.8438	NORMAL	
0656	3	0.3000	1.1000	0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	4	0.3000	3.0000	+ 0.6500	0.7545	2.8042	NA	0.0	0.0726	7.8414	LOGNORMAL	7,8
0669	4	0.6000	1.6000	+ 0.8500	0.9750	0.4500	0.4615	0.0	-0.0467	1.9967	NORMAL	
RADIUM-228					PCI/L							
0603	5	** 1.0000	2.0000	** 1.0000	NA	NA	NA	40.0	** 1.0000	2.0000	NONPARAMETRIC	2,5

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
RADIUM-228				PCI/L								
0604	5	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	60.0	** 1.0000	** 1.0000	NONPARAMETRIC	2,5
0605	7	** 1.0000	1.4000	** 1.0000	NA	NA	NA	42.9	** 1.0000	1.4000	NONPARAMETRIC	2
0606	9	** 1.0000	15.2000	** 1.0000	NA	NA	NA	22.2	** 1.0000	15.2000	NONPARAMETRIC	2
0650	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0651	7	** 1.0000	2.0000	** 1.0000	NA	NA	NA	42.9	** 1.0000	2.0000	NONPARAMETRIC	2
0652	3	** 1.0000	1.3000	** 1.0000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0653	7	** 1.0000	5.6000	1.2000	1.0909	2.9215	NA	14.3	** 1.0000	3.8984	LOGNORMAL	7,8
0654	6	** 1.0000	1.4000	** 1.0000	NA	NA	NA	33.3	** 1.0000	1.4000	NONPARAMETRIC	2,6
0655	8	** 0.9000	2.6000	** 0.9000	NA	NA	NA	25.0	** 0.9000	2.6000	NONPARAMETRIC	2
0656	3	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	4	** 1.0000	2.9000	** 1.0000	** 1.0000	4.1396	NA	0.0	** 1.0000	12.5015	LOGNORMAL	7,8
0669	4	** 1.0000	1.6000	** 1.0000	NA	NA	NA	75.0	** 1.0000	1.6000	NONPARAMETRIC	2,4
REDOX POTENTIAL				mVOLTS								
0603	1	437.4000	437.4000	437.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0604	1	453.1000	453.1000	453.1000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0605	1	441.5000	441.5000	441.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0606	1	481.7000	481.7000	481.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0652	1	455.9000	455.9000	455.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	1	443.1000	443.1000	443.1000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0654	1	111.7000	111.7000	111.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0655	1	457.9000	457.9000	457.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0656	1	423.7000	423.7000	423.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	1	431.0000	431.0000	431.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SELENIUM				MG/L								
0603	5	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2,5
0604	4	** 0.0050	0.0070	** 0.0050	NA	NA	NA	75.0	** 0.0050	0.0070	NONPARAMETRIC	2,4
0605	8	** 0.0050	0.0160	** 0.0050	NA	NA	NA	75.0	** 0.0050	0.0160	NONPARAMETRIC	2
0606	8	** 0.0050	0.0150	** 0.0050	NA	NA	NA	87.5	** 0.0050	0.0150	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SELENIUM					MG/L							
0650	4	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2,4
0651	8	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2
0652	3	** 0.0050	0.0150	** 0.0050	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0653	7	** 0.0050	0.0160	** 0.0050	NA	NA	NA	71.4	** 0.0050	0.0160	NONPARAMETRIC	2
0654	7	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2
0655	8	** 0.0050	0.0100	** 0.0050	NA	NA	NA	75.0	** 0.0050	0.0100	NONPARAMETRIC	2
0656	3	** 0.0050	0.0110	** 0.0050	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0662	4	** 0.0050	0.0070	** 0.0050	NA	NA	NA	50.0	** 0.0050	0.0070	NONPARAMETRIC	2,4
0669	4	** 0.0050	0.0090	** 0.0050	NA	NA	NA	50.0	** 0.0050	0.0090	NONPARAMETRIC	2,4
SILICA - SIO2					MG/L							
0603	4	11.0000	12.5000	+ 12.0000	11.8750	0.6292	0.0530	0.0	10.4465	13.3035	NORMAL	
0604	4	11.0000	13.2000	+ 12.5000	12.3000	1.0132	0.0824	0.0	9.9994	14.6006	NORMAL	
0605	7	0.2800	33.0000	26.0000	24.1114	10.9225	0.4530	0.0	11.1362	37.0867	NORMAL	
0606	8	10.0000	23.0000	+ 21.0000	19.8125	4.1052	0.2072	0.0	15.4612	24.1638	NORMAL	
0650	2	12.0000	13.0000	+ 12.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	6	9.0000	11.3000	+ 11.0000	10.7500	0.8666	0.0806	0.0	9.5595	11.9405	NORMAL	
0652	2	9.0000	15.8000	+ 12.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	6	5.0000	15.8000	+ 14.5000	12.4833	4.2107	0.3373	0.0	6.6989	18.2678	NORMAL	
0654	6	10.0000	13.6000	+ 13.0000	12.6000	1.2961	0.1029	0.0	10.8194	14.3806	NORMAL	
0655	7	7.0000	16.0000	15.6000	14.0429	3.2259	0.2297	0.0	10.2107	17.8750	NORMAL	
0656	3	5.0000	13.0000	11.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	3	19.0000	32.0000	20.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0669	3	5.0000	15.0000	11.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SILVER					MG/L							
0603	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
0604	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4
0605	7	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
0606	8	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
0650	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SILVER				MG/L								
0652	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6
0654	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6
0655	7	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2
0656	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
SODIUM				MG/L								
0603	6	94.0000	112.0000	+ 99.7500	102.0833	6.6213	0.0649	0.0	92.9873	111.1794	NORMAL	
0604	5	96.1000	122.0000	110.0000	107.6000	10.7100	0.0995	0.0	89.6531	125.5469	NORMAL	
0605	9	257.0000	625.0000	350.0000	422.8889	154.3668	0.3650	0.0	273.8735	571.9043	NORMAL	
0606	9	95.0000	200.0000	102.0000	115.3444	34.6043	0.3000	0.0	81.9398	148.7491	NORMAL	
0650	4	89.9000	96.4000	+ 92.4000	92.7750	2.8617	0.0308	0.0	86.2776	99.2724	NORMAL	
0651	9	121.0000	143.0000	128.0000	128.3333	6.4614	0.0503	0.0	122.0959	134.5708	NORMAL	
0652	4	68.7000	85.0000	+ 72.6500	74.7500	7.0883	0.0948	0.0	58.6561	90.8439	NORMAL	
0653	8	210.0000	267.0000	+ 229.0000	233.1250	20.5735	0.0883	0.0	211.3181	254.9319	NORMAL	
0654	8	15.4000	32.3000	+ 23.1500	23.0875	4.6329	0.2007	0.0	18.1768	27.9982	NORMAL	
0655	9	149.0000	240.0000	177.0000	185.1111	31.1667	0.1684	0.0	155.0249	215.1973	NORMAL	
0656	3	148.0000	260.0000	168.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	33.0000	75.0000	35.2000	48.3600	19.5547	0.4044	0.0	15.5919	81.1281	NORMAL	
0669	4	44.0000	77.4000	+ 53.1500	56.9250	14.6222	0.2569	0.0	23.7253	90.1247	NORMAL	
SPECIFIC CONDUCTANCE				UMHO/CM								
0603	7	415.0000	650.0000	500.0000	513.0000	71.4260	0.1392	0.0	428.1501	597.8499	NORMAL	
0604	6	385.0000	632.0000	+ 512.0000	511.8333	94.9177	0.1854	0.0	381.4396	642.2270	NORMAL	
0605	10	1350.0000	3950.0000	+ 2225.0000	2481.0000	1067.7333	0.4304	0.0	1528.4980	3433.5020	NORMAL	
0606	11	2970.0000	4390.0000	3750.0000	3815.4545	448.6282	0.1176	0.0	3441.5780	4189.3311	NORMAL	
0650	4	340.0000	420.0000	+ 360.0000	370.0000	34.6410	0.0936	0.0	291.3476	448.6524	NORMAL	
0651	10	260.0000	655.0000	+ 500.0000	500.2000	110.0048	0.2199	0.0	402.0670	598.3330	NORMAL	
0652	5	440.0000	581.0000	466.0000	489.4000	55.5770	0.1136	0.0	396.2691	582.5309	NORMAL	
0653	10	700.0000	2890.0000	+ 2000.0000	2001.0000	695.5805	0.3476	0.0	1380.4876	2621.5124	NORMAL	
0654	9	298.0000	430.0000	330.0000	343.4444	49.3663	0.1437	0.0	295.7895	391.0993	NORMAL	

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SPECIFIC CONDUCTANCE				UMHO/CM								
0655	10	3990.0000	5300.0000	+ 4600.0000	4619.0000	447.7958	0.0969	0.0	4219.5310	5018.4690	NORMAL	
0656	4	1650.0000	2100.0000	+ 1900.0000	1887.5000	246.2214	0.1304	0.0	1328.4542	2446.5458	NORMAL	
0662	6	920.0000	1450.0000	+ 1125.0000	1149.5000	172.8858	0.1504	0.0	911.9972	1387.0028	NORMAL	
0669	4	685.0000	950.0000	+ 830.0000	823.7500	122.5680	0.1488	0.0	545.4593	1102.0407	NORMAL	
SPECIFIC CONDUCTANCE, IN-SITU				UMHO/CM								
0603	1	470.0000	470.0000	470.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
STRONTIUM				MG/L								
0603	4	0.0500	0.2300	+ 0.1350	NA	NA	NA	50.0	0.0500	0.2300	NONPARAMETRIC	2,4
0604	4	0.0500	0.1800	+ 0.1100	NA	NA	NA	50.0	0.0500	0.1800	NONPARAMETRIC	2,4
0605	6	0.0500	2.3000	+ 1.3200	NA	NA	NA	33.3	0.0500	2.3000	NONPARAMETRIC	2,6
0606	7	0.0500	2.2000	1.7000	NA	NA	NA	28.6	0.0500	2.2000	NONPARAMETRIC	2
0650	2	** 0.1000	0.1000	** 0.1000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0651	6	0.0500	0.2600	+ 0.2200	NA	NA	NA	16.7	0.0500	0.2600	NONPARAMETRIC	2,6
0652	4	0.4000	0.5500	+ 0.4450	0.4600	0.0735	0.1597	0.0	0.2932	0.6268	NORMAL	
0653	5	0.9000	1.9700	1.8000	1.5640	0.4855	0.3104	0.0	0.7504	2.3776	NORMAL	
0654	5	0.3000	0.4000	0.3900	0.3580	0.0531	0.1483	0.0	0.2690	0.4470	NORMAL	
0655	6	2.5400	4.1000	+ 2.9900	3.1000	0.5576	0.1799	0.0	2.3340	3.8660	NORMAL	
0656	2	0.9000	1.0000	+ 0.9500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	4	0.0500	1.1000	+ 0.9600	NA	NA	NA	25.0	0.0500	1.1000	NONPARAMETRIC	2,4
0669	3	0.5800	0.8000	0.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SULFATE				MG/L								
0603	6	101.0000	151.0000	+ 116.0000	118.8333	16.8572	0.1419	0.0	95.6756	141.9911	NORMAL	
0604	5	95.0000	158.0000	116.0000	120.6000	22.9630	0.1904	0.0	82.1207	159.0793	NORMAL	
0605	9	800.0000	1770.0000	1080.0000	1247.3333	376.4758	0.3018	0.0	883.9087	1610.7579	NORMAL	
0606	9	961.0000	1550.0000	1230.0000	1242.5444	215.5187	0.1734	0.0	1034.4971	1450.5918	NORMAL	
0650	4	25.5000	47.7000	+ 29.5000	33.0500	10.0221	0.3032	0.0	10.2947	55.8053	NORMAL	
0651	9	108.0000	165.0000	112.0000	119.7778	17.9846	0.1501	0.0	102.4167	137.1389	NORMAL	
0652	4	56.8000	85.0000	+ 63.5000	67.2000	12.3407	0.1836	0.0	39.1804	95.2196	NORMAL	

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SULFATE				MG/L								
0653	8	744.0000	1690.0000	+ 1285.0000	1253.1250	329.1502	0.2627	0.0	904.2413	1602.0087	NORMAL	
0654	8	27.0000	53.9000	+ 40.0000	39.0750	7.7621	0.1986	0.0	30.8475	47.3025	NORMAL	
0655	9	2370.0000	3540.0000	2770.0000	2883.3333	332.7912	0.1154	0.0	2562.0789	3204.5878	NORMAL	
0656	3	571.0000	845.0000	780.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	329.0000	418.0000	356.0000	368.4000	40.4636	0.1098	0.0	300.5948	436.2052	NORMAL	
0669	4	266.0000	460.0000	+ 391.0000	377.0000	83.5743	0.2217	0.0	187.2445	566.7555	NORMAL	
SULFIDE				MG/L								
0603	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0604	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0605	5	** 0.1000	0.4000	** 0.1000	NA	NA	NA	80.0	** 0.1000	0.4000	NONPARAMETRIC	2,5
0606	6	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2,6
0650	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0652	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	5	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2,5
0654	3	** 0.1000	0.4000	** 0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0655	5	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2,5
0656	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
TEMPERATURE				C - DEGREE								
0603	7	12.0000	17.0000	15.4000	15.0571	1.4998	0.0996	0.0	13.2754	16.8389	NORMAL	
0604	6	14.0000	16.5000	+ 15.0500	15.1167	0.9411	0.0623	0.0	13.8238	16.4095	NORMAL	
0605	10	12.5000	17.5000	+ 15.5000	15.0300	1.8000	0.1198	0.0	13.4242	16.6358	NORMAL	
0606	11	8.3000	22.0000	16.0000	15.8636	3.9108	0.2465	0.0	12.6044	19.1228	NORMAL	
0650	4	16.5000	21.0000	+ 17.5000	18.1250	2.0156	0.1112	0.0	13.5487	22.7013	NORMAL	
0651	10	14.1000	17.0000	+ 15.3000	15.4800	1.0315	0.0666	0.0	14.5598	16.4002	NORMAL	
0652	5	14.5000	16.0000	15.2000	15.2600	0.7266	0.0476	0.0	14.0424	16.4776	NORMAL	
0653	10	14.9000	17.5000	+ 16.0000	16.3000	0.7616	0.0467	0.0	15.6206	16.9794	NORMAL	
0654	9	14.0000	17.0000	15.7000	15.6111	0.8418	0.0539	0.0	14.7985	16.4237	NORMAL	

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
TEMPERATURE					C - DEGREE							
0655	10	14.0000	18.0000	+ 16.1000	16.2800	1.1564	0.0710	0.0	15.2484	17.3116	NORMAL	
0656	4	14.8000	18.0000	+ 16.5000	16.4500	1.3699	0.0833	0.0	13.3396	19.5604	NORMAL	
0662	6	12.3000	18.0000	+ 16.0500	15.7500	2.2474	0.1427	0.0	12.6626	18.8374	NORMAL	
0669	4	12.7000	17.0000	+ 16.9500	15.9000	2.1339	0.1342	0.0	11.0551	20.7449	NORMAL	
THALLIUM					MG/L							
0603	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0604	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0605	5	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,5
0606	6	** 0.0100	0.1000	** 0.0100	NA	NA	NA	83.3	** 0.0100	0.1000	NONPARAMETRIC	2,6
0650	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	5	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,5
0652	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	4	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,4
0654	5	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,5
0655	5	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,5
0656	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
THORIUM-230					PCI/L							
0603	3	** 0.1000	0.5000	0.4000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0604	3	** 0.1000	0.5000	0.4000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0605	4	** 0.8000	0.8000	** 0.8000	NA	NA	NA	25.0	** 0.8000	0.8000	NONPARAMETRIC	2,4
0606	5	** 0.1000	0.5000	** 0.1000	NA	NA	NA	60.0	** 0.1000	0.5000	NONPARAMETRIC	2,5
0650	1	** 0.6000	** 0.6000	** 0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0651	3	** 0.5000	0.5000	** 0.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0652	2	** 0.6000	0.7000	** 0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0653	4	** 0.1000	0.3000	+ 0.1250	NA	NA	NA	25.0	** 0.1000	0.3000	NONPARAMETRIC	2,4
0654	3	** 0.4000	0.5000	** 0.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0655	4	** 0.1000	0.7000	+ 0.1750	NA	NA	NA	25.0	** 0.1000	0.7000	NONPARAMETRIC	2,4

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
THORIUM-230					PCI/L							
0656	2	** 0.1000	0.4000	+ 0.2250	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0662	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0669	2	** 0.1000	0.6000	+ 0.3250	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
TIN					MG/L							
0603	4	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
0604	4	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
0605	7	** 0.0050	0.0060	** 0.0050	NA	NA	NA	85.7	** 0.0050	0.0060	NONPARAMETRIC	2
0606	9	** 0.0050	0.0130	** 0.0050	NA	NA	NA	88.9	** 0.0050	0.0130	NONPARAMETRIC	2
0650	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0651	6	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,6
0652	2	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0653	7	** 0.0050	0.0240	** 0.0050	NA	NA	NA	85.7	** 0.0050	0.0240	NONPARAMETRIC	2
0654	6	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,6
0655	8	** 0.0050	0.0630	** 0.0050	NA	NA	NA	87.5	** 0.0050	0.0630	NONPARAMETRIC	2
0656	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0662	3	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0669	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
TOTAL DISSOLVED SOLIDS					MG/L							
0603	6	364.0000	418.0000	+ 388.0000	387.1667	19.5184	0.0504	0.0	360.3532	413.9801	NORMAL	
0604	5	359.0000	389.0000	383.0000	375.2000	14.4983	0.0386	0.0	350.9051	399.4949	NORMAL	
0605	9	1520.0000	3280.0000	1950.0000	2178.8889	617.3217	0.2833	0.0	1582.9677	2774.8101	NORMAL	
0606	9	1760.0000	3680.0000	2410.0000	2567.5556	701.7612	0.2733	0.0	1890.1221	3244.9890	NORMAL	
0650	4	249.0000	319.0000	+ 285.5000	284.7500	34.4323	0.1209	0.0	206.5715	362.9285	NORMAL	
0651	9	348.0000	440.0000	401.0000	401.1111	27.7824	0.0693	0.0	374.2918	427.9304	NORMAL	
0652	4	339.0000	361.0000	+ 345.0000	347.5000	9.4692	0.0272	0.0	326.0001	368.9999	NORMAL	
0653	8	1390.0000	2640.0000	+ 2160.0000	2075.0000	462.4778	0.2229	0.0	1584.7952	2565.2048	NORMAL	
0654	8	204.0000	270.0000	+ 242.5000	240.3750	20.0067	0.0832	0.0	219.1688	261.5812	NORMAL	
0655	9	3790.0000	5590.0000	4400.0000	4433.3333	548.9763	0.1238	0.0	3903.3882	4963.2785	NORMAL	
0656	3	1340.0000	1720.0000	1570.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	1060.0000	1120.0000	1070.0000	1082.0000	23.8747	0.0221	0.0	1041.9930	1122.0070	NORMAL	

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2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
TOTAL DISSOLVED SOLIDS					MG/L									
0669	4	647.0000	982.0000	+	843.0000	828.7500	145.3992	0.1754	0.0		498.6212	1158.8788	NORMAL	
TOTAL ORGANIC CARBON					MG/L									
0603	5	** 1.0000	56.1000		39.0000	NA	NA	NA	40.0	**	1.0000	56.1000	NONPARAMETRIC	2,5
0604	4	** 1.0000	41.0000	+	20.0000	NA	NA	NA	25.0	**	1.0000	41.0000	NONPARAMETRIC	2,4
0605	5	1.8000	62.6000		22.0000	11.9426	5.6053	NA	0.0	**	1.0000	214.5537	LOGNORMAL	7,8
0606	5	1.0000	82.0000		4.0000	8.6495	8.2596	NA	0.0	**	1.0000	297.5395	LOGNORMAL	7,8
0650	2	23.0000	58.5000	+	40.7500	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
0651	4	** 1.0000	103.0000	+	17.7500	NA	NA	NA	50.0	**	1.0000	103.0000	NONPARAMETRIC	2,4
0652	3	** 1.0000	48.0000	**	1.0000	NA	NA	NA	66.7		NA	NA	UNKNOWN	1
0653	5	** 1.0000	53.5000		1.0000	NA	NA	NA	40.0	**	1.0000	53.5000	NONPARAMETRIC	2,5
0654	3	** 1.0000	46.1000		32.0000	NA	NA	NA	33.3		NA	NA	UNKNOWN	1
0655	5	1.0000	101.0000		3.0000	7.6699	9.4585	NA	0.0	**	1.0000	331.1210	LOGNORMAL	7,8
0656	1	53.0000	53.0000		53.0000	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
0662	2	** 1.0000	25.0000	+	12.7500	NA	NA	NA	50.0		NA	NA	UNKNOWN	1
0669	2	** 1.0000	30.0000	+	15.2500	NA	NA	NA	50.0		NA	NA	UNKNOWN	1
TOTAL ORGANIC HALOGENS					MG/L									
0603	1	** 0.0030	** 0.0030		** 0.0030	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0604	1	0.0210	0.0210		0.0210	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
0605	1	0.0050	0.0050		0.0050	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
0606	1	0.0130	0.0130		0.0130	NA	NA	NA	0.0		NA	NA	UNKNOWN	1
URANIUM					MG/L									
0603	6	** 0.0010	0.0030	+	0.0026	NA	NA	NA	16.7	**	0.0010	0.0030	NONPARAMETRIC	2,6
0604	5	** 0.0010	0.0051		0.0027	NA	NA	NA	20.0	**	0.0010	0.0051	NONPARAMETRIC	2,5
0605	9	0.0036	0.0170		0.0063	0.0087	0.0052	0.6033	0.0		0.0036	0.0137	NORMAL	
0606	9	0.0080	0.0282		0.0140	0.0164	0.0062	0.3756	0.0		0.0105	0.0224	NORMAL	

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1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
URANIUM					MG/L							
0650	4	0.0023	0.0041	+ 0.0027	0.0029	0.0008	0.2740	0.0	** 0.0023	0.0047	NORMAL	
0651	9	0.0005	0.0090	0.0019	0.0018	2.2051	NA	11.1	0.0009	0.0040	LOGNORMAL	7,8
0652	4	** 0.0010	0.0056	+ 0.0039	NA	NA	NA	25.0	** 0.0010	0.0056	NONPARAMETRIC	2,4
0653	8	0.0060	0.0140	+ 0.0086	0.0089	0.0024	0.2686	0.0	0.0064	0.0115	NORMAL	
0654	8	0.0005	0.0037	+ 0.0009	0.0016	0.0012	0.7670	12.5	0.0003	0.0029	NORMAL	
0655	9	0.0190	0.0326	0.0281	0.0271	0.0050	0.1854	0.0	0.0223	0.0320	NORMAL	
0656	3	0.0087	0.0117	0.0093	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0662	5	0.0130	0.0253	0.0250	0.0211	0.0057	0.2723	0.0	0.0115	0.0307	NORMAL	
0669	4	0.0090	0.0155	+ 0.0134	0.0128	0.0030	0.2312	0.0	0.0061	0.0196	NORMAL	
VANADIUM					MG/L							
0603	5	** 0.0100	0.5000	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.5000	NONPARAMETRIC	2,5
0604	5	** 0.0100	0.6000	** 0.0100	NA	NA	NA	80.0	** 0.0100	0.6000	NONPARAMETRIC	2,5
0605	8	** 0.0100	0.8000	+ 0.0125	NA	NA	NA	50.0	** 0.0100	0.8000	NONPARAMETRIC	2
0606	9	** 0.0100	0.5100	** 0.0100	NA	NA	NA	55.6	** 0.0100	0.5100	NONPARAMETRIC	2
0650	3	** 0.0100	0.3300	0.1000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0651	8	** 0.0100	0.2200	+ 0.0100	NA	NA	NA	37.5	** 0.0100	0.2200	NONPARAMETRIC	2
0652	4	0.0100	0.5100	+ 0.1100	0.0572	7.7386	NA	0.0	** 0.0100	5.9587	LOGNORMAL	7,8
0653	7	** 0.0100	0.6100	0.0100	NA	NA	NA	42.9	** 0.0100	0.6100	NONPARAMETRIC	2
0654	7	** 0.0100	0.1200	** 0.0100	NA	NA	NA	71.4	** 0.0100	0.1200	NONPARAMETRIC	2
0655	8	** 0.0100	0.5200	+ 0.0200	NA	NA	NA	37.5	** 0.0100	0.5200	NONPARAMETRIC	2
0656	3	** 0.0100	0.7100	0.0300	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0662	5	** 0.0100	0.5000	0.0200	NA	NA	NA	20.0	** 0.0100	0.5000	NONPARAMETRIC	2,5
0669	4	0.0600	0.4900	+ 0.1200	0.1393	2.5452	NA	0.0	0.0167	1.1617	LOGNORMAL	7,8
ZINC					MG/L							
0603	5	** 0.0050	0.0140	** 0.0050	NA	NA	NA	60.0	** 0.0050	0.0140	NONPARAMETRIC	2,5
0604	5	** 0.0050	0.0700	** 0.0050	NA	NA	NA	60.0	** 0.0050	0.0700	NONPARAMETRIC	2,5
0605	8	** 0.0050	0.0950	** 0.0050	NA	NA	NA	62.5	** 0.0050	0.0950	NONPARAMETRIC	2
0606	9	** 0.0050	0.0700	0.0200	NA	NA	NA	33.3	** 0.0050	0.0700	NONPARAMETRIC	2

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.18 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT ALLUVIAL MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/24/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS									
LOC.	SAMP		MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL		MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ZINC						MG/L									
0650	3		0.0100	0.6170		0.3450	NA	NA	NA	0.0			NA	NA	UNKNOWN	1
0651	8	**	0.0050	0.0090	**	0.0050	NA	NA	NA	62.5	**		0.0050	0.0090	NONPARAMETRIC	2
0652	4	**	0.0050	0.0410	+	0.0067	NA	NA	NA	50.0	**		0.0050	0.0410	NONPARAMETRIC	2,4
0653	7	**	0.0050	0.0190	**	0.0050	NA	NA	NA	57.1	**		0.0050	0.0190	NONPARAMETRIC	2
0654	7	**	0.0050	0.1550	**	0.0050	NA	NA	NA	85.7	**		0.0050	0.1550	NONPARAMETRIC	2
0655	8	**	0.0050	0.2200	**	0.0050	NA	NA	NA	62.5	**		0.0050	0.2200	NONPARAMETRIC	2
0656	3	**	0.0050	0.2700		0.0260	NA	NA	NA	33.3			NA	NA	UNKNOWN	1
0662	5	**	0.0050	0.0970		0.0230	NA	NA	NA	40.0	**		0.0050	0.0970	NONPARAMETRIC	2,5
0669	4	**	0.0050	0.0540	+	0.0147	NA	NA	NA	50.0	**		0.0050	0.0540	NONPARAMETRIC	2,4

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

INPUT DATA FILENAME: M:\DART\MON01\GWQ10012.DAT

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS										
LOC.	SAMP		MINIMUM		MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS		STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY							MG/L CACO3										
0614	9		173.0000		209.0000		191.0000	190.4444	11.7485	0.0617	0.0		179.1032		201.7857	NORMAL	
0615	4		186.0000		230.0000	+	210.5000	209.2500	22.0208	0.1052	0.0		159.2517		259.2483	NORMAL	
0659	10		181.0000		214.0000	+	193.5000	194.5000	9.6177	0.0494	0.0		185.9203		203.0797	NORMAL	
0660	7		201.0000		226.0000		213.0000	214.5714	9.2711	0.0432	0.0		203.5580		225.5849	NORMAL	
ALUMINUM							MG/L										
0614	7	**	0.1000		0.6000	**	0.1000	NA	NA	NA	57.1	**	0.1000		0.6000	NONPARAMETRIC	2
0615	3	**	0.1000		0.7000		0.3000	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
0659	8	**	0.0500		0.3000	+	0.0500	NA	NA	NA	75.0	**	0.0500		0.3000	NONPARAMETRIC	2
0660	6	**	0.1000		0.3000	**	0.1000	NA	NA	NA	66.7	**	0.1000		0.3000	NONPARAMETRIC	2,6
AMMONIUM							MG/L										
0614	8	**	0.1000		0.1000	**	0.1000	NA	NA	NA	87.5	**	0.1000		0.1000	NONPARAMETRIC	2
0615	3	**	0.1000	**	0.1000	**	0.1000	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0659	9	**	0.1000		1.3000	**	0.1000	NA	NA	NA	55.6	**	0.1000		1.3000	NONPARAMETRIC	2
0660	7	**	0.1000	**	0.1000	**	0.1000	NA	NA	NA	100.0	**	0.1000	**	0.1000	NONPARAMETRIC	2
ANTIMONY							MG/L										
0614	6	**	0.0030		0.0040	**	0.0030	NA	NA	NA	83.3	**	0.0030		0.0040	NONPARAMETRIC	2,6
0615	3	**	0.0030		0.0040	**	0.0030	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
0659	7	**	0.0030	**	0.0030	**	0.0030	NA	NA	NA	100.0	**	0.0030	**	0.0030	NONPARAMETRIC	2
0660	5	**	0.0030		0.0040	**	0.0030	NA	NA	NA	80.0	**	0.0030		0.0040	NONPARAMETRIC	2,5
ARSENIC							MG/L										
0614	8		0.0020		0.0050	+	0.0050	NA	NA	NA	87.5		0.0020		0.0050	NONPARAMETRIC	2
0615	3	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0659	9		0.0050		0.0050		0.0050	NA	NA	NA	88.9		0.0050		0.0050	NONPARAMETRIC	2
0660	7		0.0040		0.0050		0.0050	NA	NA	NA	85.7		0.0040		0.0050	NONPARAMETRIC	2
BARIUM							MG/L										
0614	6	**	0.1000		0.4000	+	0.1000	NA	NA	NA	33.3	**	0.1000		0.4000	NONPARAMETRIC	2,6

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS								
LOC.	SAMP	MINIMUM		MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
BARIUM						MG/L									
0615	3	**	0.1000		0.4000	** 0.1000	NA	NA	NA	66.7		NA	NA	UNKNOWN	1
0659	7		0.0400		0.2000	0.0500	NA	NA	NA	57.1		0.0400	0.2000	NONPARAMETRIC	2
0660	5	**	0.1000		0.2000	** 0.1000	NA	NA	NA	80.0	**	0.1000	0.2000	NONPARAMETRIC	2,5
BERYLLIUM						MG/L									
0614	4	**	0.0050		0.0050	+ 0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,4
0615	1	**	0.0100	**	0.0100	** 0.0100	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0659	5	**	0.0050		0.0050	0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,5
0660	4	**	0.0050		0.0050	+ 0.0050	NA	NA	NA	100.0	**	0.0050	0.0050	NONPARAMETRIC	2,4
BORON						MG/L									
0614	7	**	0.1000		0.4000	** 0.1000	NA	NA	NA	57.1	**	0.1000	0.4000	NONPARAMETRIC	2
0615	3	**	0.1000		0.4000	0.3000	NA	NA	NA	33.3		NA	NA	UNKNOWN	1
0659	7	**	0.0500		0.1000	0.0500	NA	NA	NA	85.7	**	0.0500	0.1000	NONPARAMETRIC	2
0660	6	**	0.1000		0.2000	** 0.1000	NA	NA	NA	83.3	**	0.1000	0.2000	NONPARAMETRIC	2,6
BROMIDE						MG/L									
0614	2	**	0.1000		1.0000	+ 0.5250	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0615	1	**	2.0000	**	2.0000	** 2.0000	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0659	2	**	0.1000	**	0.1000	** 0.1000	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0660	1	**	0.1000	**	0.1000	** 0.1000	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
CADMIUM						MG/L									
0614	8	**	0.0010		0.0040	** 0.0010	NA	NA	NA	87.5	**	0.0010	0.0040	NONPARAMETRIC	2
0615	3	**	0.0010	**	0.0010	** 0.0010	NA	NA	NA	100.0		NA	NA	UNKNOWN	1
0659	9	**	0.0005		0.0040	0.0005	NA	NA	NA	88.9	**	0.0005	0.0040	NONPARAMETRIC	2
0660	7	**	0.0010		0.0040	** 0.0010	NA	NA	NA	85.7	**	0.0010	0.0040	NONPARAMETRIC	2
CALCIUM						MG/L									
0614	8		71.3000		89.9000	+ 84.3500	81.9500	7.2670	0.0887	0.0		74.2474	89.6526	NORMAL	

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS											
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CALCIUM					MG/L							
0615	3	15.2000	18.1000	17.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	18.4000	26.1000	22.7000	22.5667	2.8098	0.1245	0.0	19.8543	25.2791	NORMAL	
0660	7	2.5700	3.3200	2.9200	2.9543	0.2689	0.0910	0.0	2.6349	3.2737	NORMAL	
CHLORIDE					MG/L							
0614	8	15.0000	21.0000	+ 17.9000	17.9750	2.0012	0.1113	0.0	15.8538	20.0962	NORMAL	
0615	3	8.4000	11.0000	9.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	6.0000	11.0000	9.5000	9.0667	1.4379	0.1586	0.0	7.6786	10.4547	NORMAL	
0660	7	5.0000	8.9000	8.0000	7.3571	1.3734	0.1867	0.0	5.7256	8.9886	NORMAL	
CHROMIUM					MG/L							
0614	7	** 0.0100	0.0300	** 0.0100	NA	NA	NA	71.4	** 0.0100	0.0300	NONPARAMETRIC	2
0615	3	** 0.0100	0.0200	** 0.0100	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0659	8	** 0.0100	0.0400	** 0.0100	NA	NA	NA	75.0	** 0.0100	0.0400	NONPARAMETRIC	2
0660	6	** 0.0100	0.0300	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.0300	NONPARAMETRIC	2,6
COBALT					MG/L							
0614	7	** 0.0500	0.0700	** 0.0500	NA	NA	NA	85.7	** 0.0500	0.0700	NONPARAMETRIC	2
0615	3	** 0.0500	** 0.0500	** 0.0500	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	7	** 0.0300	0.0700	** 0.0300	NA	NA	NA	85.7	** 0.0300	0.0700	NONPARAMETRIC	2
0660	6	** 0.0500	0.0600	** 0.0500	NA	NA	NA	66.7	** 0.0500	0.0600	NONPARAMETRIC	2,6
COPPER					MG/L							
0614	6	** 0.0200	** 0.0200	** 0.0200	NA	NA	NA	100.0	** 0.0200	** 0.0200	NONPARAMETRIC	2,6
0615	3	** 0.0200	** 0.0200	** 0.0200	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	6	** 0.0100	0.0100	+ 0.0100	NA	NA	NA	100.0	** 0.0100	0.0100	NONPARAMETRIC	2,6
0660	5	** 0.0200	** 0.0200	** 0.0200	NA	NA	NA	100.0	** 0.0200	** 0.0200	NONPARAMETRIC	2,5
CYANIDE					MG/L							
0614	4	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,4

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CYANIDE				MG/L								
0615	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0660	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
FLUORIDE				MG/L								
0614	6	0.2000	0.4000	+ 0.2000	0.2333	0.0816	0.3499	0.0	0.1212	0.3455	NORMAL	
0615	3	0.3000	0.5000	0.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	6	0.1000	0.4000	+ 0.3500	0.3000	0.1265	0.4216	0.0	0.1262	0.4738	NORMAL	
0660	5	0.2000	0.7000	0.4000	0.4000	0.1871	0.4677	0.0	** 0.1000	0.7135	NORMAL	
GROSS ALPHA				PCI/L								
0614	6	20.0000	35.9000	+ 24.0000	25.4833	5.8208	0.2284	0.0	17.4870	33.4797	NORMAL	
0615	2	6.8000	9.6000	+ 8.2000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	6	4.8000	19.0000	+ 9.3000	10.2833	5.4334	0.5284	0.0	2.8192	17.7475	NORMAL	
0660	4	** 0.2000	2.0000	+ 0.5500	NA	NA	NA	0.0	** 0.2000	2.0000	NONPARAMETRIC	9,4
GROSS BETA				PCI/L								
0614	6	7.0000	17.0000	+ 15.0000	13.8833	3.6444	0.2625	0.0	8.8768	18.8899	NORMAL	
0615	2	6.1000	7.2000	+ 6.6500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	6	5.0000	11.2000	+ 8.0500	8.0000	2.3588	0.2949	0.0	4.7596	11.2404	NORMAL	
0660	4	1.6000	3.6000	+ 2.1000	2.3500	0.8813	0.3750	0.0	** 0.5000	4.3510	NORMAL	
IRON				MG/L								
0614	7	** 0.0300	0.0900	0.0300	NA	NA	NA	42.9	** 0.0300	0.0900	NONPARAMETRIC	2
0615	3	** 0.0300	0.2500	0.1300	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0659	8	0.1000	0.2100	+ 0.1700	0.1613	0.0368	0.2283	0.0	0.1222	0.2003	NORMAL	
0660	6	** 0.0300	0.0300	** 0.0300	NA	NA	NA	83.3	** 0.0300	0.0300	NONPARAMETRIC	2,6
LEAD				MG/L								
0614	7	** 0.0100	0.0100	** 0.0100	NA	NA	NA	85.7	** 0.0100	0.0100	NONPARAMETRIC	2

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
LEAD					MG/L							
0615	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	7	** 0.0050	0.0050	0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2
0660	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6
LEAD-210					PCI/L							
0614	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0615	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	1	2.0000	2.0000	2.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0660	1	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
MAGNESIUM					MG/L							
0614	8	42.1000	63.3000	+ 53.8000	52.9000	7.6253	0.1441	0.0	44.8175	60.9825	NORMAL	
0615	3	16.2000	20.0000	20.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	20.9000	29.1000	24.5000	25.3111	2.4937	0.0985	0.0	22.9038	27.7184	NORMAL	
0660	7	1.5700	1.8400	1.6900	1.6914	0.0884	0.0523	0.0	1.5864	1.7964	NORMAL	
MANGANESE					MG/L							
0614	7	** 0.0100	0.0200	** 0.0100	NA	NA	NA	85.7	** 0.0100	0.0200	NONPARAMETRIC	2
0615	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	8	0.1000	0.1400	+ 0.1150	0.1175	0.0158	0.1346	0.0	0.1007	0.1343	NORMAL	
0660	6	** 0.0100	0.0700	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.0700	NONPARAMETRIC	2,6
MERCURY					MG/L							
0614	5	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,5
0615	3	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	4	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,4
0660	4	** 0.0002	** 0.0002	** 0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,4
MOLYBDENUM					MG/L							
0614	8	** 0.0100	0.1500	+ 0.0100	NA	NA	NA	37.5	** 0.0100	0.1500	NONPARAMETRIC	2

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
MOLYBDENUM					MG/L							
0615	3	** 0.0100	0.1600	** 0.0100	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0659	9	** 0.0100	0.2500	0.0300	0.0336	3.1889	NA	11.1	0.0110	0.1028	LOGNORMAL	7,8
0660	7	** 0.0100	0.2000	** 0.0100	NA	NA	NA	57.1	** 0.0100	0.2000	NONPARAMETRIC	2
NET GROSS ALPHA ***					PCI/L							
0614	5	-2.1600	6.9200	2.3900	NA	NA	NA	0.0	-2.1600	6.9200	NONPARAMETRIC	9,5
0615	2	1.8600	5.6900	+ 3.7750	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	6	2.6700	17.9000	+ 8.0300	9.0483	5.5216	0.6102	0.0	1.4631	16.6336	NORMAL	
0660	4	-0.6300	1.6600	+ -0.3500	NA	NA	NA	0.0	-0.6300	1.6600	NONPARAMETRIC	9,4
NICKEL					MG/L							
0614	7	** 0.0400	0.0500	** 0.0400	NA	NA	NA	71.4	** 0.0400	0.0500	NONPARAMETRIC	2
0615	3	** 0.0400	0.0600	** 0.0400	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0659	7	** 0.0400	** 0.0400	** 0.0400	NA	NA	NA	100.0	** 0.0400	** 0.0400	NONPARAMETRIC	2
0660	6	** 0.0400	0.0600	** 0.0400	NA	NA	NA	66.7	** 0.0400	0.0600	NONPARAMETRIC	2,6
NITRATE					MG/L							
0614	8	6.0000	40.0000	+ 27.7000	24.9125	12.3271	0.4948	0.0	11.8463	37.9787	NORMAL	
0615	3	** 1.0000	8.8600	5.0000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0659	9	** 0.1000	7.3000	2.5000	NA	NA	NA	33.3	** 0.1000	7.3000	NONPARAMETRIC	2
0660	7	** 0.1000	5.8000	0.7000	NA	NA	NA	42.9	** 0.1000	5.8000	NONPARAMETRIC	2
NITRITE					MG/L							
0614	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0615	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NITRITE						MG/L						
0659	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0660	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
NITRITE AND NITRATE						MG/L						
0614	1	9.0000	9.0000	9.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0615	1	2.0000	2.0000	2.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	1	1.0500	1.0500	1.0500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
PH						SU						
0614	9	7.4700	8.0800	7.6600	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0615	4	7.4400	8.1000	+ 7.6973	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0659	10	7.3100	7.6400	+ 7.4350	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0660	7	8.2500	8.8800	8.6500	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE						MG/L						
0614	5	0.2000	0.8000	0.4000	0.4600	0.2191	0.4763	0.0	** 0.1000	0.8271	NORMAL	
0615	3	** 0.1000	0.5000	0.2000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0659	4	0.3000	1.4000	+ 1.1500	1.0000	0.4830	0.4830	0.0	** 0.1000	2.0968	NORMAL	
0660	4	** 0.1000	0.3000	+ 0.1750	NA	NA	NA	50.0	** 0.1000	0.3000	NONPARAMETRIC	2,4
POLONIUM-210						PCI/L						
0614	2	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0615	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0659	1	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0660	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
POTASSIUM						MG/L						
0614	8	1.5000	2.4800	+ 1.8950	1.8938	0.3556	0.1878	0.0	1.5168	2.2707	NORMAL	
0615	3	2.8600	3.3000	2.9100	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	2.5600	3.8700	3.4500	3.2678	0.4763	0.1457	0.0	2.8080	3.7275	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
POTASSIUM					MG/L							
0660	7	0.5100	1.0400	0.7000	0.7114	0.1753	0.2465	0.0	0.5031	0.9197	NORMAL	
RADIUM-226					PCI/L							
0614	6	** 0.8000	3.5000	** 0.8000	0.8532	2.0695	NA	0.0	** 0.8000	2.3173	LOGNORMAL	7,8
0615	3	** 0.1000	1.6000	1.5000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0659	7	1.5000	6.9000	4.0000	4.2286	1.7595	0.4161	0.0	2.1384	6.3187	NORMAL	
0660	5	** 0.1000	0.8000	0.5000	NA	NA	NA	20.0	** 0.1000	0.8000	NONPARAMETRIC	2,5
RADIUM-226 + RADIUM-228					PCI/L							
0614	6	1.0000	4.1000	+ 1.3000	1.7167	1.1771	0.6857	0.0	0.0996	3.3338	NORMAL	
0615	3	0.5500	1.8000	1.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	7	2.0000	11.1000	5.5000	5.9143	2.7787	0.4698	0.0	2.6133	9.2153	NORMAL	
0660	5	0.7000	2.1500	1.5000	1.4500	0.5701	0.3932	0.0	0.4947	2.4053	NORMAL	
RADIUM-228					PCI/L							
0614	6	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	66.7	** 1.0000	** 1.0000	NONPARAMETRIC	2,6
0615	3	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	7	** 1.0000	4.2000	1.5000	1.6857	1.2171	0.7220	14.3	** 1.0000	3.1316	NORMAL	
0660	5	** 0.9000	2.1000	0.9000	0.9600	0.7092	0.7388	0.0	** 0.9000	2.1485	NORMAL	
SELENIUM					MG/L							
0614	8	** 0.0050	0.0080	** 0.0050	NA	NA	NA	75.0	** 0.0050	0.0080	NONPARAMETRIC	2
0615	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	8	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2
0660	7	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2
SILICA - SIO2					MG/L							
0614	6	12.0000	14.0000	+ 13.9500	13.4833	0.8256	0.0612	0.0	12.3491	14.6175	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
7) The lognormal distribution was used because the data failed the normal distribution test.
8) The mean is geometric. The standard deviation is the value to divide or multiply with the geometric mean.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SILICA - SIO2				MG/L								
0615	3	8.0000	9.0000	9.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	6	12.0000	14.4000	+ 14.0000	13.7333	0.8641	0.0629	0.0	12.5463	14.9204	NORMAL	
0660	5	10.0000	13.0000	12.0000	11.9200	1.1541	0.0968	0.0	9.9860	13.8540	NORMAL	
SILVER				MG/L								
0614	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6
0615	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	6	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,6
0660	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5
SODIUM				MG/L								
0614	8	25.2000	31.5000	+ 28.1500	28.4250	2.3777	0.0836	0.0	25.9047	30.9453	NORMAL	
0615	3	64.1000	92.1000	78.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	67.7000	77.5000	73.6000	73.2333	3.4398	0.0470	0.0	69.9127	76.5539	NORMAL	
0660	7	100.0000	114.0000	111.0000	108.8571	5.8716	0.0539	0.0	101.8820	115.8323	NORMAL	
SPECIFIC CONDUCTANCE				UMHO/CM								
0614	9	7.8000	950.0000	650.0000	626.9778	274.5168	0.4378	0.0	361.9776	891.9780	NORMAL	
0615	4	360.0000	440.0000	+ 389.5000	394.7500	33.2202	0.0842	0.0	319.3235	470.1765	NORMAL	
0659	10	260.0000	628.0000	+ 462.5000	477.6000	104.4501	0.2187	0.0	384.4223	570.7777	NORMAL	
0660	7	250.0000	492.0000	385.0000	374.4286	72.2700	0.1930	0.0	288.5760	460.2812	NORMAL	
STRONTIUM				MG/L								
0614	5	** 0.1000	0.7000	0.6000	NA	NA	NA	40.0	** 0.1000	0.7000	NONPARAMETRIC	2,5
0615	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	6	0.2000	0.3000	+ 0.2500	0.2450	0.0399	0.1628	0.0	0.1902	0.2998	NORMAL	
0660	4	0.0400	0.1000	+ 0.0500	NA	NA	NA	50.0	0.0400	0.1000	NONPARAMETRIC	2,4
SULFATE				MG/L								
0614	8	179.0000	312.3000	+ 249.5000	246.7875	39.6390	0.1606	0.0	204.7721	288.8029	NORMAL	

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SULFATE					MG/L							
0615	3	62.0000	74.0000	70.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	84.0000	145.7000	109.0000	107.7778	17.0460	0.1582	0.0	91.3227	124.2329	NORMAL	
0660	7	11.9000	29.0000	27.0000	24.5143	5.8647	0.2392	0.0	17.5474	31.4812	NORMAL	
SULFIDE					MG/L							
0614	4	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	** 0.1000	** 0.1000	NONPARAMETRIC	2,4
0615	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0660	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
TEMPERATURE					C - DEGREE							
0614	9	12.9000	20.0000	17.0000	16.8444	1.8501	0.1098	0.0	15.0585	18.6304	NORMAL	
0615	4	15.7000	18.0000	+ 16.2500	16.5500	1.0214	0.0617	0.0	14.2308	18.8692	NORMAL	
0659	10	15.4000	18.0000	+ 16.2500	16.3900	0.8252	0.0503	0.0	15.6538	17.1262	NORMAL	
0660	7	15.6000	17.5000	17.0000	16.6571	0.7786	0.0467	0.0	15.7322	17.5821	NORMAL	
THALLIUM					MG/L							
0614	4	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,4
0615	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	5	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,5
0660	4	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,4
THORIUM-230					PCI/L							
0614	4	** 0.1000	0.6000	+ 0.2250	NA	NA	NA	25.0	** 0.1000	0.6000	NONPARAMETRIC	2,4
0615	2	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	3	** 1.0000	1.1000	** 1.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0660	2	** 0.8000	** 0.8000	** 0.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
TIN					MG/L							
0614	6	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2,6

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
TIN					MG/L							
0615	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0659	6	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,6
0660	5	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2,5
TOTAL DISSOLVED SOLIDS					MG/L							
0614	8	446.0000	644.0000	+ 603.0000	588.8750	62.8955	0.1068	0.0	522.2088	655.5412	NORMAL	
0615	3	301.0000	327.0000	309.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	316.0000	388.0000	355.0000	358.6667	24.9900	0.0697	0.0	334.5430	382.7903	NORMAL	
0660	7	260.0000	299.0000	281.0000	280.0000	14.5373	0.0519	0.0	262.7305	297.2695	NORMAL	
TOTAL ORGANIC CARBON					MG/L							
0614	4	5.0000	39.0000	+ 32.7500	27.3750	15.2062	0.5555	0.0	** 1.0000	61.9007	NORMAL	
0615	2	26.0000	39.0000	+ 32.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	4	** 1.0000	46.0000	+ 22.2500	NA	NA	NA	50.0	** 1.0000	46.0000	NONPARAMETRIC	2,4
0660	2	46.0000	55.7000	+ 50.8500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
TOTAL ORGANIC HALOGENS					MG/L							
0614	1	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0615	1	0.0030	0.0030	0.0030	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
URANIUM					MG/L							
0614	8	0.0249	0.0360	+ 0.0314	0.0313	0.0031	0.0997	0.0	0.0280	0.0346	NORMAL	
0615	3	0.0007	0.0072	0.0057	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0659	9	0.0005	0.0031	0.0017	0.0017	0.0007	0.4265	11.1	0.0010	0.0024	NORMAL	
0660	7	** 0.0003	0.0210	0.0015	NA	NA	NA	42.9	** 0.0003	0.0210	NONPARAMETRIC	2
VANADIUM					MG/L							
0614	7	** 0.0100	0.6000	** 0.0100	NA	NA	NA	57.1	** 0.0100	0.6000	NONPARAMETRIC	2

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.19 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT SHINARUMP MONITOR WELLS
SITE: MON01 MONUMENT VALLEY
04/17/85 TO 11/23/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS								
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
VANADIUM						MG/L						
0615	3	** 0.0100	0.7000	** 0.0100	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0659	8	** 0.0100	0.3500	** 0.0100	NA	NA	NA	75.0	** 0.0100	0.3500	NONPARAMETRIC	2
0660	6	** 0.0100	0.4400	** 0.0100	NA	NA	NA	66.7	** 0.0100	0.4400	NONPARAMETRIC	2,6
ZINC						MG/L						
0614	7	** 0.0050	0.8600	0.0050	NA	NA	NA	42.9	** 0.0050	0.8600	NONPARAMETRIC	2
0615	3	** 0.0050	0.0550	0.0100	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0659	8	** 0.0050	0.0840	** 0.0050	NA	NA	NA	62.5	** 0.0050	0.0840	NONPARAMETRIC	2
0660	6	** 0.0050	0.0170	** 0.0050	NA	NA	NA	50.0	** 0.0050	0.0170	NONPARAMETRIC	2,6

** The reported value is the minimum detection limit of the data set
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

INPUT DATA FILENAME: M:\DART\MON01\GWQ10014.DAT

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
ALKALINITY					MG/L CACO3								
0608	2	161.0000	167.0000	+	164.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	207.0000	224.0000		209.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	2	145.0000	147.0000	+	146.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	180.0000	192.0000	+	186.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	4	199.0000	225.0000	+	219.0000	215.5000	11.3578	0.0527	0.0	189.7121	241.2879	NORMAL	
0657	7	189.0000	227.0000		200.0000	203.5714	13.6609	0.0671	0.0	187.3431	219.7997	NORMAL	
0663	9	141.0000	218.0000		190.0000	190.7778	21.6436	0.1134	0.0	169.8845	211.6710	NORMAL	
0664	2	207.0000	233.0000	+	220.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	160.0000	189.0000		178.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
ALUMINUM					MG/L								
0608	2	0.2000	0.7000	+	0.4500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	** 0.1000	0.8000		0.2000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0618	3	0.1300	0.6000		0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	0.2000	0.6000	+	0.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	** 0.0500	0.3000		0.3000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0657	6	** 0.1000	0.3000	**	0.1000	NA	NA	NA	66.7	** 0.1000	0.3000	NONPARAMETRIC	2,6
0663	7	** 0.0500	0.3000		0.0500	NA	NA	NA	71.4	** 0.0500	0.3000	NONPARAMETRIC	2
0664	2	0.2000	0.3000	+	0.2500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	** 0.1000	0.3000		0.3000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
AMMONIUM					MG/L								
0608	2	** 0.1000	** 0.1000	**	0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.1000	** 0.1000	**	0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.1000	** 0.1000	**	0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.1000	** 0.1000	**	0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	3	** 0.1000	** 0.1000	**	0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	7	** 0.1000	1.4000	**	0.1000	NA	NA	NA	71.4	** 0.1000	1.4000	NONPARAMETRIC	2
0663	8	** 0.1000	0.6000	**	0.1000	NA	NA	NA	50.0	** 0.1000	0.6000	NONPARAMETRIC	2
0664	2	** 0.1000	** 0.1000	**	0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	3	** 0.1000	** 0.1000	**	0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
ANTIMONY					MG/L								
0608	2	** 0.0030	0.0060	+	0.0037	NA	NA	NA	50.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS									
LOC.	SAMP	MINIMUM		MAXIMUM		MEDIAN		MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *		DISTRIBUTION TYPE	FOOT NOTE
ANTIMONY						MG/L											
0611	3	**	0.0030		0.0040	**	0.0030	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
0618	2	**	0.0030	**	0.0030	**	0.0030	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0619	2	**	0.0030	**	0.0030	**	0.0030	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0625	2	**	0.0030		0.0050	+	0.0033	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0657	5	**	0.0030	**	0.0030	**	0.0030	NA	NA	NA	100.0	**	0.0030	**	0.0030	NONPARAMETRIC	2,5
0663	6	**	0.0030	**	0.0030	**	0.0030	NA	NA	NA	100.0	**	0.0030	**	0.0030	NONPARAMETRIC	2,6
0664	1	**	0.0030	**	0.0030	**	0.0030	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0668	2	**	0.0030	**	0.0030	**	0.0030	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
ARSENIC						MG/L											
0608	2	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0611	3	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0618	3	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0619	2	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0625	3	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0657	7		0.0010		0.0050		0.0050	NA	NA	NA	85.7		0.0010		0.0050	NONPARAMETRIC	2
0663	8		0.0020		0.0050	+	0.0050	NA	NA	NA	87.5		0.0020		0.0050	NONPARAMETRIC	2
0664	2	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0668	3	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
BARIUM						MG/L											
0608	2	**	0.1000		0.4000	+	0.2250	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0611	3	**	0.1000		0.5000	**	0.1000	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
0618	2	**	0.1000		0.4000	+	0.2250	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0619	2	**	0.1000		0.3000	+	0.1750	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0625	2		0.0600		0.5000	+	0.2800	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0657	5		0.2000		0.2000		0.2000	0.2000	0.0000	0.0000	0.0		0.2000		0.2000	NORMAL	
0663	6		0.0500		0.2000	+	0.0600	NA	NA	NA	50.0		0.0500		0.2000	NONPARAMETRIC	2,6
0664	1		0.4000		0.4000		0.4000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0668	2	**	0.1000		0.3000	+	0.1750	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
BERYLLIUM						MG/L											
0611	1	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
BERYLLIUM					MG/L							
0657	4	** 0.0050	0.0050	+ 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
0663	4	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,4
0668	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
BICARBONATE - HCO3					MG/L							
0618	1	175.0000	175.0000	175.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
BORON					MG/L							
0608	2	0.2000	0.4000	+ 0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	** 0.1000	1.2000	0.3000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0618	2	0.3000	0.9000	+ 0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	0.4000	0.8000	+ 0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	2	** 0.1000	0.4000	+ 0.2250	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0657	6	** 0.1000	0.3000	** 0.1000	NA	NA	NA	66.7	** 0.1000	0.3000	NONPARAMETRIC	2,6
0663	6	0.0500	0.2000	+ 0.0500	NA	NA	NA	66.7	0.0500	0.2000	NONPARAMETRIC	2,6
0664	2	** 0.1000	0.1000	** 0.1000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0668	3	** 0.1000	0.1000	** 0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
BROMIDE					MG/L							
0608	1	** 2.0000	** 2.0000	** 2.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	1	** 2.0000	** 2.0000	** 2.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	1	** 2.0000	** 2.0000	** 2.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	1	** 2.0000	** 2.0000	** 2.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0663	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
CADMIUM					MG/L							
0608	2	** 0.0010	** 0.0010	** 0.0010	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.0010	** 0.0010	** 0.0010	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.0010	** 0.0010	** 0.0010	NA	NA	NA	100.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CADMIUM					MG/L							
0619	2	** 0.0010	** 0.0010	** 0.0010	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	3	** 0.0010	** 0.0010	** 0.0010	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	7	** 0.0010	0.0050	** 0.0010	NA	NA	NA	85.7	** 0.0010	0.0050	NONPARAMETRIC	2
0663	8	** 0.0005	0.0030	+ 0.0005	NA	NA	NA	87.5	** 0.0005	0.0030	NONPARAMETRIC	2
0664	2	** 0.0010	** 0.0010	** 0.0010	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	3	** 0.0010	** 0.0010	** 0.0010	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
CALCIUM					MG/L							
0608	2	26.2000	29.9000	+ 28.0500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	16.8000	19.0000	17.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	30.6000	35.7000	31.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	37.1000	40.3000	+ 38.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	3.0000	3.4100	3.0400	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	7	60.2000	80.6000	65.5000	67.4143	6.7192	0.0997	0.0	59.4322	75.3963	NORMAL	
0663	8	2.8800	16.8000	+ 13.7000	11.9312	4.9159	0.4120	0.0	6.7206	17.1419	NORMAL	
0664	2	13.4000	16.6000	+ 15.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	6.0400	9.8800	7.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
CHLORIDE					MG/L							
0608	2	5.6000	8.0000	+ 6.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	7.4000	13.0000	9.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	3.0000	5.0000	3.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	5.8000	8.0000	+ 6.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	8.8000	10.0000	9.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	7	5.0000	10.0000	8.2000	8.0143	1.5625	0.1950	0.0	6.1581	9.8705	NORMAL	
0663	8	7.0000	11.0000	+ 9.6000	9.2000	1.2660	0.1376	0.0	7.8581	10.5419	NORMAL	
0664	2	5.0000	9.0000	+ 7.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	6.1000	8.0000	8.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
CHROMIUM					MG/L							
0608	2	** 0.0100	0.0300	+ 0.0175	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0611	3	** 0.0100	0.0200	** 0.0100	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0618	2	** 0.0100	0.0400	+ 0.0225	NA	NA	NA	50.0	NA	NA	UNKNOWN	1

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME								UNITS												
LOC.	SAMP	MINIMUM		MAXIMUM		MEDIAN		MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *		DISTRIBUTION TYPE	FOOT NOTE
CHROMIUM								MG/L									
0619	2	**	0.0100		0.0300	+	0.0175	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0625	3	**	0.0100		0.0300		0.0300	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
0657	6	**	0.0100		0.0700	**	0.0100	NA	NA	NA	50.0	**	0.0100		0.0700	NONPARAMETRIC	2,6
0663	7	**	0.0100		0.0300	**	0.0100	NA	NA	NA	85.7	**	0.0100		0.0300	NONPARAMETRIC	2
0664	2		0.0100		0.0500	+	0.0300	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0668	3	**	0.0100		0.0600		0.0200	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
COBALT								MG/L									
0608	2	**	0.0500	**	0.0500	**	0.0500	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0611	3	**	0.0500		0.0500	**	0.0500	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
0618	2	**	0.0500	**	0.0500	**	0.0500	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0619	2	**	0.0500	**	0.0500	**	0.0500	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0625	2	**	0.0500	**	0.0500	**	0.0500	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0657	6	**	0.0500	**	0.0500	**	0.0500	NA	NA	NA	100.0	**	0.0500	**	0.0500	NONPARAMETRIC	2,6
0663	6	**	0.0300	**	0.0300	**	0.0300	NA	NA	NA	100.0	**	0.0300	**	0.0300	NONPARAMETRIC	2,6
0664	2	**	0.0500	**	0.0500	**	0.0500	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0668	3	**	0.0500		0.0700	**	0.0500	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
COPPER								MG/L									
0608	2	**	0.0200	**	0.0200	**	0.0200	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0611	3	**	0.0200	**	0.0200	**	0.0200	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0618	2	**	0.0200	**	0.0200	**	0.0200	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0619	2	**	0.0200	**	0.0200	**	0.0200	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0625	1	**	0.0200	**	0.0200	**	0.0200	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0657	5	**	0.0200	**	0.0200	**	0.0200	NA	NA	NA	100.0	**	0.0200	**	0.0200	NONPARAMETRIC	2,5
0663	5	**	0.0100		0.0100		0.0100	NA	NA	NA	100.0	**	0.0100		0.0100	NONPARAMETRIC	2,5
0664	1	**	0.0200	**	0.0200	**	0.0200	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0668	2	**	0.0200		0.0200	**	0.0200	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
CYANIDE								MG/L									
0608	2	**	0.0100	**	0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1

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+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
CYANIDE					MG/L							
0611	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0663	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0664	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
DISSOLVED OXYGEN					MG/L							
0663	1	1.6000	1.6000	1.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
FLUORIDE					MG/L							
0608	2	0.2000	0.4000	+ 0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	0.3000	0.4000	0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	0.2000	0.5000	0.4000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0619	2	0.3000	0.3000	+ 0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	1	0.5000	0.5000	0.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	5	** 0.1000	0.2000	0.2000	NA	NA	NA	20.0	** 0.1000	0.2000	NONPARAMETRIC	2,5
0663	5	** 0.1000	0.3000	0.2000	NA	NA	NA	20.0	** 0.1000	0.3000	NONPARAMETRIC	2,5
0664	1	0.5000	0.5000	0.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	2	** 0.1000	0.3000	+ 0.1750	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
GROSS ALPHA					PCI/L							
0608	2	6.2000	9.9000	+ 8.0500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	2	2.0000	4.1000	+ 3.0500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	2	3.9000	5.6000	+ 4.7500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	18.0000	24.0000	+ 21.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	1.8000	9.5000	4.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	4	39.0000	49.0000	+ 44.0000	44.0000	4.1633	0.0946	0.0	34.5472	53.4528	NORMAL	
0663	6	** 0.2000	4.0000	+ 1.2000	NA	NA	NA	16.7	** 0.2000	4.0000	NONPARAMETRIC	2,6

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS										
LOC.	SAMP		MINIMUM	MAXIMUM		MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS		STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM		MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
GROSS ALPHA					PCI/L											
0664	2		6.1000	7.0000	+	6.5500	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0668	2	**	0.2000	0.8000	+	0.4500	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
GROSS BETA					PCI/L											
0608	2		6.0000	8.5000	+	7.2500	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0611	2		5.3000	7.7000	+	6.5000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0618	2		4.7000	5.0000	+	4.8500	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0619	2		13.0000	13.0000	+	13.0000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0625	3		3.4000	5.6000		5.1000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0657	4		13.0000	19.0000	+	15.5000	15.7500	2.7538	0.1748	0.0		9.4975		22.0025	NORMAL	
0663	6		2.8000	14.0000	+	4.4000	5.7000	4.1967	0.7363	0.0	**	0.5000		11.4652	NORMAL	
0664	2		7.4000	8.8000	+	8.1000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0668	2		4.1000	11.0000	+	7.5500	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
IRON					MG/L											
0608	2	**	0.0300	0.0900	+	0.0525	NA	NA	NA	50.0		NA		NA	UNKNOWN	1
0611	3	**	0.0300	0.0800		0.0400	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
0618	3		0.0300	0.0900		0.0500	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
0619	2		0.0300	0.0800	+	0.0550	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0625	3	**	0.0300	0.1900		0.0500	NA	NA	NA	33.3		NA		NA	UNKNOWN	1
0657	6	**	0.0300	0.0500	**	0.0300	NA	NA	NA	66.7	**	0.0300		0.0500	NONPARAMETRIC	2,6
0663	7	**	0.0300	0.0500	**	0.0300	NA	NA	NA	71.4	**	0.0300		0.0500	NONPARAMETRIC	2
0664	2		0.0600	0.1400	+	0.1000	NA	NA	NA	0.0		NA		NA	UNKNOWN	1
0668	3	**	0.0300	0.1100	**	0.0300	NA	NA	NA	66.7		NA		NA	UNKNOWN	1
LEAD					MG/L											
0608	2	**	0.0100	** 0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0611	3	**	0.0100	** 0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0618	2	**	0.0100	** 0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0619	2	**	0.0100	** 0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0625	2	**	0.0100	** 0.0100	**	0.0100	NA	NA	NA	100.0		NA		NA	UNKNOWN	1
0657	6	**	0.0100	** 0.0100	**	0.0100	NA	NA	NA	100.0	**	0.0100	**	0.0100	NONPARAMETRIC	2,6

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01, MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
LEAD					MG/L							
0663	6	** 0.0050	0.0050	+ 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,6
0664	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
LEAD-210					PCI/L							
0608	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0611	2	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 1.2000	** 1.2000	** 1.2000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0619	2	** 1.4000	** 1.4000	** 1.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	1	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	1	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0663	1	** 1.5000	** 1.5000	** 1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0664	1	1.7000	1.7000	1.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	1	1.5000	1.5000	1.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
MAGNESIUM					MG/L							
0608	2	21.1000	22.4000	+ 21.7500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	18.1000	22.8000	18.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	17.0000	18.0000	17.1000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	22.5000	23.9000	+ 23.2000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	2.4400	3.2000	2.6900	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	7	38.1000	50.4000	45.8000	44.9714	4.1512	0.0923	0.0	40.0401	49.9028	NORMAL	
0663	8	4.3200	14.0000	+ 10.8500	9.4863	3.9990	0.4216	0.0	5.2475	13.7250	NORMAL	
0664	2	15.1000	18.3000	+ 16.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	7.5700	17.6000	11.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
MANGANESE					MG/L							
0608	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.0100	0.2100	0.0400	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0618	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.0100	0.0200	+ 0.0125	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0625	3	** 0.0100	0.0200	0.0200	NA	NA	NA	33.3	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME						UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL				
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN		MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
MANGANESE						MG/L							
0657	6	** 0.0100	0.0600	**	0.0100	NA	NA	NA	66.7	** 0.0100	0.0600	NONPARAMETRIC	2,6
0663	7	0.0200	0.0300		0.0300	0.0271	0.0049	0.1798	0.0	0.0213	0.0329	NORMAL	
0664	2	0.0600	0.1100	+	0.0850	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	** 0.0100	0.0400		0.0200	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
MERCURY						MG/L							
0608	2	** 0.0002	** 0.0002	**	0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.0002	** 0.0002	**	0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.0002	0.0008	+	0.0005	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0619	2	** 0.0002	** 0.0002	**	0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	1	** 0.0002	** 0.0002	**	0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	4	** 0.0002	** 0.0002	**	0.0002	NA	NA	NA	100.0	** 0.0002	** 0.0002	NONPARAMETRIC	2,4
0663	3	** 0.0002	** 0.0002	**	0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0664	1	** 0.0002	** 0.0002	**	0.0002	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	2	** 0.0002	0.0005	+	0.0003	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
MOLYBDENUM						MG/L							
0608	2	** 0.0100	0.0100	**	0.0100	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0611	3	** 0.0100	0.1600	**	0.0100	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0618	3	** 0.0100	0.1900		0.0125	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0619	1	** 0.0100	** 0.0100	**	0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	3	** 0.0100	0.2600		0.1600	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0657	7	** 0.0100	0.1800		0.0100	NA	NA	NA	28.6	** 0.0100	0.1800	NONPARAMETRIC	2
0663	8	** 0.0100	0.2400	**	0.0100	NA	NA	NA	50.0	** 0.0100	0.2400	NONPARAMETRIC	2
0664	2	0.1300	0.1900	+	0.1600	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	** 0.0100	0.2100		0.1500	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
NET GROSS ALPHA ***						PCI/L							
0608	2	0.3700	1.5300	+	0.9500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	2	1.7300	3.0700	+	2.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NET GROSS ALPHA ***					PCI/L							
0618	2	0.2600	2.9900	+ 1.6250	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	-2.3700	6.3700	+ 2.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	1.5900	8.8100	3.7700	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	4	3.5200	16.1200	+ 9.8200	9.8200	5.4170	0.5516	0.0	-2.4794	22.1194	NORMAL	
0663	6	-0.9300	3.6600	+ 0.6150	NA	NA	NA	0.0	-0.9300	3.6600	NONPARAMETRIC	9,6
0664	2	-0.2000	0.2700	+ 0.0350	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	2	-0.7900	-0.0900	+ -0.4400	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
NICKEL					MG/L							
0608	2	** 0.0400	** 0.0400	** 0.0400	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.0400	** 0.0400	** 0.0400	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.0400	0.0800	+ 0.0500	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0619	2	** 0.0400	0.1500	+ 0.0850	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0625	2	** 0.0400	0.0700	+ 0.0450	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0657	6	** 0.0400	0.0600	** 0.0400	NA	NA	NA	66.7	** 0.0400	0.0600	NONPARAMETRIC	2,6
0663	6	** 0.0400	0.1000	** 0.0400	NA	NA	NA	83.3	** 0.0400	0.1000	NONPARAMETRIC	2,6
0664	2	0.0400	0.1400	+ 0.0900	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	** 0.0400	0.0900	** 0.0400	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
NITRATE					MG/L							
0608	2	1.0000	8.8600	+ 4.9300	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	** 1.0000	8.8600	5.0000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0618	2	4.0000	4.4300	+ 4.2150	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	4.0000	17.7200	+ 10.8600	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	7	6.0000	29.0000	21.0000	20.1143	7.0490	0.3504	0.0	11.7405	28.4881	NORMAL	
0663	8	0.4000	7.0000	+ 1.8000	NA	NA	NA	37.5	0.4000	7.0000	NONPARAMETRIC	2
0664	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	3	** 1.0000	6.7000	** 1.0000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
NITRITE					MG/L							
0608	2	** 0.1000	1.3200	+ 0.6850	NA	NA	NA	50.0	NA	NA	UNKNOWN	1

*** NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.
9) The nonparametic distribution was used because the data failed the normal distribution test and includes values ≤0.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
NITRITE					MG/L							
0611	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.1000	0.9900	+ 0.5200	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0619	2	** 0.1000	0.3300	+ 0.1900	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0625	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0663	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0664	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
NITRITE AND NITRATE					MG/L							
0608	1	2.4000	2.4000	2.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	1	2.0000	2.0000	2.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	1	1.3000	1.3000	1.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	1	4.1000	4.1000	4.1000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0663	1	0.7000	0.7000	0.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
PH					SU							
0608	2	7.7700	7.8300	+ 7.7990	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0611	3	7.7600	8.1700	7.9400	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0618	3	7.0500	7.6700	7.4600	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0619	2	7.4700	7.5800	+ 7.5215	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0625	4	8.3000	8.7700	+ 8.4212	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0657	7	7.1600	7.4800	7.3300	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0663	10	8.1300	9.8900	+ 8.3502	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0664	2	7.9300	8.4900	+ 8.1254	NA	NA	NA	0.0	NA	NA	UNKNOWN	
0668	3	8.7800	9.6900	9.1100	NA	NA	NA	0.0	NA	NA	UNKNOWN	
PHOSPHATE					MG/L							
0608	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.1000	1.0000	** 0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0618	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	4	** 0.1000	0.3000	** 0.1000	NA	NA	NA	75.0	** 0.1000	0.3000	NONPARAMETRIC	2,4

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
PHOSPHATE					MG/L							
0663	3	** 0.1000	0.3000	** 0.1000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0664	1	0.3000	0.3000	0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	2	** 0.1000	1.3000	+ 0.6750	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
POLONIUM-210					PCI/L							
0608	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	2	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0618	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	1	** 0.8000	** 0.8000	** 0.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0663	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0664	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
POTASSIUM					MG/L							
0608	2	2.3100	2.3200	+ 2.3150	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	2.8000	3.6500	3.4100	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	1.2000	1.5700	1.5500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	2.1900	2.2100	+ 2.2000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	0.9300	1.0600	1.0100	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	7	1.6900	3.9300	1.8000	2.2814	0.8419	0.3690	0.0	1.2814	3.2815	NORMAL	
0663	8	2.4000	7.1700	+ 2.8450	3.7325	1.9364	0.5188	0.0	1.6800	5.7850	NORMAL	
0664	2	4.1200	5.4300	+ 4.7750	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	5.0900	8.6100	5.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
RADIUM-226					PCI/L							
0608	2	** 0.1000	0.2000	+ 0.1250	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0611	3	** 0.6000	2.0000	** 0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	** 0.1000	1.0000	0.2000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0619	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	2	1.5000	2.1000	+ 1.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	5	** 0.1000	0.4000	0.3000	NA	NA	NA	20.0	** 0.1000	0.4000	NONPARAMETRIC	2,5

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
RADIUM-226					PCI/L							
0663	6	** 0.1000	0.2000	+ 0.2000	NA	NA	NA	16.7	** 0.1000	0.2000	NONPARAMETRIC	2,6
0664	1	** 0.4000	** 0.4000	** 0.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
RADIUM-226 + RADIUM-228					PCI/L							
0608	2	0.5500	0.7000	+ 0.6250	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	0.8000	2.3000	0.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	2	0.5500	0.7000	+ 0.6250	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	0.1500	0.4500	+ 0.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	2	2.0000	3.7000	+ 2.8500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	5	0.5500	1.4000	1.1000	1.0100	0.3362	0.3328	0.0	0.4467	1.5733	NORMAL	
0663	6	0.5000	2.3000	+ 0.9000	1.2250	0.8023	0.6550	0.0	0.1228	2.3272	NORMAL	
0664	1	0.7000	0.7000	0.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	1	0.5500	0.5500	0.5500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
RADIUM-228					PCI/L							
0608	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0618	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	2	** 1.0000	1.6000	+ 1.0500	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0657	5	** 1.0000	1.0000	** 1.0000	NA	NA	NA	40.0	** 1.0000	1.0000	NONPARAMETRIC	2,5
0663	6	** 1.0000	2.1000	** 1.0000	NA	NA	NA	16.7	** 1.0000	2.1000	NONPARAMETRIC	2,6
0664	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	1	** 1.0000	** 1.0000	** 1.0000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
REDOX POTENTIAL					mVOLTS							
0663	1	164.5000	164.5000	164.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SELENIUM					MG/L							
0608	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SELENIUM					MG/L							
0611	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	7	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2
0663	7	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	** 0.0050	NONPARAMETRIC	2
0664	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
SILICA - SIO2					MG/L							
0608	2	8.0000	11.0000	+ 9.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	8.0000	12.0000	11.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	2	10.0000	11.0000	+ 10.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	10.0000	11.0000	+ 10.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	1	11.0000	11.0000	11.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	5	13.0000	14.0000	13.9000	13.5800	0.5310	0.0391	0.0	12.6901	14.4699	NORMAL	
0663	5	11.0000	15.4000	12.8000	13.2400	1.9047	0.1439	0.0	10.0482	16.4318	NORMAL	
0664	1	10.0000	10.0000	10.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	2	10.0000	11.0000	+ 10.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SILVER					MG/L							
0608	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5
0663	5	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	** 0.0100	** 0.0100	NONPARAMETRIC	2,5
0664	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	2	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
SODIUM					MG/L							
0608	2	22.6000	24.8000	+ 23.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SODIUM				MG/L								
0611	3	69.3000	83.9000	76.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	6.3700	7.9000	6.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	21.8000	21.9000	+ 21.8500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	118.0000	124.0000	121.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	7	14.7000	46.4000	16.4000	20.6857	11.4170	0.5519	0.0	7.1230	34.2485	NORMAL	
0663	8	75.0000	103.0000	+ 78.0500	81.5875	9.7134	0.1191	0.0	71.2918	91.8832	NORMAL	
0664	2	63.1000	78.8000	+ 70.9500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	34.2000	68.3000	61.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SPECIFIC CONDUCTANCE				UMHO/CM								
0608	2	290.0000	355.0000	+ 322.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	379.0000	430.0000	410.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	240.0000	285.0000	250.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	330.0000	380.0000	+ 355.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	4	200.0000	456.0000	+ 437.5000	382.7500	122.9780	0.3213	0.0	103.5285	661.9715	NORMAL	
0657	7	410.0000	698.0000	500.0000	519.7143	98.3899	0.1893	0.0	402.8328	636.5958	NORMAL	
0663	10	300.0000	502.0000	+ 400.0000	402.9000	59.9675	0.1488	0.0	349.4043	456.3957	NORMAL	
0664	2	240.0000	395.0000	+ 317.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	210.0000	340.0000	325.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
STRONTIUM				MG/L								
0608	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	3	0.0500	0.1000	0.0800	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0657	4	0.5000	0.6000	+ 0.5050	0.5275	0.0486	0.0921	0.0	0.4172	0.6378	NORMAL	
0663	5	0.1000	0.5400	0.5000	0.3720	0.2062	0.5543	0.0	0.0265	0.7175	NORMAL	
0664	2	0.3000	0.4000	+ 0.3500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	2	0.1000	0.2000	+ 0.1500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SULFATE				MG/L								
0608	2	34.9000	35.0000	+ 34.9500	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	61.2000	77.0000	66.3000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
SULFATE				MG/L								
0618	3	12.0000	16.1000	15.2000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	53.0000	56.8000	+ 54.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	48.1000	88.5000	54.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0657	7	122.0000	194.0000	153.0000	160.8000	30.8363	0.1918	0.0	124.1682	197.4318	NORMAL	
0663	8	38.0000	70.4000	+ 47.0000	49.4625	9.6061	0.1942	0.0	39.2805	59.6445	NORMAL	
0664	2	22.6000	37.8000	+ 30.2000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	19.8000	41.9000	40.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
SULFIDE				MG/L								
0608	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0663	3	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0664	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	2	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
TEMPERATURE				C - DEGREE								
0608	2	15.0000	19.0000	+ 17.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	16.0000	18.0000	17.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	17.0000	20.0000	17.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	16.0000	17.0000	+ 16.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	4	15.6000	17.0000	+ 16.3500	16.3250	0.7805	0.0478	0.0	14.5529	18.0971	NORMAL	
0657	7	15.5000	18.5000	17.0000	17.0000	1.0801	0.0635	0.0	15.7169	18.2831	NORMAL	
0663	10	13.5000	18.0000	+ 16.5000	16.3500	1.3770	0.0842	0.0	15.1216	17.5784	NORMAL	
0664	2	16.0000	18.0000	+ 17.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	17.0000	18.0000	17.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
THALLIUM				MG/L								
0611	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	4	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,4

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS						STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
THALLIUM					MG/L							
0663	4	** 0.0100	0.0500	** 0.0100	NA	NA	NA	100.0	** 0.0100	0.0500	NONPARAMETRIC	2,4
0668	1	** 0.0100	** 0.0100	** 0.0100	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
THORIUM-230					PCI/L							
0608	2	** 0.5000	0.5000	** 0.5000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0611	2	** 0.8000	** 0.8000	** 0.8000	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0618	2	** 0.7000	** 0.7000	** 0.7000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	** 0.5000	** 0.5000	** 0.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	1	** 0.1000	** 0.1000	** 0.1000	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	2	** 0.4000	** 0.4000	** 0.4000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0663	3	** 0.8000	** 0.8000	** 0.8000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0664	1	** 0.6000	** 0.6000	** 0.6000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	1	** 0.9000	** 0.9000	** 0.9000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
TIN					MG/L							
0608	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0611	3	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0618	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0625	1	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0657	5	** 0.0050	0.0340	** 0.0050	NA	NA	NA	80.0	** 0.0050	0.0340	NONPARAMETRIC	2,5
0663	5	** 0.0050	0.0050	** 0.0050	NA	NA	NA	100.0	** 0.0050	0.0050	NONPARAMETRIC	2,5
0664	1	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0668	2	** 0.0050	** 0.0050	** 0.0050	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
TOTAL DISSOLVED SOLIDS					MG/L							
0608	2	216.0000	223.0000	+ 219.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	302.0000	313.0000	305.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	158.0000	190.0000	164.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	253.0000	303.0000	+ 278.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	316.0000	339.0000	324.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

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* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.
5) The stat. range is the 93.8% confidence interval due to a sample size of 5. The maximum is the 96.9% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME				UNITS					STATISTICAL RANGE 98% CONFIDENCE INTERVAL			
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
TOTAL DISSOLVED SOLIDS				MG/L								
0657	7	392.0000	563.0000	430.0000	464.0000	71.0188	0.1531	0.0	379.6338	548.3662	NORMAL	
0663	8	232.0000	335.0000	+ 277.0000	278.2500	33.7671	0.1214	0.0	242.4585	314.0415	NORMAL	
0664	2	275.0000	321.0000	+ 298.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	2.3600	259.0000	242.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
TOTAL ORGANIC CARBON				MG/L								
0608	2	19.0000	35.0000	+ 27.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	2	41.0000	47.0000	+ 44.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	2	25.0000	58.0000	+ 41.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	31.0000	34.0000	+ 32.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	2	** 1.0000	44.0000	+ 22.2500	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0657	2	45.0000	48.0000	+ 46.5000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0663	4	** 1.0000	37.0000	+ 12.7500	NA	NA	NA	50.0	** 1.0000	37.0000	NONPARAMETRIC	2,4
0664	1	46.0000	46.0000	46.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	1	38.0000	38.0000	38.0000	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
TOTAL ORGANIC HALOGENS				MG/L								
0608	1	0.0030	0.0030	0.0030	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	1	0.0070	0.0070	0.0070	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	1	** 0.0030	** 0.0030	** 0.0030	NA	NA	NA	100.0	NA	NA	UNKNOWN	1
0619	1	0.0050	0.0050	0.0050	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
URANIUM				MG/L								
0608	2	0.0085	0.0122	+ 0.0104	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0611	3	0.0004	0.0099	0.0015	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0618	3	0.0038	0.0070	0.0053	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0619	2	0.0257	0.0297	+ 0.0277	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0625	3	0.0003	0.0015	0.0010	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0657	7	0.0395	0.0663	0.0514	0.0509	0.0107	0.2109	0.0	0.0381	0.0637	NORMAL	
0663	8	** 0.0003	0.0020	+ 0.0009	NA	NA	NA	50.0	** 0.0003	0.0020	NONPARAMETRIC	2
0664	2	0.0085	0.0105	+ 0.0095	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	0.0013	0.0017	0.0013	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
4) The stat. range is the 87.5% confidence interval due to a sample size of 4. The maximum is the 93.8% one sided confidence int.

TABLE D.7.20 - GROUNDWATER QUALITY STATISTICS BY LOCATION: ALL DOWNGRADIENT AND CROSS GRADIENT AND ON SITE MONITOR WELLS IN THE DECHELLY FORMATION
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/21/92
REPORT DATE: 02/10/93

PARAMETER NAME					UNITS									
LOC.	SAMP	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	COEFF. OF VARIATION	% OF NON DETECTS	STATISTICAL RANGE 98% CONFIDENCE INTERVAL MINIMUM	MAXIMUM *	DISTRIBUTION TYPE	FOOT NOTE
VANADIUM					MG/L							
0608	2	** 0.0100	0.8000	+ 0.4025	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0611	3	** 0.0100	0.6000	** 0.0100	NA	NA	NA	66.7	NA	NA	UNKNOWN	1
0618	3	** 0.0100	0.6000	0.0800	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0619	2	** 0.0100	0.6000	+ 0.3025	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0625	3	** 0.0100	0.5500	0.4000	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0657	6	** 0.0100	0.3100	+ 0.0700	NA	NA	NA	16.7	** 0.0100	0.3100	NONPARAMETRIC	2,6
0663	7	** 0.0100	0.6000	** 0.0100	NA	NA	NA	71.4	** 0.0100	0.6000	NONPARAMETRIC	2
0664	2	0.2200	0.5000	+ 0.3600	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	0.0100	0.5000	0.1600	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
ZINC					MG/L							
0608	2	0.0050	0.0400	+ 0.0225	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0611	3	** 0.0050	0.7250	0.0100	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0618	2	0.0050	1.2600	+ 0.6325	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0619	2	0.0050	0.2900	+ 0.1475	NA	NA	NA	50.0	NA	NA	UNKNOWN	1
0625	3	** 0.0050	0.1100	0.0090	NA	NA	NA	33.3	NA	NA	UNKNOWN	1
0657	6	** 0.0050	0.1160	+ 0.0073	NA	NA	NA	50.0	** 0.0050	0.1160	NONPARAMETRIC	2,6
0663	7	** 0.0050	0.2250	** 0.0050	NA	NA	NA	71.4	** 0.0050	0.2250	NONPARAMETRIC	2
0664	2	0.0060	0.0110	+ 0.0085	NA	NA	NA	0.0	NA	NA	UNKNOWN	1
0668	3	0.0100	0.1180	0.0140	NA	NA	NA	0.0	NA	NA	UNKNOWN	1

** The reported value is the minimum detection limit of the data set
+ The sample size is even, so the median value is the arithmetic average of the two middle values
* The statistical maximum is the 99 percent one sided confidence interval, $\alpha = 0.01$
1) A minimum of 4 samples must be available for the statistical analysis.
2) The nonparametric distribution was used because the nondetected values comprise more than 15% of the samples.
6) The stat. range is the 96.9% confidence interval due to a sample size of 6. The maximum is the 98.5% one sided confidence int.

INPUT DATA FILENAME: M:\DART\MON01\GWQ10015.DAT

Table D.7.21 - Molybdenum Data for Monitor Wells 625, 664, and 668
SITE: MON01 MONUMENT VALLEY
08/17/85 TO 11/21/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MOLYBDENUM	0625	08/17/85	0001	DC	C	MG/L		0.26		0.01	-
	0625	04/23/86	0001	DC	C			0.16		0.01	-
	0625	02/26/92	0001	DC	C		<	0.01		0.01	-
	0625	11/21/92	0001	DC	C		<	0.0049	#N	0.0049	-
	0664	10/27/85	0001	DC	D			0.19		0.01	-
	0664	04/24/86	0001	DC	D			0.13		0.01	-
	0668	10/24/85	0001	DC	D			0.21		0.01	-
	0668	04/25/86	0001	DC	D			0.15		0.01	-
	0668	06/25/89	0001	DC	D		<	0.01		0.01	-

FORMATION OF COMPLETION CODE:
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION

FLOW RELATIONSHIP CODE:
C - CROSS GRADIENT
D - DOWN GRADIENT

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)

OTHER PARAMETER VALUE FLAGS:
- THE DATA HAS NOT YET UNDERGONE QUALITY CONTROL TESTS.
N - SPIKE SAMPLE RECOVERY NOT WITHIN CONTROL LIMITS

DATA FILE NAME: M:\DART\MON01\GWQ10017.DAT

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ALKALINITY	0616	04/21/85	0001	AL	N	MG/L CACO3		226.00		-	-
	0616	08/02/85	0001	AL	N			196.00		-	-
	0616	06/03/91	0001	AL	N			214.		-	-
	0616	06/03/91	N001	AL	N			214.		-	-
	0616	02/27/92	0001	AL	N			228		-	-
	0616	02/27/92	N001	AL	N			228		-	-
	0616	11/24/92	0001	AL	N			231		-	-
	0617	04/21/85	0001	AL	N			265.00		-	-
	0617	07/31/85	0001	AL	N			293.00		-	-
	0617	02/27/92	0001	AL	N			268		-	-
	0617	02/27/92	N001	AL	N			268		-	-
	0617	11/24/92	0001	AL	N			271		-	-
ALUMINUM	0616	06/08/82	0001	AL	N	MG/L	<	0.05		0.1	-
	0616	04/21/85	0001	AL	N			0.80		0.1	-
	0616	08/02/85	0001	AL	N			0.20		0.1	-
	0616	06/03/91	0001	AL	N		<	0.05		0.05	-
	0616	02/27/92	0001	AL	N		<	0.05		0.05	-
	0617	04/21/85	0001	AL	N			0.80		0.1	-
	0617	07/31/85	0001	AL	N			0.20		0.1	-
	0617	02/27/92	0001	AL	N		<	0.05		0.05	-
ALUMINUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.05		0.05	-
	0616	02/27/92	N001	AL	N		<	0.05		0.05	-
	0617	02/27/92	N001	AL	N		<	0.05		0.05	-
AMMONIUM	0616	04/21/85	0001	AL	N	MG/L		0.52		0.1	-
	0616	08/02/85	0001	AL	N		<	0.10		0.1	-
	0616	06/03/91	0001	AL	N			0.1		0.1	-
	0616	02/27/92	0001	AL	N		<	0.1		0.1	-
	0617	04/21/85	0001	AL	N			0.26		0.1	-
	0617	07/31/85	0001	AL	N		<	0.10		0.1	-
	0617	02/27/92	0001	AL	N		<	0.1		0.1	-
AMMONIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		0.1		0.1	-
	0616	02/27/92	N001	AL	N		<	0.1		0.1	-
	0617	02/27/92	N001	AL	N		<	0.1		0.1	-
ANTIMONY	0616	04/21/85	0001	AL	N	MG/L	<	0.003		0.003	-
	0616	08/02/85	0001	AL	N		<	0.003		0.003	-
	0616	06/03/91	0001	AL	N		<	0.003		0.003	-
	0616	02/27/92	0001	AL	N		<	0.003		0.003	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ANTIMONY	0617	04/21/85	0001	AL	N	MG/L	<	0.003		0.003	-
	0617	07/31/85	0001	AL	N		<	0.003		0.003	-
	0617	02/27/92	0001	AL	N		<	0.003		0.003	-
ANTIMONY (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.003		0.003	-
	0616	02/27/92	N001	AL	N		<	0.003		0.003	-
	0617	02/27/92	N001	AL	N		<	0.003		0.003	-
ARSENIC	0616	06/08/82	0001	AL	N	MG/L	<	0.01		0.01	-
	0616	04/21/85	0001	AL	N		<	0.01		0.01	-
	0616	08/02/85	0001	AL	N		<	0.01		0.01	-
	0616	06/03/91	0001	AL	N		<	0.01		0.01	-
	0616	02/27/92	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-
	0617	07/31/85	0001	AL	N		<	0.01		0.01	-
	0617	02/27/92	0001	AL	N		<	0.01		0.01	-
ARSENIC (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
	0616	02/27/92	N001	AL	N		<	0.01		0.01	-
	0617	02/27/92	N001	AL	N		<	0.01		0.01	-
BARIUM	0616	04/21/85	0001	AL	N	MG/L	<	0.10		0.1	-
	0616	08/02/85	0001	AL	N			0.30		0.1	-
	0616	06/03/91	0001	AL	N			0.11		0.01	-
	0616	02/27/92	0001	AL	N			0.12		0.01	-
	0617	04/21/85	0001	AL	N		<	0.10		0.1	-
	0617	07/31/85	0001	AL	N			0.20		0.1	-
	0617	02/27/92	0001	AL	N			0.05		0.01	-
BARIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		0.01		0.01	-
	0616	02/27/92	N001	AL	N			0.13		0.01	-
	0617	02/27/92	N001	AL	N			0.05		0.01	-
BERYLLIUM	0616	06/03/91	0001	AL	N	MG/L	<	0.005		0.005	-
BERYLLIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.005		0.005	-
BICARBONATE - HCO3	0616	06/08/82	0001	AL	N	MG/L		248.00		-	-
BORON	0616	04/21/85	0001	AL	N	MG/L		0.20		0.1	-
	0616	08/02/85	0001	AL	N			0.30		0.1	-
	0616	06/03/91	0001	AL	N		<	0.05		0.05	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
BORON	0617	04/21/85	0001	AL	N	MG/L		0.20		0.1	-
	0617	07/31/85	0001	AL	N			0.40		0.1	-
BORON (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		0.19		0.05	-
BROMIDE	0616	04/21/85	0001	AL	N	MG/L	<	2.00		2.	-
	0616	06/03/91	0001	AL	N		<	0.1		0.1	-
	0617	04/21/85	0001	AL	N		<	2.00		2.	-
BROMIDE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.1		0.1	-
CADMIUM	0616	04/21/85	0001	AL	N	MG/L	<	0.001		0.001	-
	0616	08/02/85	0001	AL	N		<	0.001		0.001	-
	0616	06/03/91	0001	AL	N		<	0.001		0.001	-
	0616	02/27/92	0001	AL	N		<	0.001		0.001	-
	0617	04/21/85	0001	AL	N		<	0.001		00.001	-
	0617	07/31/85	0001	AL	N		<	0.001		0.001	-
	0617	02/27/92	0001	AL	N		<	0.001		0.001	-
CADMIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.001		0.001	-
	0616	02/27/92	N001	AL	N		<	0.001		0.001	-
	0617	02/27/92	N001	AL	N		<	0.001		0.001	-
CALCIUM	0616	06/08/82	0001	AL	N	MG/L		32.50	a	0.01	-
	0616	04/21/85	0001	AL	N			35.50		0.01	-
	0616	08/02/85	0001	AL	N			31.10		0.01	-
	0616	06/03/91	0001	AL	N			35.6		0.5	-
	0616	02/27/92	0001	AL	N			30.3		0.5	-
	0617	04/21/85	0001	AL	N			18.00		0.01	-
	0617	07/31/85	0001	AL	N			18.50		0.01	-
	0617	02/27/92	0001	AL	N			18.1		0.1	-
CALCIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		4.5		0.1	-
	0616	02/27/92	N001	AL	N			31.5		0.5	-
	0617	02/27/92	N001	AL	N			18.3		0.1	-
CHLORIDE	0616	06/08/82	0001	AL	N	MG/L		24.00	a	1.	-
	0616	04/21/85	0001	AL	N			10.00		1.	-
	0616	08/02/85	0001	AL	N			16.00		1.	-
	0616	06/03/91	0001	AL	N			11.4		0.5	-
	0616	02/27/92	0001	AL	N			9.7		0.5	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
N - UNKNOWN

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
CHLORIDE	0617	04/21/85	0001	AL	N	MG/L		27.00		1.	-
	0617	07/31/85	0001	AL	N			23.00		1.	-
	0617	02/27/92	0001	AL	N			15.5		0.5	-
CHLORIDE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		11.3		0.5	-
	0616	02/27/92	N001	AL	N			9.8		0.5	-
	0617	02/27/92	N001	AL	N			15.8		0.5	-
CHROMIUM	0616	04/21/85	0001	AL	N	MG/L	<	0.01		0.01	-
	0616	08/02/85	0001	AL	N			0.04		0.01	-
	0616	06/03/91	0001	AL	N		<	0.01		0.01	-
	0616	02/27/92	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-
	0617	07/31/85	0001	AL	N			0.03		0.01	-
	0617	02/27/92	0001	AL	N		<	0.01		0.01	-
CHROMIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
	0616	02/27/92	N001	AL	N		<	0.01		0.01	-
	0617	02/27/92	N001	AL	N		<	0.01		0.01	-
COBALT	0616	04/21/85	0001	AL	N	MG/L	<	0.05		0.05	-
	0616	08/02/85	0001	AL	N		<	0.05		0.05	-
	0616	06/03/91	0001	AL	N		<	0.03		0.03	-
	0617	04/21/85	0001	AL	N		<	0.05		0.05	-
	0617	07/31/85	0001	AL	N		<	0.05		0.05	-
COBALT (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.03		0.03	-
COPPER	0616	04/21/85	0001	AL	N	MG/L	<	0.02		0.02	-
	0616	08/02/85	0001	AL	N			0.03		0.02	-
	0616	06/03/91	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.02		0.02	-
	0617	07/31/85	0001	AL	N			0.03		0.02	-
COPPER (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
CYANIDE	0616	04/21/85	0001	AL	N	MG/L	<	0.01		0.01	-
	0616	08/02/85	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-
	0617	07/31/85	0001	AL	N		<	0.01		0.01	-
FLUORIDE	0616	06/08/82	0001	AL	N	MG/L	<	1.00	a	1.	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
FLUORIDE	0616	04/21/85	0001	AL	N	MG/L		0.50		0.1	-
	0616	08/02/85	0001	AL	N			0.60		0.1	-
	0616	06/03/91	0001	AL	N			0.3		0.1	-
	0617	04/21/85	0001	AL	N			0.60		0.1	-
	0617	07/31/85	0001	AL	N			0.90		0.1	-
FLUORIDE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		0.3		0.1	-
GROSS ALPHA	0616	04/21/85	0001	AL	N	PCI/L		3.90		0.2	3.90000
	0616	08/02/85	0001	AL	N			5.40		0.2	3.90000
	0616	06/03/91	0001	AL	N			10.7		1.	6.2
	0616	02/27/92	0001	AL	N			1.2		1.0	3.9
	0617	04/21/85	0001	AL	N			1.20		0.2	4.80000
	0617	07/31/85	0001	AL	N			3.10		0.2	4.80000
	0617	02/27/92	0001	AL	N			3.3		1.0	5.4
GROSS ALPHA (TOTAL)	0616	06/03/91	N001	AL	N	PCI/L		6.5		1.	7.1
	0616	02/27/92	N001	AL	N			3.7		1.0	4.2
	0617	02/27/92	N001	AL	N			0.0		1.0	5.2
GROSS BETA	0616	04/21/85	0001	AL	N	PCI/L		3.30		1.	1.70000
	0616	08/02/85	0001	AL	N			2.30		1.	3.40000
	0616	06/03/91	0001	AL	N			3.5		0.5	3.2
	0616	02/27/92	0001	AL	N			1.8		0.5	2.6
	0617	04/21/85	0001	AL	N			3.60		1.	1.90000
	0617	07/31/85	0001	AL	N			1.00		1.	3.20000
	0617	02/27/92	0001	AL	N			0.0		0.5	2.8
GROSS BETA (TOTAL)	0616	06/03/91	N001	AL	N	PCI/L		4.4		0.5	3.5
	0616	02/27/92	N001	AL	N			2.2		0.5	2.6
	0617	02/27/92	N001	AL	N			2.5		0.5	3.1
IRON	0616	06/08/82	0001	AL	N	MG/L	<	0.10	a	0.1	-
	0616	04/21/85	0001	AL	N			0.03		0.03	-
	0616	08/02/85	0001	AL	N			0.06		0.03	-
	0616	06/03/91	0001	AL	N		<	0.03		0.03	-
	0616	02/27/92	0001	AL	N		<	0.03		0.03	-
	0617	04/21/85	0001	AL	N			0.03		0.03	-
	0617	07/31/85	0001	AL	N			0.18		0.03	-
	0617	02/27/92	0001	AL	N		<	0.03		0.03	-
IRON (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		0.16		0.03	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
IRON (TOTAL)	0616	02/27/92	N001	AL	N	MG/L		0.14		0.03	-
	0617	02/27/92	N001	AL	N		<	0.03		0.03	-
LEAD	0616	04/21/85	0001	AL	N	MG/L	<	0.01		0.01	-
	0616	08/02/85	0001	AL	N		<	0.01		0.01	-
	0616	06/03/91	0001	AL	N		<	0.005		0.005	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-
	0617	07/31/85	0001	AL	N		<	0.01		0.01	-
LEAD (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
LEAD-210	0616	04/21/85	0001	AL	N	PCI/L		1.20		1.5	1.00000
	0616	08/02/85	0001	AL	N			1.20		1.5	1.20000
	0617	04/21/85	0001	AL	N		<	1.10000	b	1.5	1.10000
	0617	07/31/85	0001	AL	N		<	1.00000	b	1.5	1.00000
MAGNESIUM	0616	06/08/82	0001	AL	N	MG/L		24.00	a	0.001	-
	0616	04/21/85	0001	AL	N			22.80		0.001	-
	0616	08/02/85	0001	AL	N			23.60		0.001	-
	0616	06/03/91	0001	AL	N			28.4		0.1	-
	0616	02/27/92	0001	AL	N			25.6		0.1	-
	0617	04/21/85	0001	AL	N			31.20		0.001	-
	0617	07/31/85	0001	AL	N			29.70		0.001	-
	0617	02/27/92	0001	AL	N			33.0		0.1	-
MAGNESIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		26.1		0.1	-
	0616	02/27/92	N001	AL	N			28.2		0.1	-
	0617	02/27/92	N001	AL	N			35.3		0.1	-
MANGANESE	0616	04/21/85	0001	AL	N	MG/L	<	0.01		0.01	-
	0616	08/02/85	0001	AL	N		<	0.01		0.01	-
	0616	06/03/91	0001	AL	N		<	0.01		0.01	-
	0616	02/27/92	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-
	0617	07/31/85	0001	AL	N		<	0.01		0.01	-
	0617	02/27/92	0001	AL	N		<	0.01		0.01	-
MANGANESE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
	0616	02/27/92	N001	AL	N		<	0.01		0.01	-
	0617	02/27/92	N001	AL	N		<	0.01		0.01	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT
b - CHANGED PARAMETER VALUE

FLOW RELATIONSHIP CODE:
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TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
MERCURY	0616	04/21/85	0001	AL	N	MG/L	<	0.0002		0.0002	-
	0616	08/02/85	0001	AL	N		<	0.0002		0.0002	-
	0617	04/21/85	0001	AL	N		<	0.0002		0.0002	-
	0617	07/31/85	0001	AL	N		<	0.0002		0.0002	-
MOLYBDENUM	0616	06/08/82	0001	AL	N	MG/L	<	0.025	a	0.025	-
	0616	04/21/85	0001	AL	N		<	0.01		0.01	-
	0616	08/02/85	0001	AL	N			0.08		0.01	-
	0616	06/03/91	0001	AL	N			0.01		0.01	-
	0616	02/27/92	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-
	0617	07/31/85	0001	AL	N			0.06		0.01	-
	0617	02/27/92	0001	AL	N			0.01		0.01	-
MOLYBDENUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
	0616	02/27/92	N001	AL	N		<	0.01		0.01	-
	0617	02/27/92	N001	AL	N			0.02		0.01	-
NET GROSS ALPHA *	0616	04/21/85	0001	AL	N	PCI/L		2.19		-	-
	0616	08/02/85	0001	AL	N			3.89		-	-
	0616	06/03/91	0001	AL	N			10.01		-	-
	0616	02/27/92	0001	AL	N			-1.54		-	-
	0617	04/21/85	0001	AL	N			-2.50		-	-
	0617	07/31/85	0001	AL	N			0.15		-	-
	0617	02/27/92	0001	AL	N			-0.13		-	-
NET GROSS ALPHA (TOTAL) **	0616	06/03/91	N001	AL	N	PCI/L		6.16		-	-
	0616	02/27/92	N001	AL	N			0.96		-	-
	0617	02/27/92	N001	AL	N			-2.06		-	-
NICKEL	0616	04/21/85	0001	AL	N	MG/L	<	0.04		0.04	-
	0616	08/02/85	0001	AL	N			0.06		0.04	-
	0616	06/03/91	0001	AL	N		<	0.04		0.04	-
	0617	04/21/85	0001	AL	N		<	0.04		0.04	-
	0617	07/31/85	0001	AL	N			0.08		0.04	-
NICKEL (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.04		0.04	-

* NET GROSS ALPHA (GROSS ALPHA - URANIUM) WITH 1 MG URANIUM = 686 PCI
** NET GROSS ALPHA (TOTAL) (TOTAL GROSS ALPHA - TOTAL URANIUM)

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
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FLOW RELATIONSHIP CODE:
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TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
NITRATE	0616	04/21/85	0001	AL	N	MG/L		8.86		1.	-
	0616	08/02/85	0001	AL	N			3.00		1.	-
	0616	06/03/91	0001	AL	N			6.2		1.	-
	0616	02/27/92	0001	AL	N			2.4		1.0	-
	0617	04/21/85	0001	AL	N			22.15		1.	-
	0617	07/31/85	0001	AL	N			6.00		1.	-
	0617	02/27/92	0001	AL	N			12.6		1.0	-
NITRATE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		5.7		1.	-
	0616	02/27/92	N001	AL	N			4.9		1.0	-
	0617	02/27/92	N001	AL	N			13.0		1.0	-
NITRITE	0616	04/21/85	0001	AL	N	MG/L		0.33		0.1	-
	0616	08/02/85	0001	AL	N		<	0.10		0.1	-
	0617	07/31/85	0001	AL	N		<	0.10		0.1	-
NITRITE AND NITRATE	0616	04/21/85	0001	AL	N	MG/L		2.10		0.1	-
	0616	06/03/91	0001	AL	N			1.40		0.05	-
	0617	04/21/85	0001	AL	N			5.00		0.1	-
NITRITE AND NITRATE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		1.29		0.05	-
PH	0616	06/08/82	0001	AL	N	SU		6.90		-	-
	0616	04/21/85	0001	AL	N			8.11		-	-
	0616	08/02/85	0001	AL	N			7.52		-	-
	0616	06/03/91	0001	AL	N			7.89		-	-
	0616	06/03/91	N001	AL	N			7.89		-	-
	0616	02/27/92	0001	AL	N			8.25		-	-
	0616	02/27/92	N001	AL	N			8.25		-	-
	0616	11/24/92	0001	AL	N			8.90		-	-
	0617	04/21/85	0001	AL	N			8.17		-	-
	0617	07/31/85	0001	AL	N			7.74		-	-
	0617	02/27/92	0001	AL	N			8.39		-	-
	0617	02/27/92	N001	AL	N			8.39		-	-
	0617	11/24/92	0001	AL	N			8.57		-	-
PHOSPHATE	0616	04/21/85	0001	AL	N	MG/L		0.20		0.1	-
	0616	08/02/85	0001	AL	N		<	0.1		0.1	-
	0617	04/21/85	0001	AL	N		<	0.10		0.1	-
	0617	07/31/85	0001	AL	N		<	0.1		0.1	-
POLONIUM-210	0616	04/21/85	0001	AL	N	PCI/L	<	0.80000	b	1.	0.80000

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
b - CHANGED PARAMETER VALUE

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
POLONIUM-210	0616	08/02/85	0001	AL	N	PCI/L	<	0.70000	b	1.	0.70000
	0617	04/21/85	0001	AL	N		<	0.80000	b	1.	0.80000
	0617	07/31/85	0001	AL	N		<	0.60000	b	1.	0.60000
POTASSIUM	0616	06/08/82	0001	AL	N	MG/L		1.00	a	0.01	-
	0616	04/21/85	0001	AL	N			1.07		0.01	-
	0616	08/02/85	0001	AL	N			2.08		0.01	-
	0616	06/03/91	0001	AL	N			1.06		0.01	-
	0616	02/27/92	0001	AL	N			0.87		0.01	-
	0617	04/21/85	0001	AL	N			0.91		0.01	-
	0617	07/31/85	0001	AL	N			0.76		0.01	-
	0617	02/27/92	0001	AL	N			0.55		0.01	-
POTASSIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		1.28		0.01	-
	0616	02/27/92	N001	AL	N			0.84		0.01	-
	0617	02/27/92	N001	AL	N			0.63		0.01	-
RADIUM-226	0616	06/08/82	0001	AL	N	PCI/L	<	2.00	ae	2.	-
	0616	04/21/85	0001	AL	N			0.10	c	0.3	0.20000
	0616	08/02/85	0001	AL	N			0.50	c	0.8	0.30000
	0616	06/03/91	0001	AL	N			0.0		1.	0.2
	0616	02/27/92	0001	AL	N			0.0		1.0	0.2
	0617	04/21/85	0001	AL	N		<	0.20000	d	0.1	0.20000
	0617	07/31/85	0001	AL	N			0.10	c	0.3	0.20000
	0617	02/27/92	0001	AL	N			0.1		1.0	0.2
RADIUM-226 (TOTAL)	0616	06/03/91	N001	AL	N	PCI/L		0.1		1.	0.3
	0616	02/27/92	N001	AL	N			0.0		1.0	0.1
	0617	02/27/92	N001	AL	N			0.0		1.0	0.2
RADIUM-226 + RADIUM-228	0616	04/21/85	0001	AL	N	PCI/L		0.60		-	-
	0616	08/02/85	0001	AL	N			1.00		-	-
	0616	06/03/91	0001	AL	N			0.40		-	-
	0616	02/27/92	0001	AL	N			2.30		-	-
	0617	04/21/85	0001	AL	N			0.55		-	-
	0617	07/31/85	0001	AL	N			0.60		-	-
	0617	02/27/92	0001	AL	N			1.70		-	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

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SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT
b - CHANGED PARAMETER VALUE
c - CHANGED DETECTION LIMIT
d - CHANGED DETECTION LIMIT AND PARAMETER VALUE
e - NO UNCERTAINTY VALUE REPORTED

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
RADIUM-226 + RADIUM-228 TOTAL	0616	06/03/91	N001	AL	N	PCI/L		7.80		-	-
	0616	02/27/92	N001	AL	N			0.00		-	-
	0617	02/27/92	N001	AL	N			0.00		-	-
RADIUM-228	0616	04/21/85	0001	AL	N	PCI/L	<	1.00000	b	1.	1.00000
	0616	08/02/85	0001	AL	N		<	0.70000	b	1.	0.70000
	0616	06/03/91	0001	AL	N			0.4		1.	1.6
	0616	02/27/92	0001	AL	N			2.3		1.0	1.1
	0617	04/21/85	0001	AL	N		<	0.70000	b	1.	0.70000
	0617	07/31/85	0001	AL	N		<	0.80000	b	1.	0.80000
	0617	02/27/92	0001	AL	N			1.6		1.0	1.0
RADIUM-228 (TOTAL)	0616	06/03/91	N001	AL	N	PCI/L		7.7		1.	2.3
	0616	02/27/92	N001	AL	N			0.0		1.0	1.8
	0617	02/27/92	N001	AL	N			0.0		1.0	3.0
SELENIUM	0616	06/08/82	0001	AL	N	MG/L	<	0.005	a	0.005	-
	0616	04/21/85	0001	AL	N		<	0.005		0.005	-
	0616	08/02/85	0001	AL	N		<	0.005		0.005	-
	0616	02/27/92	0001	AL	N			0.005		0.005	-
	0617	04/21/85	0001	AL	N		<	0.005		0.005	-
	0617	07/31/85	0001	AL	N		<	0.005		0.005	-
	0617	02/27/92	0001	AL	N			0.007		0.005	-
SELENIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		0.006		0.005	-
	0616	02/27/92	N001	AL	N		<	0.005		0.005	-
	0617	02/27/92	N001	AL	N			0.005		0.005	-
SILICA - SIO2	0616	04/21/85	0001	AL	N	MG/L		25.00		2.	-
	0616	08/02/85	0001	AL	N			11.00		2.	-
	0616	06/03/91	0001	AL	N			26.1		0.1	-
	0617	04/21/85	0001	AL	N			33.00		2.	-
	0617	07/31/85	0001	AL	N			5.00		2.	-
SILICA - SIO2 (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		8.7		0.1	-
SILVER	0616	04/21/85	0001	AL	N	MG/L	<	0.01		0.01	-
	0616	08/02/85	0001	AL	N		<	0.01		0.01	-
	0616	06/03/91	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT
b - CHANGED PARAMETER VALUE

FLOW RELATIONSHIP CODE:
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SAMPLE ID CODES:
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TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	PARAMETER VALUE	PARAMETER FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
SILVER	0617	07/31/85	0001	AL	N	MG/L	<	0.01		0.01	-
SILVER (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
SODIUM	0616	06/08/82	0001	AL	N	MG/L		80.10	a	0.002	-
	0616	04/21/85	0001	AL	N			34.20		0.002	-
	0616	08/02/85	0001	AL	N			50.10		0.002	-
	0616	06/03/91	0001	AL	N			66.		1.	-
	0616	02/27/92	0001	AL	N			57.		1.	-
	0617	04/21/85	0001	AL	N			150.00		0.002	-
	0617	07/31/85	0001	AL	N			134.00		0.002	-
	0617	02/27/92	0001	AL	N			91.		1.	-
SODIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		63.		1.	-
	0616	02/27/92	N001	AL	N			61.		1.	-
	0617	02/27/92	N001	AL	N			93.		1.	-
SPECIFIC CONDUCTANCE	0616	06/08/82	0001	AL	N	UMHO/CM		500.00		-	-
	0616	04/21/85	0001	AL	N			390.00		-	-
	0616	08/02/85	0001	AL	N			700.00		-	-
	0616	06/03/91	0001	AL	N			602.		-	-
	0616	06/03/91	N001	AL	N			602.		-	-
	0616	02/27/92	0001	AL	N			397		-	-
	0616	02/27/92	N001	AL	N			397		-	-
	0616	11/24/92	0001	AL	N			400		-	-
	0617	04/21/85	0001	AL	N			650.00		-	-
	0617	07/31/85	0001	AL	N			900.00		-	-
	0617	02/27/92	0001	AL	N			525		-	-
	0617	02/27/92	N001	AL	N			525		-	-
	0617	11/24/92	0001	AL	N			500		-	-
STRONTIUM	0616	04/21/85	0001	AL	N	MG/L	<	0.10		0.1	-
	0616	08/02/85	0001	AL	N		<	0.10		0.1	-
	0616	06/03/91	0001	AL	N			0.43		0.01	-
	0616	02/27/92	0001	AL	N			0.40		0.01	-
	0617	04/21/85	0001	AL	N		<	0.10		0.1	-
	0617	07/31/85	0001	AL	N		<	0.10		0.1	-
	0617	02/27/92	0001	AL	N			0.37		0.01	-
STRONTIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		0.05		0.01	-
	0616	02/27/92	N001	AL	N			0.44		0.01	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
STRONTIUM (TOTAL)	0617	02/27/92	N001	AL	N	MG/L		0.39		0.01	-
SULFATE	0616	06/08/82	0001	AL	N	MG/L		80.00	a	0.1	-
	0616	04/21/85	0001	AL	N			55.80		0.1	-
	0616	08/02/85	0001	AL	N			61.30		0.1	-
	0616	06/03/91	0001	AL	N			134.		10.	-
	0616	02/27/92	0001	AL	N			69.		10.	-
	0617	04/21/85	0001	AL	N			158.00		0.1	-
	0617	07/31/85	0001	AL	N			144.00		0.1	-
	0617	02/27/92	0001	AL	N			85.		10.	-
SULFATE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L		82.		0.1	-
	0616	02/27/92	N001	AL	N			77.		10.	-
	0617	02/27/92	N001	AL	N			91.		10.	-
SULFIDE	0616	04/21/85	0001	AL	N	MG/L	<	0.10		0.1	-
	0616	08/02/85	0001	AL	N		<	0.01		0.1	-
	0617	04/21/85	0001	AL	N		<	0.10		0.1	-
	0617	07/31/85	0001	AL	N		<	0.01		0.1	-
SULFIDE (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	1.	I	1.	-
TEMPERATURE	0616	06/08/82	0001	AL	N	C - DEGREE		19.00		-	-
	0616	04/21/85	0001	AL	N			13.00		-	-
	0616	08/02/85	0001	AL	N			19.00		-	-
	0616	06/03/91	0001	AL	N			15.7		-	-
	0616	06/03/91	N001	AL	N			15.7		-	-
	0616	02/27/92	0001	AL	N			8.6		-	-
	0616	02/27/92	N001	AL	N			8.6		-	-
	0616	11/24/92	0001	AL	N			9.0		-	-
	0617	04/21/85	0001	AL	N			14.00		-	-
	0617	07/31/85	0001	AL	N			21.00		-	-
	0617	02/27/92	0001	AL	N			9.7		-	-
	0617	02/27/92	N001	AL	N			9.7		-	-
	0617	11/24/92	0001	AL	N			10.1		-	-
THALLIUM	0616	06/03/91	0001	AL	N	MG/L	<	0.01		0.01	-
THALLIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
THORIUM-230	0616	04/21/85	0001	AL	N	PCI/L		0.10	c	0.7	0.60000

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:
I - INCREASED DETECTION LIMIT DUE TO REQUIRED DILUTION
a - ADDED DETECTION LIMIT
c - CHANGED DETECTION LIMIT

FLOW RELATIONSHIP CODE:
N - UNKNOWN

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER VALUE PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
THORIUM-230	0616	08/02/85	0001	AL	N	PCI/L		0.20	c	0.7	0.50000
	0616	06/03/91	0001	AL	N			0.8		1.	0.3
	0617	04/21/85	0001	AL	N			0.20	c	0.9	0.70000
	0617	07/31/85	0001	AL	N			0.20		1.	0.80000
THORIUM-230 (TOTAL)	0616	06/03/91	N001	AL	N	PCI/L		1.4		1.	0.5
TIN	0616	04/21/85	0001	AL	N	MG/L	<	0.005		0.005	-
	0616	08/02/85	0001	AL	N		<	0.005		0.005	-
	0616	06/03/91	0001	AL	N		<	0.01	I	0.01	-
	0617	04/21/85	0001	AL	N		<	0.005		0.005	-
	0617	07/31/85	0001	AL	N		<	0.005		0.005	-
TIN (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01	I	0.01	-
TOTAL DISSOLVED SOLIDS	0616	06/08/82	0001	AL	N	MG/L		366.00	a	10.	-
	0616	04/21/85	0001	AL	N			294.00		10.	-
	0616	08/02/85	0001	AL	N			368.00		10.	-
	0616	06/03/91	0001	AL	N			378.		10.	-
	0616	02/27/92	0001	AL	N			349.		10.	-
	0617	04/21/85	0001	AL	N			626.00		10.	-
	0617	07/31/85	0001	AL	N			581.00		10.	-
	0617	02/27/92	0001	AL	N			442.		10.	-
TOTAL ORGANIC CARBON	0616	04/21/85	0001	AL	N	MG/L		79.00		1.	-
	0616	08/02/85	0001	AL	N			46.00		1.	-
	0616	06/03/91	0001	AL	N			1.		1.	-
	0616	06/03/91	N001	AL	N		<	1.		1.	-
	0616	02/27/92	0001	AL	N		<	1.		1.	-
	0616	02/27/92	N001	AL	N		<	1.		1.	-
	0617	04/21/85	0001	AL	N			41.00		1.	-
	0617	07/31/85	0001	AL	N			44.00		1.	-
	0617	02/27/92	0001	AL	N		<	1.		1.	-
	0617	02/27/92	N001	AL	N		<	1.		1.	-
TOTAL ORGANIC HALOGENS	0616	04/21/85	0001	AL	N	MG/L		0.005		-	0.00500
	0617	04/21/85	0001	AL	N			0.005		-	0.00100
URANIUM	0616	06/08/82	0001	AL	N	MG/L		0.004	a	0.003	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
N - UNKNOWN

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

OTHER PARAMETER VALUE FLAGS:
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a - ADDED DETECTION LIMIT
c - CHANGED DETECTION LIMIT

TABLE D.7.22 - Groundwater Quality Data for Domestic Wells 616 and 617
SITE: MON01 MONUMENT VALLEY
06/08/82 TO 11/24/92
REPORT DATE: 02/17/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PARAMETER PVI	VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
URANIUM	0616	04/21/85	0001	AL	N	MG/L		0.0025	c	0.0025	-
	0616	08/02/85	0001	AL	N			0.0022	c	0.0022	-
	0616	06/03/91	0001	AL	N			0.001		0.001	-
	0616	02/27/92	0001	AL	N			0.004		0.001	-
	0617	04/21/85	0001	AL	N			0.0054		0.003	-
	0617	07/31/85	0001	AL	N			0.0043		0.003	-
	0617	02/27/92	0001	AL	N			0.005		0.001	-
URANIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.001		0.001	-
	0616	02/27/92	N001	AL	N			0.004		0.001	-
	0617	02/27/92	N001	AL	N			0.003		0.001	-
VANADIUM	0616	06/08/82	0001	AL	N	MG/L	<	0.025	a	0.025	-
	0616	04/21/85	0001	AL	N		<	0.01		0.01	-
	0616	08/02/85	0001	AL	N			0.50		0.01	-
	0616	06/03/91	0001	AL	N		<	0.01		0.01	-
	0616	02/27/92	0001	AL	N		<	0.01		0.01	-
	0617	04/21/85	0001	AL	N		<	0.01		0.01	-
	0617	07/31/85	0001	AL	N			0.60		0.01	-
	0617	02/27/92	0001	AL	N			0.02		0.01	-
VANADIUM (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.01		0.01	-
	0616	02/27/92	N001	AL	N		<	0.01		0.01	-
	0617	02/27/92	N001	AL	N			0.01		0.01	-
ZINC	0616	04/21/85	0001	AL	N	MG/L		1.00		0.005	-
	0616	08/02/85	0001	AL	N			0.12		0.005	-
	0616	06/03/91	0001	AL	N		<	0.005		0.005	-
	0616	02/27/92	0001	AL	N		<	0.005		0.005	-
	0617	04/21/85	0001	AL	N			1.60		0.005	-
	0617	07/31/85	0001	AL	N			0.01		0.005	-
	0617	02/27/92	0001	AL	N		<	0.005		0.005	-
ZINC (TOTAL)	0616	06/03/91	N001	AL	N	MG/L	<	0.005		0.005	-
	0616	02/27/92	N001	AL	N			0.039		0.005	-
	0617	02/27/92	N001	AL	N		<	0.005		0.005	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
N - UNKNOWN

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

SAMPLE ID CODES:
0001 - FILTERED SAMPLE (.45 MICRONS)
N001 - UNFILTERED SAMPLE

OTHER PARAMETER VALUE FLAGS:
a - ADDED DETECTION LIMIT
c - CHANGED DETECTION LIMIT

DATA FILE NAME: M:\DART\MON01\GWQ10018.DAT

D.8 SURFACE-WATER HYDROLOGY

D.8.1 GENERAL

The nearest occurrences of perennial surface water at the Mexican Hat site in the area of the tailings are three sewage lagoons at the northwest corner of the site. One of these sewage lagoons contains approximately 475,000 gallons of untreated liquid wastes; the other two lagoons are available to receive overflow from the active sewage lagoon. Recharge to these lagoons is from the sewage discharge system serving the community of Halchita. The impounded wastes recharge the upper hydrostratigraphic unit by infiltration through the unlined pond base; no surface discharge from the pond is evident. Overflow from the pond drains northwestward toward the San Juan River via a small, unnamed arroyo.

The San Juan River represents the largest surface-water occurrence in the area. The river is approximately one air mile north of the tailings site and 240 feet lower in elevation.

The arroyos in the area of the site, Gypsum Creek being the largest, contain ephemeral occurrences of surface water. Several seeps have been reported at various times within these drainages, but in general, surface water in the arroyos is confined to periods immediately following precipitation events.

D.8.2 DRAINAGE AND FLOW

Gypsum Creek, an ephemeral stream, is located approximately 2000 feet east of the tailings pile. Due to the ephemeral nature of flows within Gypsum Creek, no records of flow within the creek exist. This creek is separated from the tailings site by a low ridge line, and is incised approximately 100 feet below the elevation of the tailings site. The effects of flows within Gypsum Creek, in terms of affecting the tailings site, are considered negligible.

The site is drained by a network of arroyos that ultimately discharge into the San Juan River (Figure D.8.1). The tailings site is located approximately one mile south of the San Juan River, a large, perennial-flowing tributary of the Colorado River.

These networks of arroyos are similarly incised, ephemeral, and have no record of measured discharges. Due to the relatively small size of the upstream watershed, slightly greater than 360 acres, and the relatively deeply incised nature of the arroyos, the effects of flows within these arroyos upon the tailings site is likewise considered negligible.

D.8.3 FLOODING ANALYSIS

The Mexican Hat tailings site is approximately one air mile south of the San Juan River and 240 feet above the riverbed. The potential for floodwaters reaching the pile is considered negligible; therefore, a flood analysis is not required.

D.8.4 WATER QUALITY

Tailings site

Perennial flowing surface water is present within the San Juan River, located approximately one mile north of the tailings site. The river receives sporadic discharges from the arroyos draining the area of the tailings site, at the confluence of Gypsum Creek and the San Juan River (see Figure D.8.1).

Water-quality analyses for samples withdrawn from the San Juan River, both upstream and downstream of the tailings site, are available from several sources. The U.S. Geological Survey (USGS) has collected water-quality data continuously since 1927 at a sampling station located on the south bank of the river, downstream from the confluence of the river and Gypsum Creek (Figure D.8.1). The USGS (1985) data indicate that the flow-weighted TDS concentration averaged approximately 360 milligrams per liter over the 59-year period of record. The dominant ions are normally calcium and sulfate, except during spring runoff when bicarbonate and calcium dominate. The pH value of the water generally ranges from 7.5 to 8. The river is generally free of chemical constituents with concentrations in excess of EPA drinking water standards, although occasionally iron, manganese, and sulfate do occur in concentrations marginally to substantially above EPA drinking water standards. Due to the relatively large flow, and subsequent diluting effect within the river, it is unlikely that the sporadic discharges from the arroyos draining the area of the tailings have any measurable impact upon the chemical quality of the San Juan River.

Radiological water-quality data have been reported for samples collected with the San Juan River, both upstream and downstream of the tailings site. These data are found in reports compiled by the EPA (1973), Geochemistry and Environmental Chemistry Research (GECR, 1982), and DOE (see Section D.2). Sample locations are shown in Figure D.8.1, and water-quality analyses are reported in Table D.8.1. These data indicate that Ra-226 and total uranium concentrations measured upstream of the tailings site do not vary significantly from those concentrations measured downstream of the site.

Borrow sites

Due to the ephemeral nature of surface-water flows within the arroyos draining the areas of the borrow sites, no water-quality data are available for these locations. Even if available, water-quality analyses

of water within the arroyos would not be indicative of stream-water chemistry, because of evaporative effects, unless the water-quality samples could be collected during periods of stream flow.

D.8.5 WATER USE

The Halchita community obtains all of its water from the San Juan River. This is accomplished by use of a Navajo Tribal Utility Authority (NTUA) pumping station and water treatment plant located on the south bank of the San Juan River below the point where Gypsum Creek empties into the river. The treated water is pumped, via an aqueduct, into three holding tanks located in the hills to the east of Halchita. The average production rate at the pumping station for the three-year period of May 1982 to May 1985, was approximately 9.74 million gallons per year.

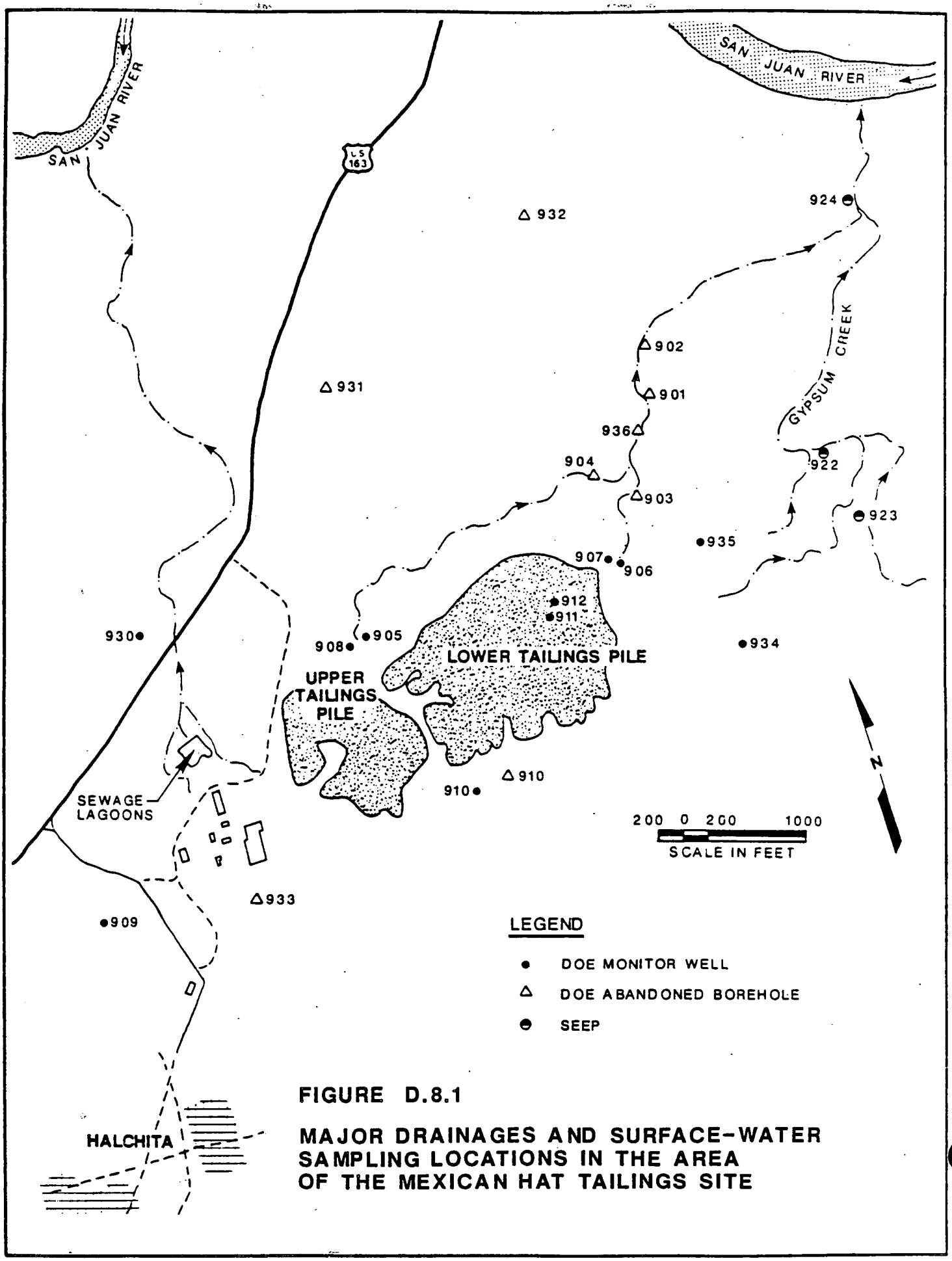

FIGURE D.8.1

MAJOR DRAINAGES AND SURFACE-WATER SAMPLING LOCATIONS IN THE AREA OF THE MEXICAN HAT TAILINGS SITE

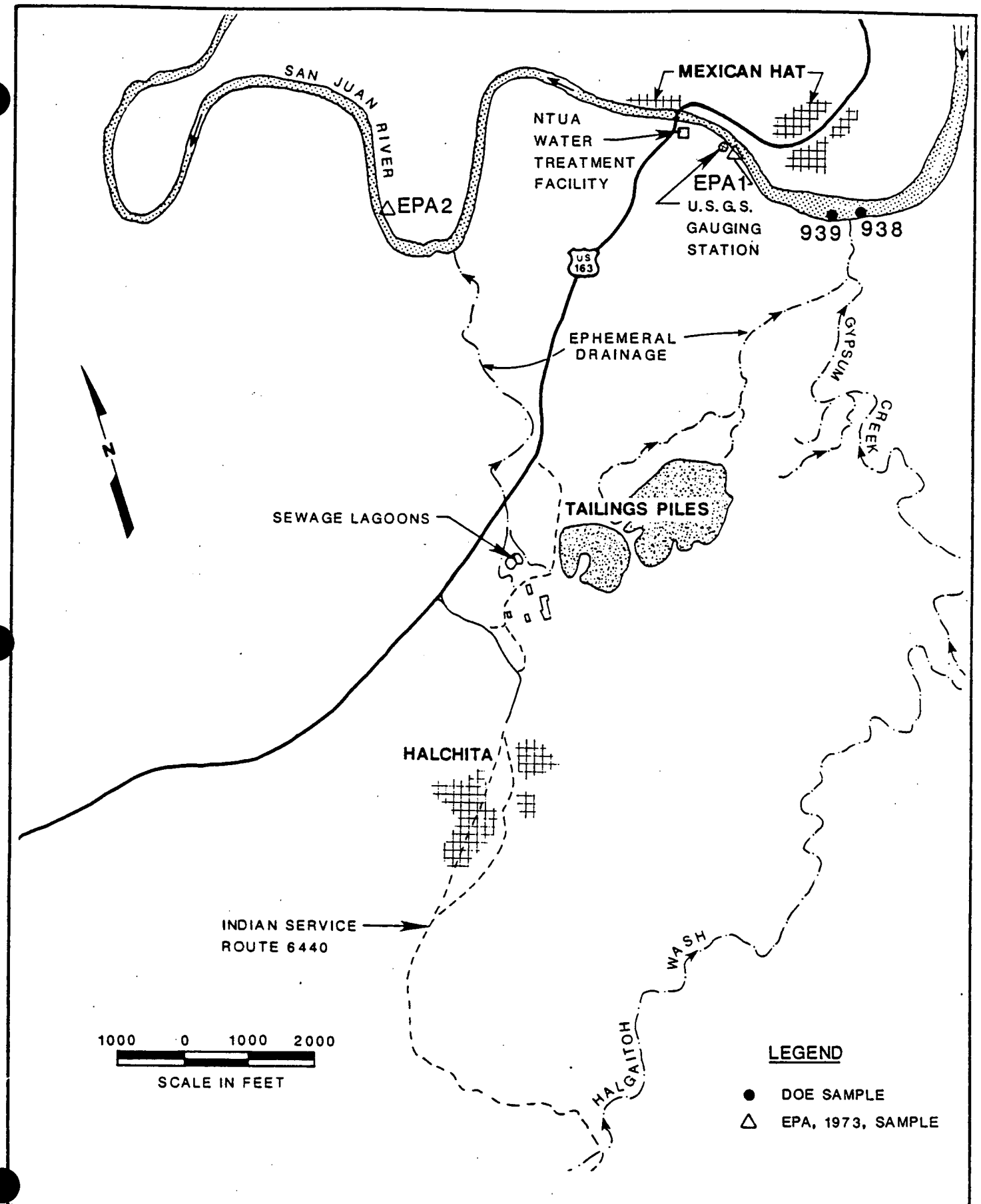

FIGURE D.8.2
SURFACE-WATER SAMPLING LOCATIONS ON THE SAN JUAN RIVER

Table D.8.1 Radiological analyses of surface-water samples collected in the area of Mexican Hat tailings site

	Location identification						
Constituent	EPA1	EPA2	938	939	954	955	961
Uranium, mg/l	--	--	0.0009	0.0050	0.0014	0.0017	0.0024
Ra-226, pCi/g	0.13	0.17	0.4 ± 0.2	0.2 ± 0.2	--	--	--

D.9 METEOROLOGICAL DATA

Meteorological data are essential in order to estimate the length of the construction season, plan construction dust and runoff controls, design long-term erosion control and proper cover for the stabilized tailings, and determine any special protection required for personnel or equipment.

D.9.1 WEATHER PATTERNS

The climate at the Mexican Hat site is of the semiarid desert type, with light precipitation, low relative humidity, and large ranges in daily and annual temperatures. The winters are cold but not usually severe, with Fahrenheit temperatures of zero degrees or below occurring only every second or third year. The summers are characterized by hot, dry weather with high temperatures in the 90s and low 100s (°F) (FBD and SNL, 1983). Wind directions depend on the local pressure gradient and terrain features, and average wind velocities are generally less than 10 miles per hour (mph). Thunderstorms with accompanying lightning are relatively common, especially during the warmer months of the year. Winds associated with storm fronts or severe thunderstorms may occasionally exceed 60 mph, but normally are between 30 and 40 mph. More severe weather events such as hailstorms and tornadoes are less frequent (Stevens et al., 1983).

D.9.2 WIND

A one-year wind record from the White Mesa Project at Blanding, Utah, shows an overall average wind speed of 9.2 mph (all directions) with the most frequent direction being from the south (Table D.9.1) (NRC, 1979). Blanding is approximately 35 air miles northeast of the site. Wind measurements at the tailings site in July and August 1976 showed the wind blowing predominantly from the southwest at an average velocity of five mph, with gusts up to 40 mph (FBD and SNL, 1983).

Atmospheric stability data for the Farmington, New Mexico, airport are provided in Table D.9.2. This station is approximately 90 air miles west-southwest of Mexican Hat; however, it is the closest station for which these data are available.

D.9.3 TEMPERATURE

Temperature data for the Mexican Hat site are provided in Table D.9.3. The average annual maximum and minimum temperatures are 71.9°F and 40.7°F, respectively. The average monthly maximum temperatures range from 43.4°F in January to 98.4°F in July, and the average monthly minimum temperatures range from 18.9°F to 65.2°F in the same months, respectively. Diurnal temperature ranges are wide, commonly 30°F or more (Stevens et al., 1983).

D.9.4 PRECIPITATION

Precipitation data for the Mexican Hat site are provided in Table D.9.3. The average annual precipitation is 6.09 inches, more than half of which occurs as rain during July through January. Approximately 60 percent of the annual precipitation occurs between the average freeze-free (32°F) dates. Snowfall averages 3.3 inches annually, and all of this occurs during November through February (Stevens et al., 1983). The 10-year 24-hour precipitation frequency value for the Mexican Hat area is 1.7 inches (Miller et al., 1973).

D.9.5 FROST

The average freeze-free (32°F) period at the Mexican Hat site is April 19 through October 23, or 190 days (Stevens et al., 1983). Data on the depth to the frost line at the Mexican Hat site are not available.

D.9.6 EVAPORATION

Estimated pan evaporation rates for the Mexican Hat site are provided in Table D.9.3. The estimated annual evaporation rate is 84.41 inches, most of which would occur during April through October (Stevens et al., 1983). Pan evaporation rates were measured at Mexican Hat during April through November of 1957 through 1976. The average monthly rates were as follows (Crowell, 1985):

April	9.07 inches	August	12.68 inches
May	12.35 inches	September	9.48 inches
June	14.49 inches	October	5.49 inches
July	15.22 inches	November	2.34 inches

Reportedly, 75 percent of the evaporation at Mexican Hat occurs during April through October (DOC, 1968).

Based on the period 1946 to 1955, the mean annual lake evaporation at Mexican Hat is approximately 50 inches (DOC, 1968).

Table D.9.1 Wind speed at Blanding, Utah[a]

Direction	Average speed (miles per hour)	Frequency[b] (percent)
N	8.5	5.9
NNE	8.7	7.4
NE	8.1	9.1
ENE	6.2	4.2
E	5.7	3.5
ESE	7.6	3.8
SE	8.0	5.7
SSE	5.8	5.1
S	9.4	9.6
SSW	11.9	7.9
SW	10.8	8.5
WSW	11.8	4.1
W	11.0	5.0
WNW	9.5	4.0
NW	10.9	9.4
NNW	9.6	7.1
All	9.2	

[a]Data for the one-year period of March 1, 1977, to February 28, 1978, at Blanding, Utah, adapted from NRC, 1979.
[b]Does not total 100 percent because of rounding.

Table D.9.2 Atmospheric stability distribution for the Farmington, New Mexico, airport

Stability class	Stability description	Frequency (percent)
A	Extremely unstable	4.68
B	Moderately unstable	8.74
C	Slightly unstable	12.96
D	Neutral	15.81
E	Slightly stable	12.73
F	Moderately stable	15.08

Ref. DOE, 1984.

Table D.9.3 Temperature, precipitation, and pan evaporation data for Mexican Hat, Utah[a]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual means or totals
Normal maximum temperature[b]	43.4	52.9	61.2	71.1	81.6	93.0	98.4	95.2	87.6	74.4	57.8	45.3	71.9
Normal minimum temperature[b]	18.9	24.8	30.1	38.4	48.1	57.2	65.2	63.1	52.8	40.1	28.7	20.0	40.7
Normal monthly precipitation[c]	0.50	0.43	0.38	0.31	0.35	0.19	0.66	0.65	0.54	0.96	0.51	0.61	6.09
Average monthly snow[c]	1.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	3.3
Estimated pan evaporation[c]	0.35	1.10	3.11	7.15	11.71	14.51	15.55	12.85	9.34	5.69	2.16	0.89	84.41

[a]Station 5582, elevation 4120 feet above sea level; period of record 1951-1980.
[b]Degrees Fahrenheit (°F).
[c]Inches.

Ref. Stevens et al., 1983.

REFERENCES

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Remedial Action Plan for the Codisposal and Stabilization of the Monument Valley and Mexican Hat Uranium Mill Tailings at Mexican Hat, Utah

Addenda D1 through D7 of Appendix D

Final

February 1993

Appendix B of the
Cooperative Agreement
No. DE-FC04-83AL16258

Uranium Mill Tailings Remedial Action Project

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ADDENDUM D1

RADIOLOGIC CHARACTERIZATION OF THE MEXICAN HAT, UTAH,

URANIUM MILL TAILINGS REMEDIAL ACTION SITE

(Note: The data on microfiche and the Plate 1 referenced in this document are available in the DOE UMTRA Project Office, Albuquerque, New Mexico.)

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RADIOLOGIC CHARACTERIZATION OF THE MEXICAN HAT, UTAH, URANIUM MILL TAILINGS REMEDIAL ACTION SITE

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Bendix Field Engineering Corporation
Grand Junction Operations

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Plate 1. Base Map for the Mexican Hat, Utah, Site

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1.0 INTRODUCTION

This radiologic characterization of the inactive uranium millsite at Mexican Hat, Utah, was conducted by Bendix Field Engineering Corporation (Bendix) for the U.S. Department of Energy (DOE), Grand Junction Projects Office, in response to and in accord with a Statement of Work prepared by the DOE Uranium Mill Tailings Remedial Action Project (UMTRAP) Technical Assistance Contractor, Jacobs Engineering Group, Inc. (JEG). The objective of this project was to determine the horizontal and vertical extent of contamination that exceeds the U.S. Environmental Protection Agency (EPA) standards at the Mexican Hat site. The data presented in this report are required for characterization of the areas adjacent to the Mexican Hat tailings piles and for the subsequent design of cleanup activities. Some on-pile sampling was required to determine the depth of the 15-pCi/g Ra-226 interface in an area where wind and water erosion has taken place.

An orientation visit to the site was conducted on 4-8 June 1984, in conjunction with Jacobs Engineering Group, to determine the approximate extent of contamination that exceeds EPA standards surrounding the piles, to establish survey control points and baselines for later establishment of grid lines, to assess drilling requirements, and to gather background radiologic and geochemical data to be used to determine exposure rates, disequilibrium between radium and its radon daughters, moisture content in soils, and concentrations of radium, thorium, and potassium in soils. The information gained from this visit was used in determining the scope of work required for the radiologic site characterization.

Fieldwork at Mexican Hat was conducted on 10-24 September 1984. Radiometric measurements, soil samples, and building surveys were completed on 20 September and drilling was completed on 24 September 1984.

2.0 BACKGROUND

2.1 LOCATION

The inactive uranium millsite is located on the Navajo Nation (Indian Reservation) approximately 1.5 miles southwest of the town of Mexican Hat, Utah (see Figure 1). The mill housing area, now the community of Halchita, is located 0.5 mile southwest of the millsite. The millsite is within Section 13, Township 42 South, Range 18 East, Salt Lake Base and Meridian, San Juan County, Utah.

2.2 GEOLOGIC AND HYDROLOGIC SETTING

The Mexican Hat site is located within the southern Monument Upwarp region of the Colorado Plateau. This portion of the north-south elongated uplift contains several small plunging anticlines. The millsite is in the Mexican Hat syncline which is a sharp downfold between the Raplee Anticline to the east and the Cedar Mesa-Halgaito Anticlines to the west. The site is on the gently east-dipping (3 to 6 degrees) west limb of the syncline.

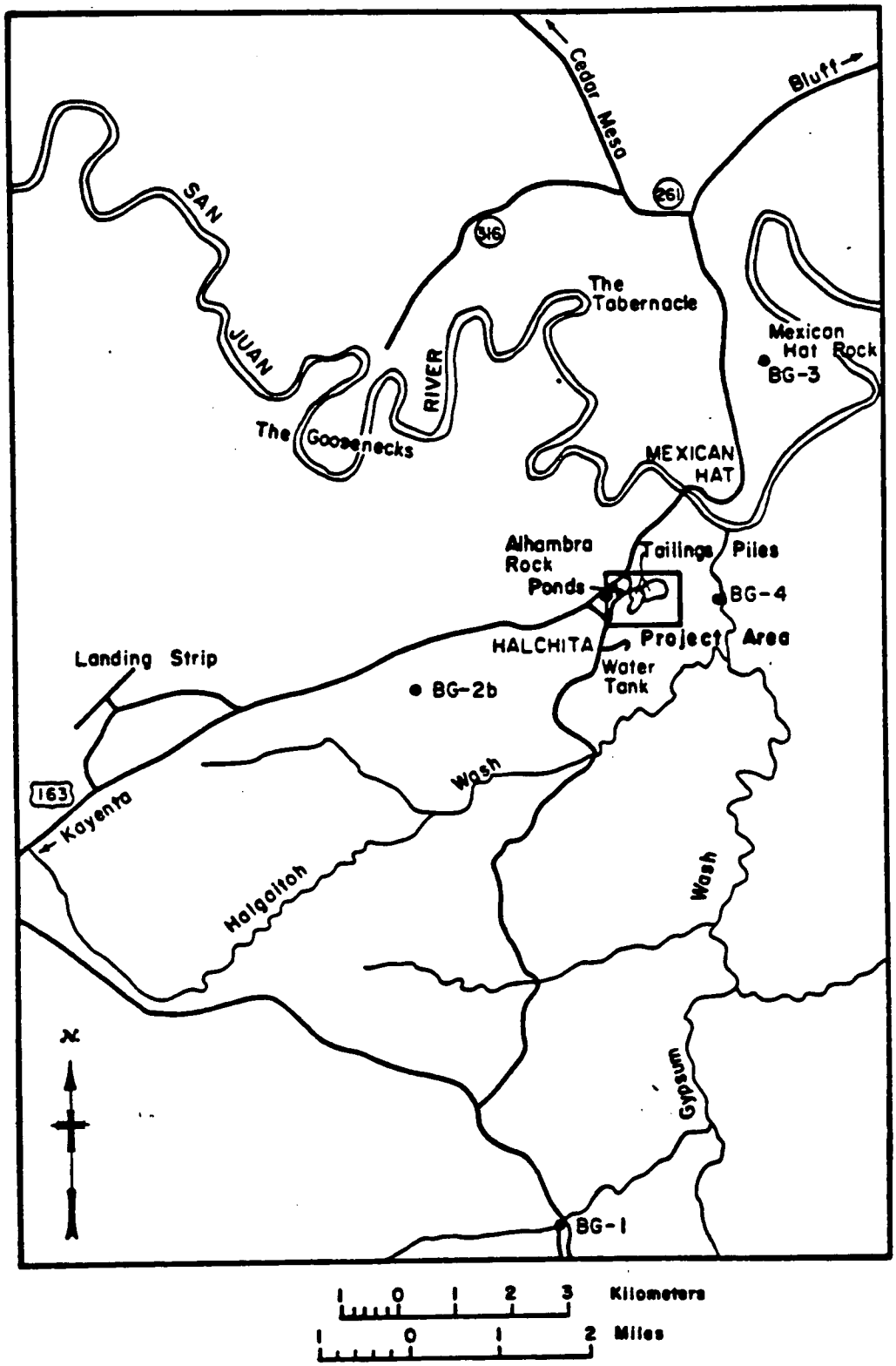

Figure 1. Location Map of the Mexican Hat Site Showing Background-Measurement Locations

Sedimentary rocks of the millsite area consist of fine-grained silty sandstones and shales of the Halgaito Tongue, a member of the Cutler Formation of Pennsylvanian age. These beds are a distinctive red to chocolate-brown in color and range in thickness from approximately 50 to 100 ft. The mill area and tailings piles are underlain by Halgaito redbeds. To the east of the tailings piles in the bottoms of the major arroyos draining the site are resistant limestone beds, probably part of the Rico Formation (or facies of the Cutler Formation), which underlie rocks of the Halgaito Tongue.

Unlike many other millsites, the Mexican Hat site does not contain a developed soil horizon or alluvial cover. Most of the site is located on bedrock or weathered bedrock. Accumulations of unconsolidated material greater than 2 ft thick are mainly restricted to man-made mixtures of bedrock, tailings, ore, and debris. Due to the color contrast between the Halgaito redbeds and contaminated materials (often white to gray), it is generally not difficult to identify contaminated materials.

Surface drainage at the millsite is to the east-northeast via tributary arroyos which drain into Gypsum Wash less than one mile from where it empties into the San Juan River. These arroyos are usually dry, with water flow restricted to infrequent periods of heavy rainfall.

Due to the fine-grained nature of the Halgaito sandstones and shales and to the arid climate at the millsite, no major near-surface groundwater aquifers exist. The major source of domestic water in the area is the San Juan River.

2.3 SITE HISTORY

The mill at Mexican Hat was built and operated by Texas-Zinc Minerals Corporation from 1957 to 1963. The mill was acquired by the Atlas Corporation in 1963 and was operated by them until operations ceased in 1965. A sulfuric acid plant continued to operate at the site until 1970. After the mill closure, control of the site reverted to the Navajo Nation. The site was used for a short period as a trade school (carpentry, welding, electrical, etc.) operated by the Utah Trades Commission. Presently the only continuously occupied portion of the site is the former mill office building which is now the Halchita Health Center.

Much of the ore processed at the mill came from the White Canyon district of Utah. This ore contained, along with uranium, a considerable amount of copper sulfides from which copper was also recovered. Brown and others (1974) described the process of recovery as a froth-flotation process followed by acid leaching. The leached flotation concentrates were filtered to recover a final copper product and the filtrate was combined with main-circuit leach slurry from the flotation tailings. A five-stage counter-current thickener circuit was used to separate leached solids and pregnant liquor, which was then clarified before solvent extraction. The loaded organic solvent was stripped with an ammonium nitrate solution, which was then neutralized with magnesium hydroxide to precipitate the final uranium product.

The tailings were distributed to two piles (referred to as the upper and lower piles) by a cyclone separator which built up the dams with coarse sand and

allowed the slimes to flow toward the center and southwestern portions of the piles.

The mill processed a total of 2.2 million tons of ore which assayed at an average of 0.28 percent U_3O_8 and produced 5700 tons of U_3O_8 concentrate for sale to the U.S. Atomic Energy Commission.

2.4 PREVIOUS WORK

Prior to the start of fieldwork for this characterization project, a thorough literature search was performed to identify published information pertaining to remedial action at the Mexican Hat site. The results of this search are presented in the bibliography at the end of this report (Section 7.0).

Previous studies at Mexican Hat include the following: an environmental survey of the uranium mill tailings piles at Mexican Hat by the U.S. Environmental Protection Agency conducted in May 1968; a cooperative site visit to assess site conditions by the U.S. Atomic Energy Commission, Environmental Protection Agency, and the State of Utah in May 1974; an engineering assessment of the site by Ford, Bacon and Davis Utah, Inc. under contract to the U.S. Energy Research and Development Administration in 1974; a radiologic impact assessment of the site by Oak Ridge National Laboratory for the U.S. Department of Energy in March 1980; and an aerial radiologic survey of the area surrounding the site by EG&G Energy Measurement Group for the U.S. Department of Energy Office of Operational Safety in September 1980.

2.5 SITE CONDITIONS

The remains of eight mill buildings exist at the site. Of the eight buildings only two are still in use. The former mill office building has been converted to a health center and is in good condition. A metal building once used as a chemistry lab and later as a sheet metal shop is now used for storage and remains locked. The long building once used for a trade school is abandoned but appears to contain a large amount of salvageable materials. An empty metal storage shed, in good condition, also appears to be salvageable. Other buildings including the scale house, ore-crushing building, and generator building are either contaminated or do not lend themselves to salvage.

Other remains of the milling operations include foundations of buildings that have been removed, tanks used for holding crushed ore, tanks used in the manufacture of sulfuric acid, and miscellaneous buried junk materials. A sewage pond, water line, and electrical transformer are also present and in use at the site.

The tailings piles, although crusted, are not covered or stabilized and access to the piles, as well as the entire site, is not restricted. Both wind and water erosion have occurred on the piles. The piles occupy a natural drainage area and although berms and dikes were built to reduce the amount of tailings being washed or blown off of the piles, arroyos downstream from the pile contain tailings for a considerable distance. The prevailing wind direction and drainage direction are both to the northeast. Therefore an area surrounding the northeast corner of the lower pile contains both visible windblown and

water-transported tailings contamination. Outward from the pile to the east and northeast, contamination is confined to a thin (generally less than 1-in. thick) blanket of windblown tailings over a broad area and to scattered sand bars (generally less than 1-ft thick) containing tailings, located along the bottoms of arroyos draining the pile area.

Due to the variable topography at the site (rolling hills, narrow ridges, and deep arroyos), much of the access to sampling, measurement, and drilling sites was accomplished by the use of three-wheeled, all-terrain cycles (ATCs). A portion of the drilling at the site was accomplished using a portable hand-held gas-powered auger.

3.0 PROCEDURES

The measurement techniques, instrumentation, and procedures used for the Mexican Hat radiologic characterization were based primarily on protocols developed by the DOE Division of Remedial Action Projects (DRAP) Technical Measurements Center (TMC) and on field-implementation experience gained during radiologic characterizations of other UMTRAP sites (Allen, Showalter, and others, 1983; Allen, Steele, and others, 1983; Allen and Strong, 1984; Marutzky and others, 1983; Shay and others, 1984; Shay and Rush, 1984; and Goodknight and Walker, 1984).

All activities at or in support of the project were performed in compliance with the provisions set forth in an approved Quality Assurance Program Plan (QAPP). To ensure the health and safety of personnel assigned to the project, a comprehensive health and safety plan was followed during the fieldwork phase of the project. This plan included monitoring of external radiologic exposure, potential for internal radiologic exposure (i.e., inhalation of airborne radioactive dust), personnel contamination, site access, and equipment contamination.

For purposes of this study, radiometric measurements made indirectly by measurement of radiation from sources other than the decay of the nuclide of interest are reported as 'equivalent' concentrations, denoted by an 'e' prefix, e.g., pCi(eRa-226)/g. Similarly, 'e' is used to report equivalent elemental concentrations (e.g., eK, eTh) calculated from the natural abundance of the nuclide (K-40 for eK) or a daughter in equilibrium with the parent (Tl-208 for eTh). Equivalent concentration is that concentration of nuclide/element of interest in equilibrium with its daughter products that yields the same measurement as the sample.

All instruments used for radiologic characterization were calibrated at the DOE calibration facilities in Grand Junction, Colorado, both before and after the fieldwork session. Instrument-response field checks were made before use each day, and the results were monitored for compliance with quality-control limits established on the statistical basis of previous response checks. The methods used for instrument-response field checks are described in Appendix A.

3.1 AREA DESIGNATIONS

The Mexican Hat site was divided into six areas (Areas A through F, Plate 1) as described in the Statement of Work, delineated on the basis of differing contamination patterns. These areas are the following: (A) windblown contamination north, northeast, and east of the tailings piles and arroyos containing both wind- and water-transported contamination; (B) windblown contamination south of the piles; (C) mill yard and ore-storage area; (D) ponds and contaminated arroyo in the northwest portion of the site; and (E) and (F) wind and water erosion adjacent to retaining dikes ringing the upper and lower tailings piles respectively. The type and amount of work required to characterize each area are discussed later in this report.

3.2 PHYSICAL SURVEY

The physical survey was conducted by a Bendix surveyor using a Theodolite and Geodimeter to establish baselines from horizontal control stations as shown on the Horizontal and Vertical Control map supplied by Jacobs Engineering Group. The millsite at Mexican Hat differed from previous sites in that the property boundary lines coincide with the baselines used to establish the grid network. A distance check was made between boundary points before baselines were established.

Once the baselines were established, several auxiliary lines were established with the instruments at right angles to the baselines to aid in gridding the different areas. All other gridpoints were set by steel tape and line of sight from established points. These gridpoints were located to the nearest 0.5 ft.

The borehole locations in Areas C and D were staked in the same manner as the gridpoints, using steel tape and existing points as line of sight. The boreholes located in Areas E and F were staked at approximate locations based on the work statement sample-design map provided by Jacobs Engineering Group. Many of the planned boreholes were moved to locations of easier access. After drilling, all holes in Areas E and F were surveyed from existing control stations. Elevations of all boreholes were established by differential leveling between control stations.

Many of these holes were moved and restaked by the Bendix Site Manager and the Technical Assistance Contractor to more accessible locations or to locations that would yield the best subsurface information (e.g., boreholes Hat-124, Hat-125, and Hat-158 in Area A).

3.3 SOIL SAMPLING AND DELTA-GAMMA RADIUM MEASUREMENTS AT GRIDPOINTS

A total of 145 gridpoints were established in Areas A through D for soil samples and delta-gamma measurements. Each grid point had a 0-to-6-in. soil sample taken for laboratory gamma-ray spectroscopic analysis. Delta-gamma measurements were made at a depth of 6 in. at specified gridpoints for field guidance in sampling. The purpose of the 0-to-6-in. soil sample was to determine the extent of surface contamination exceeding the EPA standard of 5 pCi/g Ra-226 above background. Subsequent subsurface delta-gamma measurements and soil samples were taken to define areas where the EPA standard of 15 pCi/g Ra-

226 was exceeded. The higher limit only applies to areas that will be excavated and then backfilled; the lower limit must be applied to areas that may be excavated but are not backfilled with at least 15 cm of soil. The procedure used for gridpoints in Areas A and B was (1) a 0-to-6-in. soil sample taken at each gridpoint, (2) a 6-in. delta-gamma measurement taken at one half of the gridpoints, and (3) a 6-to-12-in. soil sample where a 6-in. delta-gamma measurement indicates Ra-226 activity greater than 5 pCi/g, followed by a 12-in. delta-gamma measurement. This alternating procedure was continued until the delta measurement indicated less than 5 pCi/g or until an 18-to-24-in. soil sample was taken. In Areas C and D at every specified gridpoint this alternating soil sample/delta-gamma measurement protocol was also used.

3.3.1 Soil Sampling

Several steps were taken to ensure the integrity of the soil samples during the soil-sampling process. The samples were excavated using specially constructed shovels designed to produce samples of equal size. Care was taken to collect a uniform vertical cross section of the 6-in. layer sampled. Care was also taken to clean the sample-gathering equipment to prevent cross-contamination. Sample ticket books with the prefix MHD were used for samples collected in the field during this project. Pertinent information such as sample type, grid location, sample depth, project code, sampler's name, and soil conditions were placed on each sample ticket. A paper record of the sample-ticket number was placed inside the plastic bag holding the sample and the top of the bag was then folded twice and stapled shut to retain moisture. Using a permanent ink marker, the sample number, location, and depth were written on the plastic bag. The plastic bag was then placed in a duck-cloth bag which was also labeled with the sample number and depth. The samples were then boxed and returned to Grand Junction for analysis by the Bendix Analytical Chemistry Laboratory.

Following transport to Grand Junction, the soil samples were weighed, dried, reweighed, crushed and ground to -28 mesh, blended, and sealed in sample cans. The difference in weight after drying, or loss on drying (LOD), in percent, was recorded for about 10 percent of the samples submitted for analysis. These values were used later to calculate moisture correction factors. The samples were stored for at least 21 days to allow the radon and radon daughters to reach equilibrium with any radium present. The samples were analyzed for radium, potassium, and thorium using high-resolution germanium gamma-ray spectroscopy systems. The systems were calibrated against the New Brunswick Laboratory (NBL) Series 100-A certified gamma-ray standards. All samples were positioned on a detector by means of an automatic sample changer to maintain consistent sample/detector geometry. The laboratory procedures used are described in detail in the Handbook of Analytical and Sample-Preparation Methods (Bendix Field Engineering Corporation, 1984c).

Amplifier gain and baseline were manually checked daily, using a Th-232 source. Two known control samples were analyzed each day; acceptance of the data set thus generated required that at least one control be within one standard deviation and that both controls be within two standard deviations of the statistically established individual ranges. In addition to analysis of known controls, 10 percent of the blended samples were split and analyzed for radium concentration as blind duplicates. The duplicates are identified with an MBG sample prefix.

3.3.2 Delta-Gamma Radium Measurements

In-situ measurements of equivalent radium at gridpoints were made using a Bendix delta-gamma system containing internal collimation and prefilters. The Bendix system was operated on counting plateau using a delta (difference) technique. The detector was placed on the surface to be assayed and an UP count was collected for 120 seconds; a high-density shield was then placed between the detector and the surface being assayed and a DOWN count of 120 seconds was collected. The UP/DOWN counter automatically registered the difference or delta count.

The statistical validity of the delta-gamma measurements was monitored in the field by taking two or more sets of measurements at each location. The procedures used in determining the statistical validity of the measurements and for data reduction are described in Section 6.3 of the Radiologic Field Measurements Procedures Manual (Bendix Field Engineering Corporation, 1984a). The mean of the count sets was determined arithmetically, and the standard deviation of each count set was calculated using the equation

$$\sigma_{N_d} = \sqrt{2N_u - N_d} \qquad (1)$$

where σ is the standard deviation and where N_g and N_d are the unshielded (UP) gross counts and the shielded (DOWN) difference or delta counts, respectively. A statistical check was made to determine if the second set of measurements was within 2σ of the first. If not, a third set of measurements was made. The data were summed and σ was calculated for the total measurement. A check was made to determine whether σ is less than 15 percent of the difference count using the equation

$$U_d = \frac{\sigma_{N_d}}{N_d}(100) \qquad (2)$$

where U_d is the percent uncertainty of the difference count. If this criterion could not be met after three 120-second measurements, the data were flagged as being semiquantitative.

A calibration factor and three major corrections were applied to the raw delta-gamma readings to obtain radium concentrations in picoCuries of equivalent radium per gram [pCi(eRa-226)/g]. Calibration of the instruments was performed at the Department of Energy (DOE) Walker Field calibration pads in Grand Junction, Colorado. The stripping factors necessary to calculate raw equivalent-radium concentrations from the delta-gamma readings were obtained from the calibration data.

A correction for contributions from radioelements other than Ra-226 was made to compensate for the fact that the raw data collected in the delta-gamma measurements are the result of all gamma radiation reaching the detector. The correction factor used in the field was derived from potassium and thorium concentrations determined from in-situ gamma-ray-spectrometer measurements and laboratory gamma-ray-spectroscopic analysis of soil samples obtained during the orientation visit to the site. The correction factor used in this report was obtained from gamma-ray-spectroscopic analysis of soil samples collected during the fieldwork phase of the project.

A correction factor was also applied for soil-moisture content since soil moisture reduces the total gamma-ray flux at the surface and because concentrations are conventionally based on dry sample weight. This correction factor was obtained through laboratory loss-on-drying (LOD) measurements performed on selected soil samples taken during the fieldwork phase of the project. Due to the small variability in soil conditions at the site, an average soil-moisture value, together with the moisture-content values for the calibration pads, was converted to a single correction factor to be applied to all of the delta-gamma measurements.

A disequilibrium factor was applied to the data to correct for the disequilibrium between radium and its gamma-emitting daughter products. This disequilibrium is due to loss of radon gas, radium's first daughter, from the soil. In-situ delta-gamma measurements include these gamma-ray-emitting radon daughters. When the correction for radon loss is applied, the apparent concentration of radium measured in situ increases. The disequilibrium factor was derived from laboratory analysis of selected soil samples. Equivalent-radium concentrations were measured at 2 to 12 hours after canning, and again after 6 days. Estimates of the radon disequilibrium ratio were made by calculating the radium concentration at disequilibrium and at equilibrium, using the standard equations for ingrowth and decay of the various isotopes involved (Marutzky and others, 1984; Scott and Dodd, 1960).

3.4 ARROYO DELTA-GAMMA MEASUREMENTS

To semiquantitatively characterize the extent of contamination in arroyos draining the site in Areas A and D, delta-gamma measurements were made at 200-ft intervals until three successive surface delta-gamma measurements indicated radium concentrations less than 5 pCi/g or until physical access became impossible.

Starting at surveyed gridpoints established during the physical survey, a ROLLATAPE bicycle wheel distance-measuring device was used to establish delta-gamma measurement locations at approximately 200-ft intervals along the bottoms of the arroyos.

At each location a surface delta-gamma measurement was made. Where surface measurements indicated Ra-226 concentrations greater than 5 pCi/g, an additional measurement was made at a depth of 6 in. This procedure was followed until (1) a measurement indicated Ra-226 concentrations were less than 5 pCi/g, (2) a measurement was made at a depth of 18 in. or (3) competent bedrock was reached.

The same statistical checks and corrections that were applied to delta-gamma measurements at grid points (cf. Section 3.3.2) were used for measurements taken in the arroyos. No soil samples were taken in the arroyos with the exception of surveyed grid points used as starting points for the arroyo delta-gamma survey.

3.5 BOREHOLE SAMPLING, DRILLING, AND LOGGING

3.5.1 Sampling

For each borehole location, a 0-to-6-in. surface soil sample was taken prior to drilling. The samples were collected in the same manner as those at grid points described in Section 3.3.1. No further subsurface sampling was required at borehole locations for this study.

3.5.2 Drilling

Borehole drilling was accomplished, using standard geotechnical techniques, with a CME 550 auger rig where access permitted. Hollow-stem augers (6-5/8 in. O.D. by 3-1/4 in. I.D.) were used to drill to total depth in each hole. Augers were left in place in the hole during radiometric logging operations to prevent hole collapse and to minimize smearing of any downhole contamination. A retrievable center bit was used for drilling to avoid contamination within the auger itself; the center bit was removed for radiometric logging. The driller furnished three auger heads so that two holes could be left open for geophysical logging while the third hole was being drilled.

The boreholes were drilled to either the total estimated depth as specified in the Statement of Work or until the driller reached a point of refusal (stopped downward penetration) due to conditions such as shallow bedrock, buried concrete, large rocks, or other material that would stop penetration.

Borehole locations which were inaccessible by a truck-mounted auger rig were drilled using a portable gas-powered 'Little Beaver' drill with a 4-in.-diameter auger. The boreholes were drilled and then immediately logged with the auger removed. Equipment transport to these holes was accomplished using three-wheeled ATCs.

Once geophysical logging operations were completed, hole abandonment was accomplished by filling the hole with auger cuttings or with other nearby natural material found on the ground surface. Holes that exceeded 8 ft or more in depth and that encountered groundwater were filled with a bentonite slurry having at least a 55-second viscosity.

A Bendix drilling supervisor monitored the drilling operations and maintained a record of footage drilled and materials used. The drilling supervisor also checked the augers and drill bits for contamination after removal from each borehole, using an Eberline PAC-6 Alpha Meter. Tools measuring greater than 200 counts per minute (cpm) were cleaned to remove the apparent source of contamination. The tools were then rechecked and recleaned if necessary, until measurements were less than 60 cpm.

3.5.3 Geophysical Logging

Boreholes accessible by two-wheel-drive truck and that were at least 5 feet in depth were logged using a Bendix computer-based geophysical-borehole-logging (Compulogger) system. The probe, which contains a 2-in.-diameter-by 6-in.-long sodium iodide detector, was raised from the bottom to the top of the borehole

at an approximate rate of 1.5 ft per minute; data were recorded at each 0.5-ft interval. Repeat logs were made of the entire borehole to confirm the measurements obtained during the main logging phase.

The gamma-ray detection system was operated in a linear (energy-proportional) mode. Uphole electronics provided system-gain stabilization by monitoring the 835-keV gamma-ray peak from a manganese-54 source contained in the probe. Pulse-height data were collected from single-channel-analyzer (SCA) windows corresponding to the principal energy peaks from the decays of potassium, radium, and thorium. Data from a fourth SCA window, the total-count window (1050 to 3000 keV), were collected to provide statistically improved radium concentrations.

After returning to Grand Junction, the data from the Bendix computer-based logging system were electronically transferred from a nine-track tape on the CDC-815 computer to a disk on the Zenith Z-100 portable computer and verified according to approved quality-assurance procedures. Data from the total count channel were corrected to reflect an average subsurface moisture content of 6.3 percent.

Data from the total-count channel were also corrected for gamma-ray attenuation caused by the auger casing and auger joints. The correction factor was determined in the calibration models at Grand Junction, using sections of casing identical to the casing used at the field site. This factor is an equation which corrects all counts to the observed count rate in the constant-thickness casing. At positions far from the auger joint, the function has a value of 1.0, but as the depth measured approaches the center of the joint, the value of the correction factor increases to a maximum value. Three coefficients determine the correction, one for the maximum value at the center, one for the distance from the center at which the correction reaches one-half of the maximum, and one which controls the speed at which the exponential curves approach the maximum and minimum values.

The depth of auger joints was determined by measuring the height of the auger above the ground surface for each borehole. Since the total auger length was known, the depth of the auger joints could be calculated. The auger joint correction was applied once the joint depth was known.

The data were then spatially deconvolved (George and Price, 1982) to produce logs of apparent-radium concentration versus depth. Corrections were applied for contributions from potassium and thorium. Contributions from potassium and thorium to the apparent radium analysis for the truck-mounted system are 1 pCi(eRa-226)/g for 1 percent potassium and 0.133 pCi(eRa-226)/g for 1 ppm thorium-232, respectively. The average concentrations of potassium and thorium, based on soil samples taken at the site, are 1.3 percent and 6.6 ppm, respectively.

In those areas not accessible by two-wheel drive truck or at shallow boreholes less than 5 feet in depth, logging was performed using a portable gross-count system. This system consists of an Eberline Model PRS-1 field survey meter (RASCAL) connected by 20 ft of cable to a waterproof Eberline Model SPA-3, 2-in.-by-2-in. sodium iodide detector. The system is operated on counting plateau in a gross-count mode, which counts all gamma rays whose energies exceed approximately 30 keV.

The probe was manually lowered to the bottom of the borehole in 6-in. increments, with 30-second measurements recorded manually at each step. The data measurements recorded while lowering the detector were identified as 'Phase 1'. The probe was then raised to the top of the borehole in 6-in. increments, with 30-second measurements again recorded at each step. Data recorded while the detector was being raised were identified as 'Phase 2'.

Most of the data were manually entered into the data base of a Zenith Z-100 portable computer and verified in the field according to approved quality-assurance procedures. Data taken during the last two days of fieldwork were entered and verified upon returning to Grand Junction. The data were then corrected for average moisture content and for gamma-ray attenuation caused by the auger-stem casing, as described for the truck-mounted logging system. These data were also corrected for auger-joint effects.

The borehole-logging systems were field-checked prior to logging each day, using a special monazite sand for the truck-mounted system and a radium check source for the portable system. The resulting data were recorded and compared with previous field-check data and with the two-standard-deviation limits for quality control. Repeat logging phases were run for each hole and the results of both the main and repeat phases were checked for agreement. Additional repeat logs were collected where disagreements in the data were observed. When possible, the apparent cause of the disagreement was noted.

The logging systems were calibrated, both before and after the fieldwork, using the DOE borehole-calibration models at Grand Junction, Colorado, and with the computer program LOGCAL (Showalter and others, 1984). Pre-fieldwork calibration was performed to process the data, while post-fieldwork calibration permitted detection of any equipment malfunctions. The resulting data were then archived in a permanent calibration data base.

3.6 BUILDING SURVEYS AND MEASUREMENTS

3.6.1 Exposure-Rate Measurements

Two indoor exposure-rate measurements were made at the same location in the approximate center of each building using a Reuter-Stokes Model RSS-111 Pressurized Ionization Chamber (PIC). This instrument, widely used for exposure rate measurements, produces a nearly flat response to gamma rays ranging in energy from 100 keV to 3 MeV and is also designed to respond linearly in gamma fields up to 100 mR/h.

A daily instrument check was made using a 1-μCi radium check source placed in the source-holding fixture at the top of the ion chamber. First, with the source removed, a background reading was obtained using a Bendix-modified readout to determine the average exposure rate over a time interval of 90 seconds. Following the background exposure-rate determination, the 1-μCi source was placed in the source holder and the same procedure was used to determine the average exposure rate. The background exposure rate was subtracted from the second exposure rate to determine net exposure rate from the source. The resulting value was recorded and checked for compliance with quality-control limits. To monitor PIC performance at higher exposure-rate levels, the procedure was repeated using a 10-μCi check source.

Two exposure-rate measurements were taken at the approximate center of each building at a height of 3 feet using a counting time of 180 seconds (3 minutes). The exposure-rate readings in μR/h were then entered into a field data book.

3.6.2 Alpha Measurements

An Eberline Air Proportional Alpha Detector was used to obtain gross-alpha measurements inside the site buildings. These measurements, recorded in counts per minute (cpm), were made to determine surface contamination levels. The overall objective of the measurements was to determine the extent of decontamination needed in the buildings.

A daily instrument-response check was made using a set of plutonium check sources. The detector was placed over the source and a reading was recorded. The detector was rotated 180 degrees and a second reading was recorded. The two readings were averaged and the result was checked to determine if the reading was within 2σ of the value (in cpm) stated on the reference check source. If the readings were not within 2σ, the procedure was repeated.

If the second test failed, the instrument was tagged 'DO NOT USE' and returned to Grand Junction for repair.

Two alpha measurements were made at each delineated location within the abandoned buildings. Four measurement locations were delineated for every 1000 square feet of floor space, with a minimum of four locations per building. The first reading was a direct surface reading. The location was then wiped or brushed clean and a second reading was taken. A marked decrease in count rate provided an indication that the contamination is removable. For the two buildings still in use, the Halchita Health Center and the locked storage building, both direct readings and smears were collected. The smears were taken at the same location as the direct reading. The smears were counted using a Ludlum Model 2000 Scaler with a Ludlum Model 43-17 detector for a period of 3 minutes. A sketch of each building showing the approximate alpha-measurement location was provided with the data.

3.7 BACKGROUND MEASUREMENTS

The four areas selected for background measurements near the site include an area approximately 3 miles northeast of the site near the Mexican Hat Rock, an area 5 miles to the south, an area 2 miles to the west-southwest, and an area 0.5 mile to the east. The background site to the east was located just west of Gypsum Wash, since there are no access roads across Gypsum Wash to allow establishment of a background site at least 3 miles east of the site. Three miles to the east of the site is the crest of the Raplee Anticline which is in a different geologic setting. All of the background sites were located in silty sandstones and shales of the Halgaito Tongue of the Cutler Formation, similar to the geologic setting at the millsite.

At each background site, PIC gamma exposure-rate measurements, delta-gamma measurements, and soil samples were taken. Soil samples taken during the

orientation visit were analyzed for Ra-226, Th, K, and moisture (LOD). One sample was analyzed for U-234, U-238, and Th-230. Soil samples taken at background sites during the fieldwork phase were analyzed for Ra-226, Th, and K.

4.0 RESULTS

Data obtained during the fieldwork phase of the project are presented in Appendices B through G. Discussion of the results of each task performed both during and after fieldwork is presented in subsequent sections of this report.

4.1 PHYSICAL-SURVEY RESULTS

Before establishing the baselines used in gridding the site, the Theodolite and Geodimeter were set up over two separate brass-capped control points, and the distance between the two points was measured. The measured distance was compared to the calculated distance and results indicated that the difference between the measured and the calculated distances was insignificant (less than 0.30 ft). Following this check, the baselines were established.

From the baselines, several auxiliary lines were established with the Theodolite and Geodimeter at right angles to the baselines. From these lines, gridpoints were set by tape and line of sight. A total of 145 gridpoints for sampling and measurements were established.

Boreholes in Areas C and D were located using a steel tape and existing points as line of sight prior to drilling. Several boreholes in Areas C and D were moved by the Bendix Site Manager to avoid powerlines, concrete foundations, surface bedrock, or other obstructions. These holes were usually moved only a few feet using a measuring tape and line of sight. Boreholes in Areas E and F were staked at approximate locations, based on the sample design map provided by Jacobs Engineering Group. Many of these holes were moved and restaked by the Bendix Site Manager and the Technical Assistance Contractor to more accessible locations or to locations that would yield the best subsurface information. After drilling, all holes in Areas E and F were surveyed from existing control stations to the nearest 0.5 ft.

Elevations of all boreholes were established by differential leveling between control stations. In the mill yard and ore-storage area, traverses were made from Station 5 to Station 7 to Station 6 and back to Station 5, and from Station 7 to Station 8. The differences in elevation survey closures noted at Stations 7, 6, and 5 were -0.04, -0.01, and 0.03 ft, respectively, and the difference in elevation noted at Station 8 was -0.03 ft. Around the upper tailings pile a traverse was made from Station 3 to Station 7 and back to Station 3. No difference in elevation closure was noted within this traverse. Around the lower tailings pile a traverse was made from Station 2 to Station 7 to Station 3 and back to Station 2. The differences in elevation closures noted at Stations 7, 3, and 2 were -0.17, +0.01, and +0.10 ft, respectively. The overall closure difference noted at Station 2 was -0.07 ft. All borehole elevations were determined to the nearest 0.1 ft.

The location of survey control stations, established gridpoints, and borehole locations are shown on Plate 1.

4.2 SOIL SAMPLING RESULTS

A total of 293 soil samples were collected and analyzed for radium, thorium, and potassium; results are presented in Appendix B, Table B-1. Duplicate analyses were performed on 27 samples for all three radionuclides; the results are presented in Appendix C, Table C-1. Duplicate samples are identified by the prefix MBG. Appendix C, Table C-2, presents the radium data for the original and duplicate analyses to permit comparison of the results.

The differing contamination patterns described in Section 3.1 of this report, with the exception of arroyo contamination where soil samples were not taken, are indicated in the results of soil-sample analyses. Figure 2 shows the distribution of radium concentrations for soil samples collected at 0-to-6-in. depths. Figure 3 shows the location of soil samples having greater than 5 pCi(eRa-226)/g radium concentrations in soil samples taken at 0-to-6-in. depths.

Windblown contamination (Area A) exceeding 5 pCi/g radium-226 in surface (0 to 6 in.) soil samples is present in a broad area to the northeast and east of the lower tailings pile. Soil samples taken at grid points N10152 and E9290, N10000 and E9200, N9960 and E9246, and N10600 and E10400 contain radium concentrations of 369, 535, 676, and 100 pCi/g, respectively. The first three samples are related to small piles of material containing uranium ore and the fourth was taken from the bottom of an arroyo containing water-transported tailings. All of the remaining soil samples in Area A containing greater than 5 pCi/g Ra-226 are related to windblown contamination. As shown by the delta-gamma data taken at a depth of 6 in., the windblown contamination is restricted to the upper 6 in. of material except for an area along the eastern edge of the lower pile. Only one surface soil sample in Area B has a concentration of radium-226 exceeding 5 pCi/g. This indicates that windblown contamination is insignificant south of the pile.

Contamination in soil samples taken from the mill and ore-storage areas (Area C) is highly variable. West of approximately E7600, the radium-226 concentrations in soil samples are at or near background concentrations (1 to 4 pCi/g). East of approximately E7600 to the upper tailings pile, the radium concentrations vary greatly ranging from 3 to 363 pCi/g, reflecting the scattered ore, tailings, and contaminated debris found in this area. Many of the soil samples taken in Area C correspond to borehole locations.

Soil samples taken in Area D have concentrations of Ra-226 at or near background levels, except those taken in the wash or arroyo which drains Area D to the north. The samples from the wash have Ra-226 concentrations ranging from 2 to 482 pCi/g, which represent spotty contamination by tailings and slimes being transported downstream during periods of heavy rainfall.

Equivalent-thorium concentrations in soil samples are highly variable, ranging from 0 to 1384 ppm. The highest concentrations of thorium are related to soil

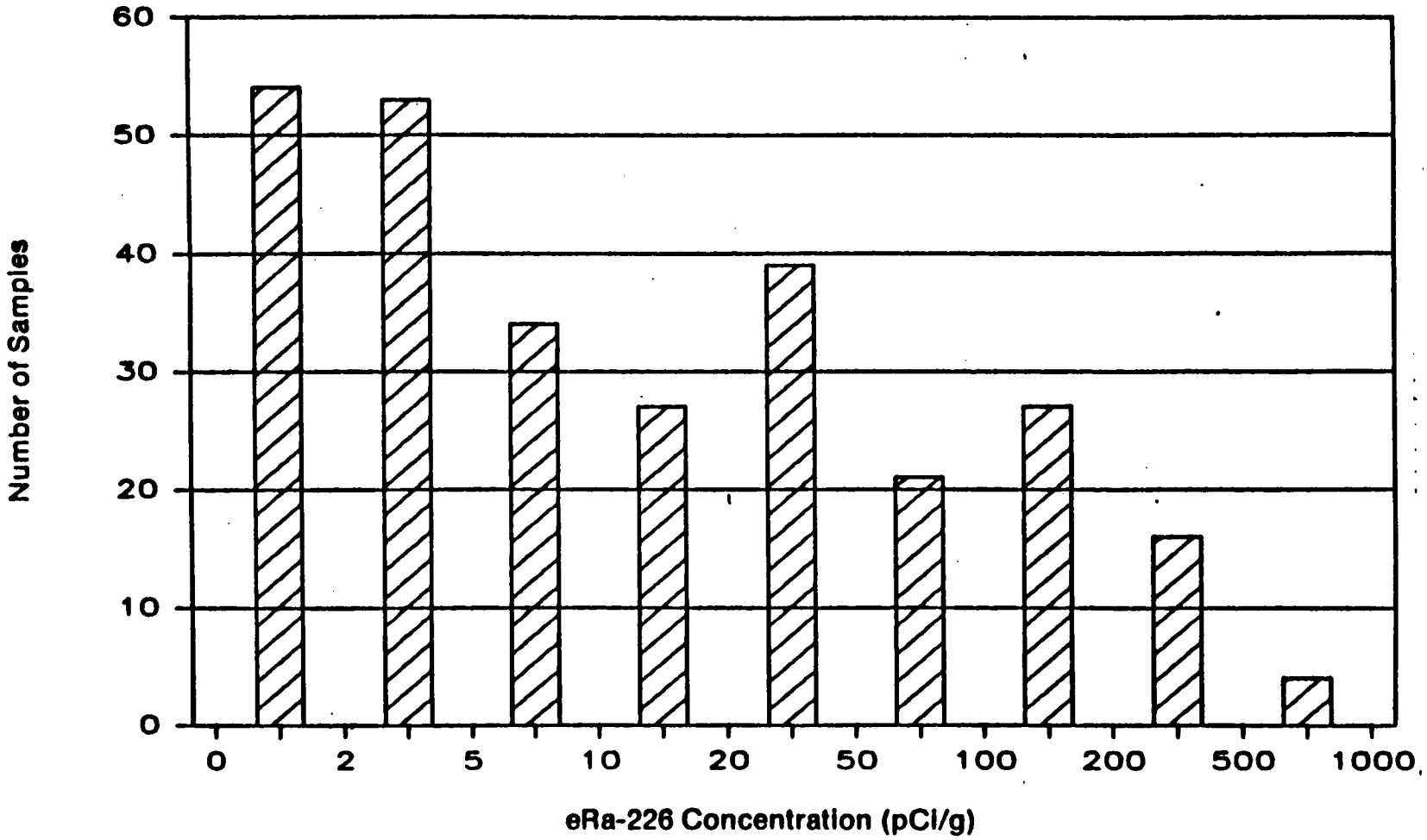

Figure 2. Histogram of Analytical Results for eRa-226 in Soils

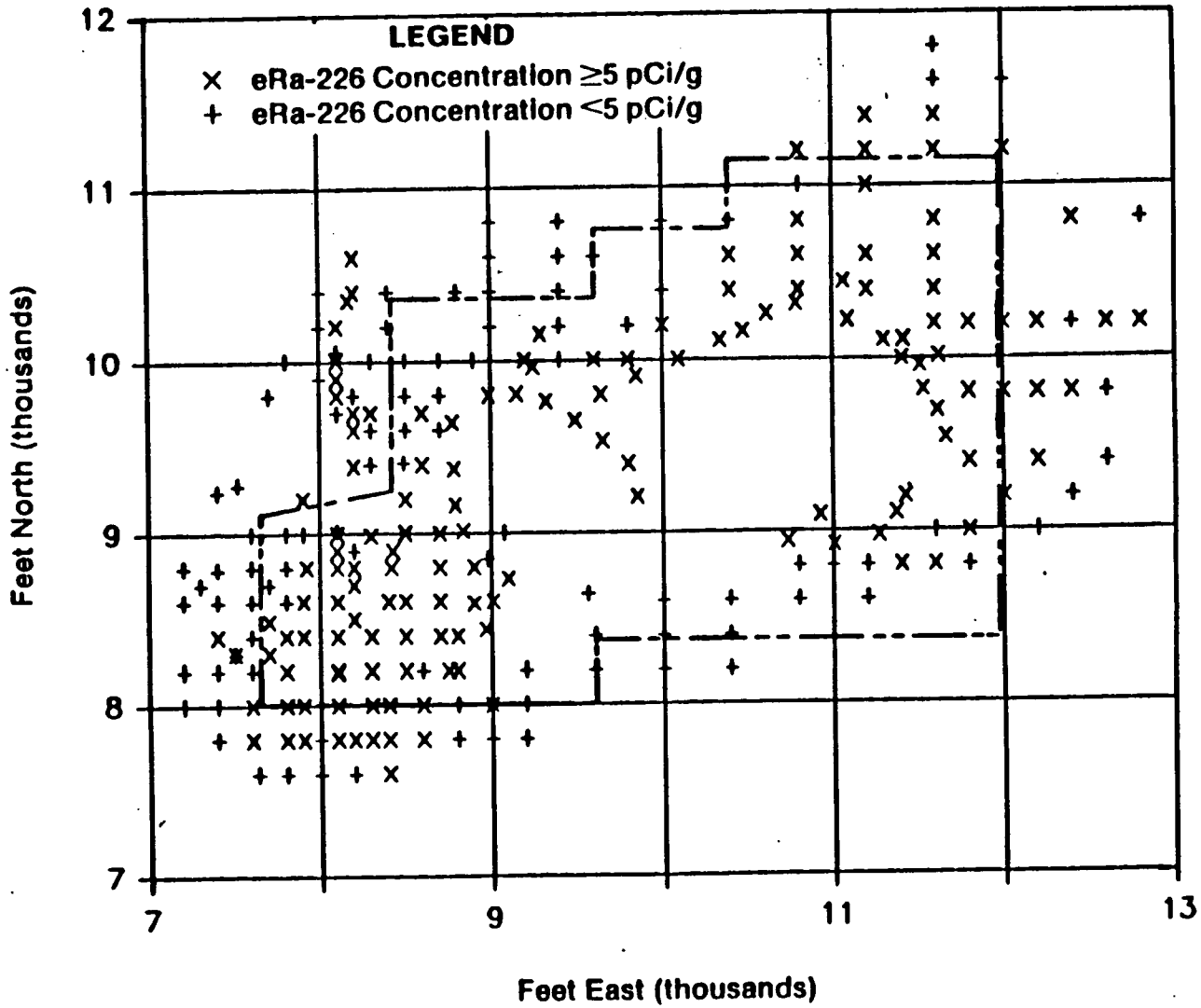

Figure 3. Locations of Soil Samples Having eRa-226 Concentrations Greater Than 5 pCi/g at Depths of 0 to 6 Inches

samples containing uranium ore and tailings. The locations of soil samples containing thorium in concentrations greater than 15 ppm are shown in Figure 4. A discussion on correction factors used to correct radiologic measurements for thorium contributions is presented in Section 4.3 of this report.

Potassium concentrations in soil samples are generally low but are also variable and range from below detection limit (<0.5 percent) to 3.2 percent. A discussion on correction factors used to correct radiologic measurements for potassium contributions is presented in the following section.

4.3 DELTA-GAMMA MEASUREMENTS

4.3.1 Soil-Moisture Correction Factors

Loss-on-drying (LOD) measurements were performed on ten percent (28) of the soil samples collected during the fieldwork phase of the study and on 16 samples collected during the site-orientation visit, to derive an average soil-moisture-content value for the site (Appendix B, Table B-2). Based on 25 soil samples taken at a depth of 0 to 6 in., the average moisture is 1.6 percent. Two samples taken at a depth of 6 to 12 in. and one sample taken at a depth of 12 to 18 in. had moisture contents of 1.13 percent, 2.65 percent, and 6.26 percent, respectively.

Soil-moisture corrections were applied to in-situ radium measurements to convert the measurements to dry-weight radium concentrations. The corrections were calculated, using the moisture content of the soil, from the equation

$$F_m = 1 + 1.11\ [M/(1-M)] \tag{3}$$

where M is the fraction of the total weight accounted for by water (Marutzky and others, 1984).

Because calibration-pad moisture must also be taken into account, the ratio of the soil-moisture correction to the calibration-pad-moisture correction is applied to the data as follows:

$$F'_m = \frac{1 + 1.11\ [M_f/(1-M_f)]}{1 + 1.11\ [M_p/(1-M_p)]} \tag{4}$$

where M_f is the soil-moisture content determined for each sampling depth interval in the study area and M_p is the calibration-pad moisture content (approximately 11 percent). Since the moisture content for the 6-to-12-in. depths was not significantly different from those of the 0-to-6-in. samples, the same correction factor ($F'_m = 0.89$) was applied for data in these depth ranges. For the seven soil samples taken below a depth of 12 in., a correction factor of $F'_m = 0.94$ was applied.

4.3.2 Disequilibrium Correction Factor

Radon escaping from the soil decreases the apparent concentration of radium measured in situ because the in-situ measurement technique actually measures gamma-ray-emitting radon daughters. The amount of this decrease is the fraction of radon that escapes from the soil.

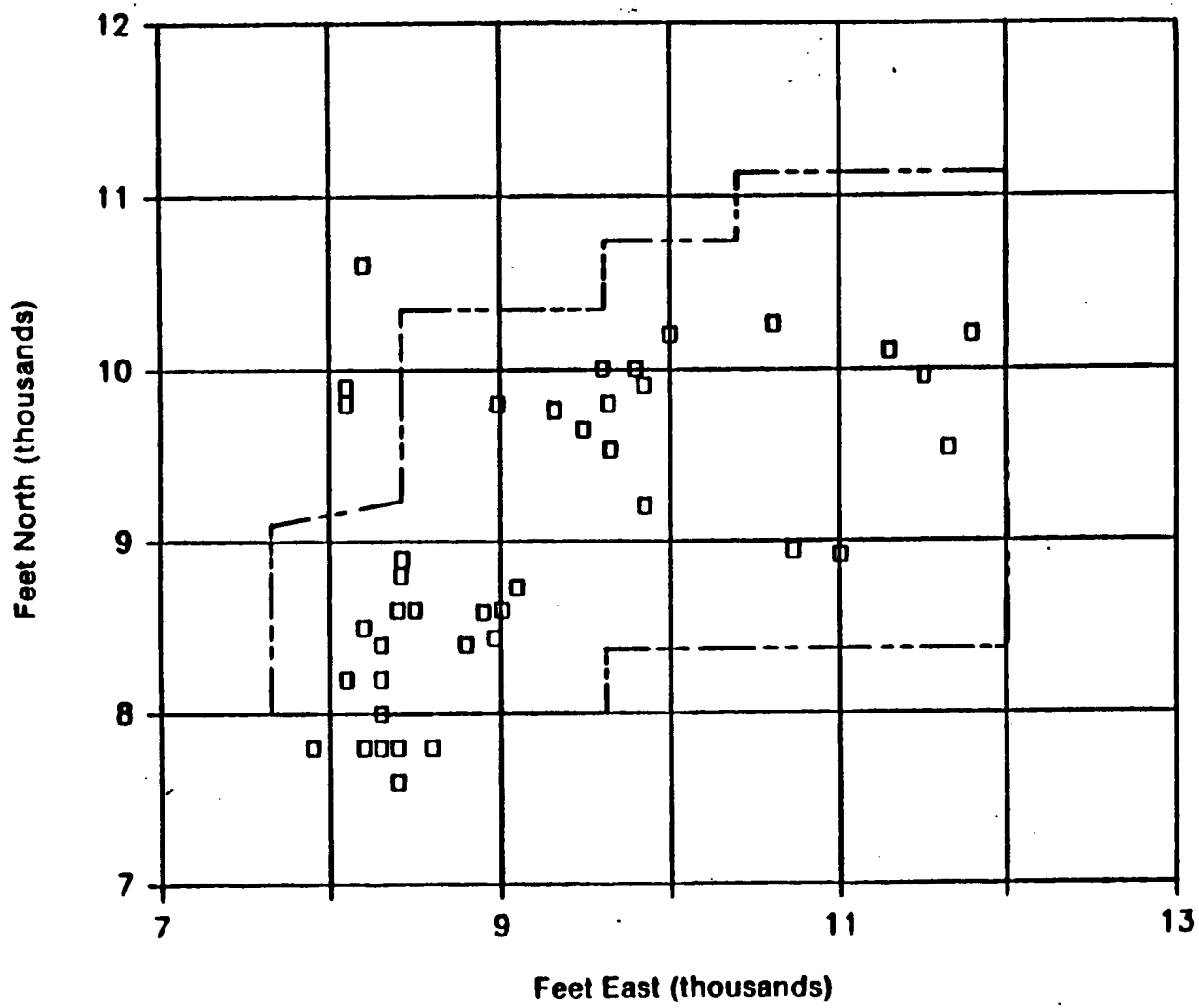

Figure 4. Locations of Soil Samples Having Thorium Concentrations Greater Than 15 ppm at Depths of 0 to 6 Inches

Results of laboratory measurements of disequilibrium between radium and its radon daughters for 2 samples taken during the site orientation visit were 17.8 ± 1.0 percent and 18.6 ± 1.0 percent. The average of the two values is 18.2 ± 1.0 percent. This value is lower than previous site disequilibrium values probably due to the low moisture content of the soils (1.6 percent for depths 0 to 6 in.).

The equation used for disequilibrium correction is

$$F_e = 1/(1-E) \tag{5}$$

where F_e is the disequilibrium correction and E is the fraction of radon escaping from the soil. The apparent-radium concentration calculated from in-situ data is multiplied by the disequilibrium factor to determine actual radium concentration. Because the calibration pads also emanate radon (approximately 10 percent), the final correction applied to the field data is the ratio between the field disequilibrium correction and the calibration-pad disequilibrium correction, or

$$F'_e = \frac{1/(1-E_f)}{1/(1-E_p)} = 1.10 \tag{6}$$

where E_p is the fraction of radon escaping from the pads (10 percent) and E_f is the fraction of radon escaping from the soil (18.2 percent).

4.3.3 Delta-Gamma Measurement Results

The raw data collected during the field survey were converted to equivalent-radium concentrations using correction factors for moisture, disequilibrium, and thorium and potassium concentrations, as well as the necessary calibration factors obtained from calibrations performed on the DOE Walker Field calibration pads.

The equation for data reduction is

$$C_{Ra} = [(k_{Ra})RF'_m - (S_K C_K) - (S_{Th} C_{Th})]\ F'_e \tag{7}$$

where C_{Ra} is radium concentration in pCi(eRa-226)/g, k_{Ra} is the delta-count calibration factor in pCi(eRa-226)/g per cps, R is average net count rate in cps, F'_m is the moisture correction factor (average per area), S_K is the stripping factor in pCi(eRa-226)/g per percent K, C_K is percent K (average per area), S_{Th} is the stripping factor in pCi(eRa-226)/g per ppm Th, C_{Th} is ppm Th (average per area), and F'_e is the disequilibrium correction factor (average per area).

The disequilibrium correction factor (F'_e) determined for this study is 1.10 (cf. Section 4.3.2). The moisture correction factor (F'_m) for this study area is 0.89 for measurements less than or equal to 12 in. in depth and 0.94 for measurements greater than 12 in. in depth. Mean thorium and potassium concentrations for the millsite were determined from laboratory analysis of a group of soil samples containing very high concentrations of thorium. The statistical mean for thorium is 38 ppm. To compensate for these high values, all thorium values greater than 15 ppm were, for the purpose of data reduction, placed in a separate file where the locations of the high thorium samples were

checked against locations of delta-gamma measurements. Delta measurements taken at the same location as soil samples containing high thorium were corrected individually for thorium. The remaining delta-gamma measurements were corrected for thorium using a mean concentration of 6.6 ppm. A mean potassium concentration (C_K) of 1.3 percent was used to reduce the delta-gamma data.

Uncertainties in radium-concentration values were calculated using the equation

$$\sigma = k_{Ra}[(2N_u - N_d)^{1/2}/t](F_e')(F_m') \qquad (8)$$

where σ is the uncertainty in radium concentration, N_u and N_d are the unshielded (UP) counts and delta or difference counts, respectively, t is the counting interval (time in seconds for the UP count), and the other parameters are as defined above. These uncertainties reflect counting errors only. Not included are the uncertainties in the equivalent-radium concentration introduced by the errors associated with each correction and calibration factor. At low radium concentrations, the counting uncertainty is, most likely, the largest source of error in the measurement. At high concentrations, however, the reported counting uncertainty is likely to be overshadowed by errors introduced by the correction- and calibration-factor uncertainties.

Equivalent-radium concentrations determined using the delta-gamma method and their associated two-standard-deviation counting uncertainties are reported in Appendix D, Table D-1. Figure 5 shows locations where the equivalent-radium content of the soil exceeds 5 pCi/g as determined by the delta-gamma method. Figure 6 illustrates the distribution of the delta-gamma measurements over the range of equivalent-radium concentrations determined for the site.

With the exception of delta-gamma measurements in arroyos, nearly all of the delta-gamma measurements were made at a depth of 6 in. as specified in the Statement of Work. The measurements were made at approximately half of the gridpoints in Areas A and B, and at all of the gridpoints (excluding borehole locations) in Areas C and D following the collection of a 0-to-6-in. soil sample. The alternating soil sample/delta-gamma measurement method described in Section 3.3 was used to determine the depth of contamination exceeding EPA standards.

The results of delta-gamma measurements taken in areas containing windblown contamination (Areas A and B) indicate that equivalent Ra-226 concentrations below a depth of 6 in. are at or near background concentrations. By comparing the 0-to-6-in. soil-sample data and the 6-in. delta-gamma measurement data, it appears that windblown contamination exceeding 5 pCi/g Ra-226 is confined to near-surface (0 to 6 in.) materials.

Delta-gamma measurements in arroyos of Area A indicate that extensive contamination consisting of a mixture of water- and wind-transported tailings is present in scattered sand bars along each of four arroyos surveyed. The extent of the contamination usually extends outside of available site maps. Therefore, in Appendix D, Table D-2, location values of 99999 are given for measurements taken outside the site map. However, in the remarks section of the data-entry sheets, the measurements are referenced to a known point (e.g., 400 ft downstream from N10600, E8200). The depths of contamination exceeding EPA standards generally correspond to depths needed to reach bedrock. The arroyo bottoms at the site are floored by bedrock and in many cases bedrock is reached

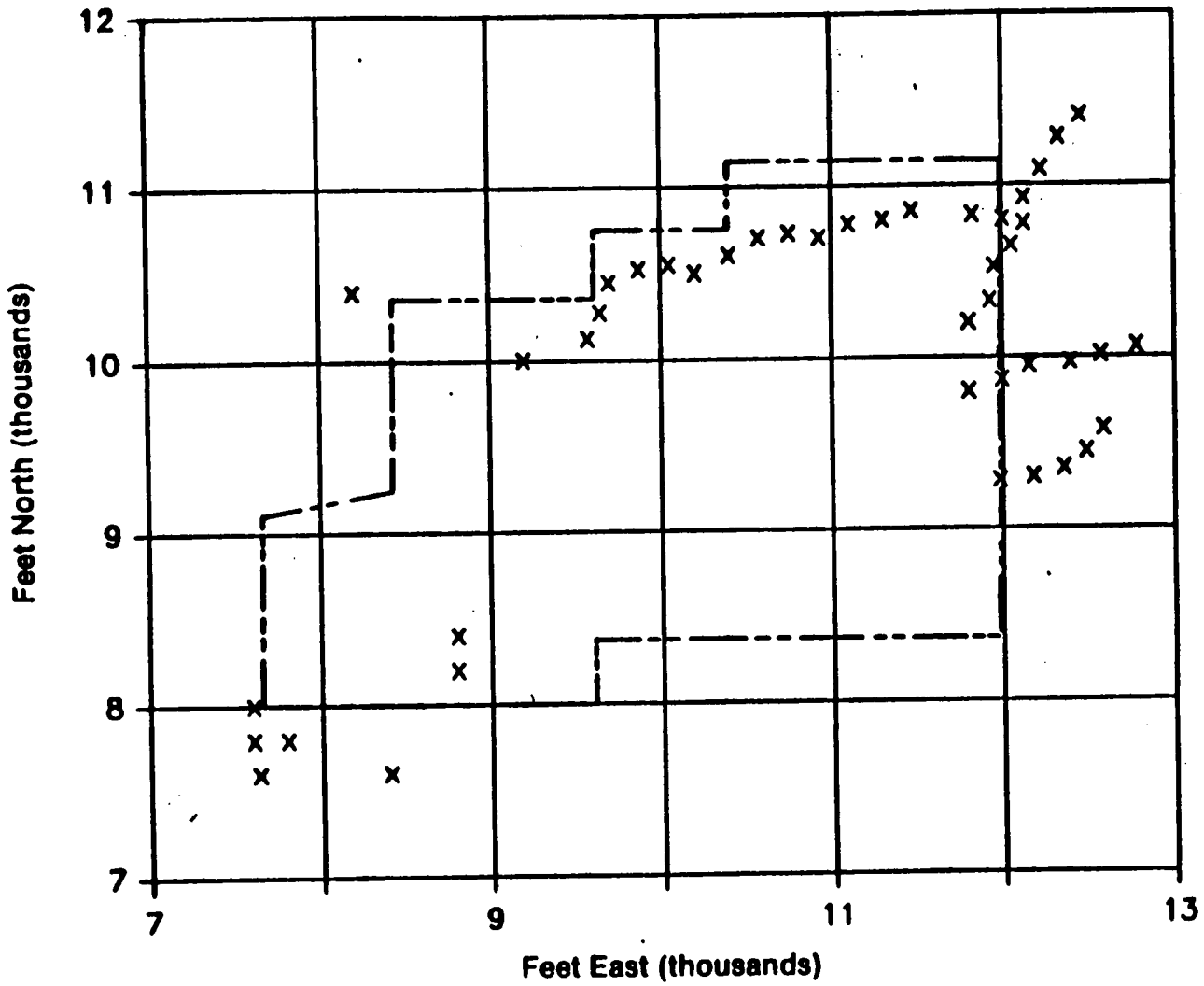

Figure 5. Locations of Delta-Gamma Measurements Greater Than 5 pCi(eRa-226)/g

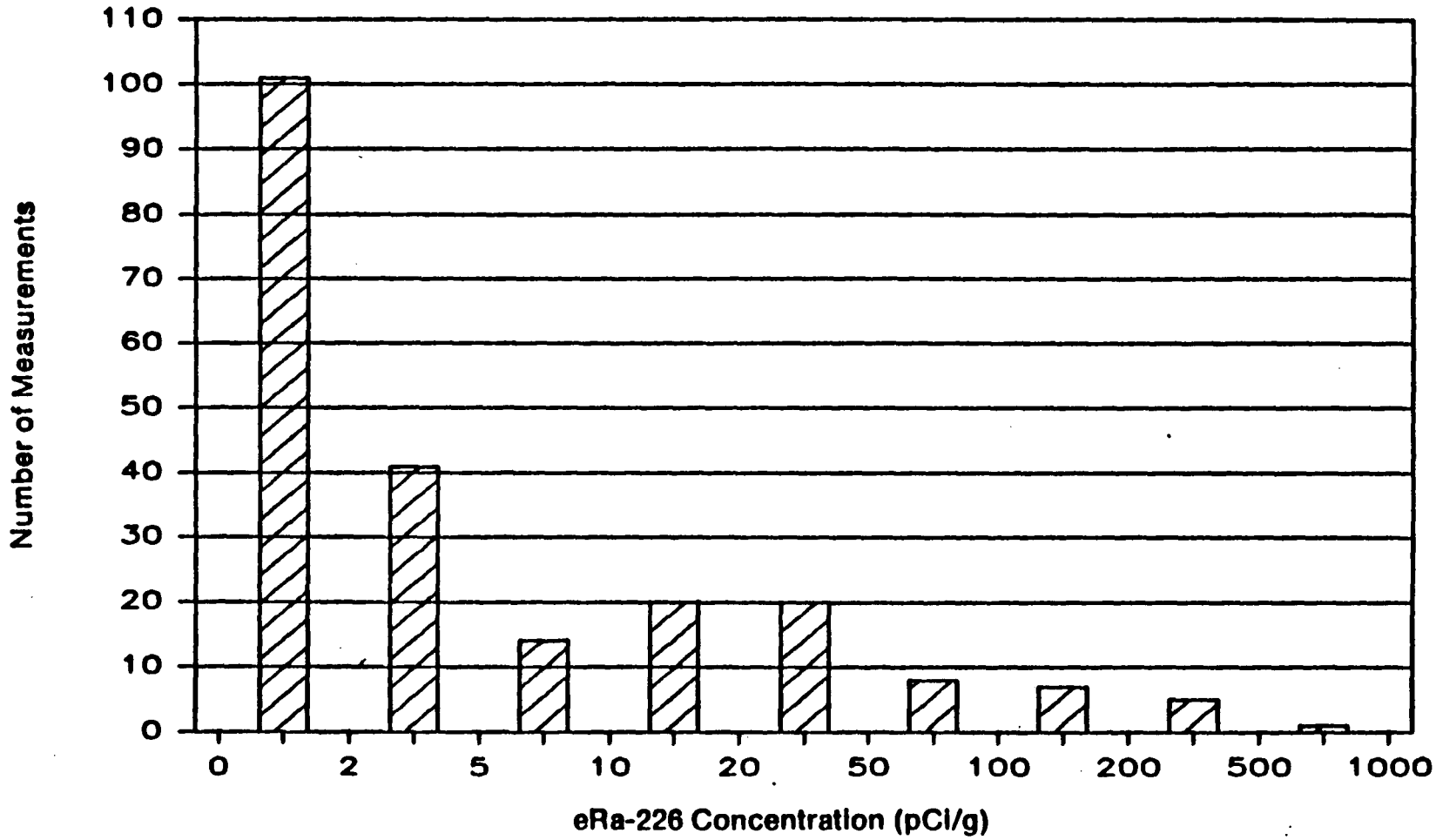

Figure 6. Histogram of Delta-Gamma Measurement Results for eRa-226

at a depth of 3 to 4 in. Once bedrock is reached, the equivalent-radium concentration falls below the EPA standard of 5 pCi/g above background. The arroyo in Area D contains the same type of concentration, but due to a greater thickness of material in the bottom of the arroyo south of U.S. Highway 163, the arroyo was characterized by drilling. North of the highway, surface delta-gamma measurements indicate the contamination extends only approximately 300 ft downstream from the highway.

The delta-gamma measurements from the mill yard and ore-storage area (Area C) indicate that with the exception of six gridpoints (N8200, E7600; N8000, E7600; N7800, E7600; N7600, E7635; N7800, E8200; and N7600, E8400) the eRa-226 concentrations at a depth of 6 in. are less than 5 pCi/g. Of the six measurement locations that contain concentrations greater than 5 pCi/g, four are located in a borrow-pit area between the gravel road on the west edge of the millsite and ore-storage area and the paved road to Halchita. The remaining two locations are located adjacent to small ore piles still present in the ore-storage area. Delta-gamma measurements at two of the above gridpoints (N7800, E8200 and N7600, E8400) yielded negative eRa-226 concentrations due to corrections for high thorium concentrations. Soil samples taken at a depth of 0 to 6 in. at these locations contain 138 and 857 ppm eTh, respectively. Other soil samples in Area C also contain high concentrations of thorium. These samples, however, corresponded to borehole locations and will be discussed in Section 4.4.2.

4.4 BOREHOLE DRILLING, SAMPLING, AND LOGGING RESULTS

4.4.1 Drilling and Sampling Results

A total of 117 boreholes were drilled, of which 47 were located in the mill yard and ore-storage area (Area C), 17 were located in the sewage pond and arroyo area in the northwest portion of the site (Area D), 23 were located along the periphery of the upper pile (Area E), 28 were located along the periphery of the lower pile (Area F), and 2 holes were added to test piles of contaminated material in Area A. The borehole numbers, coordinates, and elevations are included in Appendix E.

Boreholes in Area C were drilled by truck-mounted auger according to the locations specified in the Statement of Work, with the exception of 8 boreholes (HAT-013, 017, 022, 023, 026, 037, 048, and 051) that were moved to avoid utilities, existing structures, and other obstructions. Borehole HAT-057 was deleted since it was located directly on bedrock. Borehole depths were generally shallower than originally estimated depths due to the shallow depth to bedrock.

Boreholes in Area D were drilled with a truck-mounted auger according to the Statement of Work with the exception of boreholes HAT-071, 073, 078, 086, and 088 which were moved due to difficult access or shallow depth to bedrock. Borehole HAT-084 was abandoned due to both the lack of access and to shallow depth to bedrock. Borehole HAT-085 was drilled using a portable auger.

Boreholes in Areas E and F, which had approximate locations specified in the Statement of Work, were drilled with both truck-mounted auger in easily accessible locations and portable auger in difficult-access areas. Boreholes were located by the Technical Assistance Contractor and the Bendix site manager to

accommodate drilling and to provide the best subsurface information. Boreholes originally located along the southern periphery of both piles were moved inward to the edge of the tailings because the original approximate locations were 10 to 12 ft in elevation above the tailings piles, which would have required drilling approximately 10 ft of bedrock to reach the desired depth. These holes were drilled to determine the amount of leaching of contamination below the tailings/bedrock interface.

In Area A two small areas contained thick accumulations of contaminated materials (tailings, uranium ore, sulfur, and other debris) which could not be fully evaluated using the delta-gamma measurements. One borehole was placed in the approximate center of each pile of contaminated material.

A soil sample was taken from a depth of 0 to 6 in. at each borehole location prior to drilling. Appendix B, Table B-1 contains the results of analysis of the samples.

4.4.2 Geophysical Borehole-Logging Results

4.4.2.1 Borehole Logging with the Truck-Mounted System. The truck-mounted spectral gamma-ray logging system was used to log 32 boreholes of which 10 were in Area C, 9 were in Area D, 6 were in Area E, and 7 were in Area F. The radiometric logs are provided on microfiche in Appendix E; borehole-logging and equipment data are presented in Table E-1.

The logs of boreholes located in the ore-storage area (Area C) indicate that contamination exceeding the EPA standard of 5 pCi(eRa-226)/g above background is spotty and ranges from no contamination (HAT-021, 023, 029, and 045) to contamination at a depth of 5 ft (HAT-022). The deepest and most extensive contamination is found in boreholes surrounding the foundation of the old mill (HAT-022, 026, 031, and 035). The borehole drilled next to the truck scale also contains contamination from the surface to 4 ft in depth.

Logs of boreholes located in Area D also indicate that contamination exceeding EPA standards is spotty. In general the contamination is shallow (0 to 6 in. in HAT-073, 074, 080, 084, and 088) with the exception of boreholes HAT-071, 075, 081, 083, and 086, which have spotty contamination to a depth of 4 ft, 7.5 ft, 10.5 ft, 6.5 ft, and 2 ft, respectively. These holes are located in the arroyo containing water-transported tailings.

The logs of boreholes using the truck-mounted system located in Areas E and F are confined to boreholes located along the northern periphery of the upper and lower piles with the exception of boreholes HAT-120 and 121, located on the west edge of the upper pile and HAT-110 located on the south portion of the berm road between the upper and lower pile. Contamination, with the exception of boreholes HAT-102 and 103, is deep, often extending to the total depth of the hole.

4.4.2.2 Borehole Logging with the RASCAL Portable System. The RASCAL system was used to log boreholes that were generally not accessible by the truck-mounted logging system or that were shallow (<5 ft). The radiometric logs are provided on microfiche in Appendix E; borehole-logging and equipment data are presented in Table E-2.

Uncertainties in the final eRa-226 concentrations were calculated at the 95 percent confidence level (two standard deviations) and include terms for the following parameters:

- Statistics of the observed count rate.
- The deconvolution algorithm.
- Correction factors for casing, auger joints, and moisture, as well as background contributions of potassium and thorium concentrations.
- The k-factor (conversion factor for total gamma-ray count rate to radium concentration) for the system.

These calculated uncertainties may be used, together with calculated concentration values, to quantify radium concentrations as being definitely below specific limits with 95 percent confidence.

Radium concentrations at or near the surface, as indicated by borehole radiometric logs, do not agree with concentrations determined from gamma-ray spectroscopic analysis of 0-to-6-in.-deep soil samples, because the calibration procedure does not simulate the air/earth interface at the top of the borehole. The borehole-logging systems are calibrated in the middle of a zone of radioactive material assumed to appear infinitely thick and homogenous for gamma-ray generation and propagation. This same assumption is then made for the borehole when processing the log data, with appropriate deconvolution to correct for adjacent bed effects, but not near-surface and surface measurements for the air/earth interface effects.

A total of 82 boreholes were logged using the RASCAL system. Fourteen of these boreholes were drilled with a portable auger and were logged without casing. The remaining boreholes were logged through hollow-stem augers.

RASCAL borehole logs in Area C indicate that contamination, as with the truck-mounted logging, is spotty as was also indicated by the Compulogger system. Of 37 holes logged using the RASCAL system in this area, 27 of the boreholes did not contain contamination exceeding EPA standards below a depth of 6 in. Of the 10 that did contain greater than 5 pCi(eRa-226)/g below a depth of 6 in., only 4 had contamination below a depth of 1 ft.

RASCAL logs from boreholes in Area D indicated no contamination exceeding EPA standards below a depth of 6 in.

Logs of boreholes in Areas E and F indicate that contamination along the northern periphery of the upper and lower piles (HAT-101, 152, 154, 155, 156, and 158) is shallow, with depths to 6 in. or less. Contamination along the eastern periphery of the lower pile (windblown-tailings area) is more extensive, with depths to 12 ft. Boreholes on the southern periphery were drilled to bedrock on the edge of the tailings with a portable auger. In most cases the contamination exceeds 5 pCi(eRa-226)/g at the bottom of the hole. To fully test the amount of leaching below the tailings/Halgaito shale interface requires truck-mounted rotary drilling. Logs of boreholes along the west edge of the upper pile indicate that contamination is shallow, with depths generally less than 1 ft.

Logs of the two boreholes in Area A (HAT-124 and 125), which were drilled to test small piles of contamination, indicate that in HAT-124 approximately 7 ft of contaminated material exists from surface to bedrock; HAT-125 appears to contain a 5-ft-thick zone of contaminated material.

4.5 BUILDING SURVEY RESULTS

The eight buildings at the Mexican Hat site stand in relatively high gamma fields (often referred to as 'pile shine') due to their proximity to the tailings piles and the ore-storage area, and consequently only one indoor gamma exposure-rate measurement was made in the approximate center of each building at a height of one meter. Surface alpha measurements were made at approximately four locations per 1000 square feet of floor space. In abandoned buildings a surface reading was taken, the surface was brushed and wiped with a disposable wipe, and then a second reading was taken. This procedure gave a general indication of removable versus nonremovable contamination levels. In the two occupied buildings (the Halchita Health Clinic and the sheet metal shop, which is now used as a storage shed) direct measurements were taken, followed by smears on Rad-wipe filter paper which were then counted. Appendix F provides building diagrams showing measurement locations (Figures F-1 through F-8) and alpha contamination and exposure-rate measurement data (Tables F-1 through F-8).

The Halchita Health Clinic (building number 8) and the sheet metal shop storage building (building number 2) show little sign of alpha contamination. Alpha measurements in the former trade school building (building number 5) also indicate that little alpha contamination is present, ranging from 10 to a maximum of 130 cpm. Much of the alpha activity appears to be removable. Building 5 appears to contain a large amount of salvageable materials (e.g. structural steel). Another small metal building (building number 3) has higher alpha activity on the floor (135-220 cpm), but most of the alpha contamination appears to be removable and the building itself appears to be in good condition. The remaining buildings, the scale house building (number 7), ore-crushing building (number 1), generator building (number 4), and the small brick building (number 6), were either highly contaminated (number 7 and number 1) or had little salvage value (number 4 and number 6).

4.6 BACKGROUND CHARACTERIZATION RESULTS

Four locations were chosen for background measurements in the area of the Mexican Hat site (cf. Figure 1). Three of five background locations established during the site orientation visit were chosen as final background locations for the site. A fourth location was established during the fieldwork phase of the project. Background measurement areas were to be, according to the Statement of Work, at least 3 miles east or northeast of the site and at least 1 mile from the site in other directions. Background locations BG-1, 2b, 3, and 4 are located approximately 5 miles south, 2 miles west-southwest, 3 miles northeast, and 0.5 mile east of the Mexican Hat site, respectively. The background location BG-4 is located just west of Gypsum Wash; the lack of access to areas east of Gypsum Wash prevented the establishment of a background site 3 miles east as stated in the Statement of Work. All of the background

sites were located on weathered, red silty sandstones and shales of the Halgaito Tongue, a member of the Cutler Formation, similar to the geologic setting at the Mexican Hat site.

Gamma exposure-rate measurements, delta measurements, and soil samples were taken at each background location. Results of measurements and laboratory analyses of soil samples are presented in Appendix G, Table G-1.

The PIC exposure-rate measurements yield a mean background exposure rate of 11.6 ± 0.7 μR/h for the Mexican Hat area which is consistent with values reported by previous studies.

Delta-gamma measurements at each background location indicate that background eRa-226 concentrations range from 1.1 to 2.5 pCi/g with a mean of 1.6 ± 0.4 pCi/g.

Analyses of soil samples taken from the background locations had Ra-226 concentrations ranging from 0.7 to 2 pCi/g and a mean of 1.2 ± 0.4 pCi/g, Th concentrations ranging from 1 to 9.9 ppm and a mean of 5.4 ± 2.8 ppm, and K concentrations ranging from 1.3 to 1.8 percent and a mean of 1.4 ± 0.3 percent. For purposes of determining areas containing 5 pCi (eRa-226)/g above background, a background concentration of 1 pCi (eRa-226)/g can be used.

5.0 SUMMARY

Arroyo contamination consisting of windblown and water-transported tailings is the most widespread and problematic contamination at the Mexican Hat site. Spotty contamination is present in the bottom of arroyos from the north, northeast, and east edges of the tailings piles to their confluence with Gypsum Wash, approximately 2200 ft downstream from the lower pile. The contamination consists of elongated sand bars ranging in thickness from 6 in. to approximately 2 ft. This material contains eRa-226 concentrations greater than the EPA standard of 5 pCi/g above background.

Surface windblown contamination is widespread to the northeast and east of the tailings piles; contamination exceeds 5 pCi(eRa-226)/g approximately 1000 ft north and approximately 800 ft east of the lower pile. Results show that most of this contamination does not extend below a depth of 6 in. To the south and west no windblown contamination exceeding 5 pCi(eRa-226)/g was found.

Contamination in the ore-storage and mill areas is spotty and, due to the shallow depth to bedrock, is generally shallow as well. This contamination consists of a variety of materials including tailings, uranium ore, and other buried debris. The deepest contamination occurs in an area surrounding the large concrete foundation of the old mill.

The sewage pond and arroyo area in the northwest portion of the site do not appear to contain contamination exceeding 5 pCi(eRa-226)/g except in and along the banks of the small arroyo draining to the north. Results of drilling indicate that near the head of the arroyo (near the upper pile) water-transported tailings contamination exceeding EPA standards is present to as much as 10.5 ft in depth. Farther to the north near U.S. Highway 163, the contamina-

tion is shallow (less than 1 ft), except for dozed material on the east bank of the arroyo where contaminated material has been piled to a thickness of approximately 4 ft.

Several buildings at the Mexican Hat site are salvageable or contain large amounts of salvageable materials which are not contaminated. The Halchita Health Clinic was found to be free of contamination and in good condition. The sheet metal shop (former lab building), which is now used for storage of insulation and building supplies, was also found to be uncontaminated and in good condition. An empty metal shed was found to contain minor contamination but it appears that most of this contamination is in the form of removable radioactive dust, and the building is in good condition. The long building formerly used as a trade school also appears to contain minor removable contamination. Although missing large areas of metal siding and roofing, this building contains a large amount of salvageable materials. The remaining buildings are either contaminated or have little salvage value.

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Appendix A

INSTRUMENT-PERFORMANCE FIELD CHECKS

Instrument-response field checks were performed on each instrument before use each day. These checks were performed in an area near the motel in Mexican Hat at which the radiologic-characterization field crew was housed.

Readings were recorded in the appropriate data book and plotted on a graph that displayed a history of previous field-check results and specified quality-control limits, which were established as two standard deviations (2σ) from the mean of the previous readings. Readings which fell outside these limits were repeated to determine if they were the result of an instrumentation problem or of the statistical probability that approximately 5 percent could be expected to fall outside these specified limits. Values used for the mean and standard deviation were based on field-check data accumulated during the previous site characterizations.

For field-checking the Bendix delta-gamma units, a field-check source fixture held both the detector and a uranium-button source in a fixed geometry while a 100-second UP count was collected. The source was then removed to a point beyond its range of influence, and a 100-second DOWN count was collected. The resulting delta count was recorded in the appropriate data book, plotted on the graph, and checked for compliance with the 2-sigma quality-control limits.

A calibration jig was used for field-checking the portable spectrometers. A 240-second background count was followed by successive 240-second counts with a uranium-button source and a thorium-button source. The uranium source provided test counts in the K and gross-count channels as well as in the U channel, and the thorium source provided a test of the Th channel. Background counts in each channel were subtracted from the source counts, and net counts were recorded in the appropriate data book. Again, the counts were plotted and checked for compliance with quality-control limits.

For field-checking the Reuter-Stokes pressurized ionization chamber (PIC), a small source-holding fixture mounted permanently to the detector housing was used. A background reading was obtained using a built-in integrator to determine the average exposure-rate in μR/h over a 90-second interval. Following determination of background exposure rate, a radium button source was placed in the source-holding fixture and the average exposure rate over a 90-second interval was again determined. The background rate was subtracted from this second rate to determine the net exposure rate from the source. The rate was recorded in the appropriate data book and checked for compliance with quality-control limits. To monitor PIC performance at two different exposure levels, the procedure was repeated using 1-μCi and 10-μCi check sources.

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Appendix B

ANALYTICAL DATA FOR SOIL SAMPLES

Table B-1 presents gamma-ray-spectroscopy data for the soil samples collected. The analytical uncertainties are reported at the two-standard-deviation (2σ) level. Radium, thorium, and potassium values represent equivalent concentrations. The MHD numbers in the table are sample numbers. The depth indicated refers to the top of a 6-inch sample interval. The borehole number is included for those samples taken from borehole locations. A less-than sign (<) indicates the value is below the detection limits of the analytical instrument being used.

Table B-1

Gamma-Ray-Spectroscopy Data for Soil Samples

Grid Coordinates		Depth	Bore-hole	MHD	Concentration		
North	East	(in.)	No.	No.	Ra-226 (pCi/g)	Thorium (ppm)	Potassium (%)
11800	11600	0		198	2 ± 1	5 ± 1	2.1 ± 0.5
11600	11600	0		197	3 ± 1	< 2 ± 0	0.9 ± 0.2
11600	12000	0		200	4 ± 1	4 ± 1	1.1 ± 0.3
11400	11200	0		192	8 ± 1	11 ± 2	1.4 ± 0.3
11400	11600	0		196	6 ± 1	< 2 ± 0	1.0 ± 0.2
11202	11600	0		195	6 ± 1	< 2 ± 0	0.8 ± 0.2
11200	10800	0		189	7 ± 1	9 ± 2	1.1 ± 0.3
11200	11200	0		193	6 ± 1	6 ± 2	1.5 ± 0.3
11200	12000	0		199	10 ± 1	< 2 ± 0	1.2 ± 0.3
11000	10400	0		188	5 ± 1	6 ± 2	0.9 ± 0.2
11000	10802	0		190	5 ± 1	6 ± 2	1.1 ± 0.2
11000	11200	0		194	8 ± 1	8 ± 2	2.1 ± 0.5
10800	9000	0		131	1 ± 1	9 ± 2	1.7 ± 0.4
10800	9400	0		132	2 ± 1	4 ± 1	1.4 ± 0.4
10800	10000	0		184	2 ± 1	4 ± 1	1.0 ± 0.2
10800	10400	0		187	3 ± 1	7 ± 2	1.3 ± 0.3
10800	10800	0		191	6 ± 1	7 ± 2	1.0 ± 0.2
10800	11600	0		144	35 ± 2	15 ± 4	1.1 ± 0.3
10800	12400	0		152	7 ± 1	4 ± 2	1.1 ± 0.3
10800	12800	0		153	4 ± 1	6 ± 2	1.5 ± 0.3
10600	8200	0		311	15 ± 1	19 ± 3	1.0 ± 0.2
10600	9000	0		130	2 ± 1	6 ± 1	1.0 ± 0.3
10600	9400	0		183	2 ± 1	7 ± 2	1.3 ± 0.3
10600	9600	0		133	2 ± 1	10 ± 2	1.8 ± 0.4
10600	10400	0		185	100 ± 5	< 3 ± 0	1.0 ± 0.3
10600	10400	6		186	64 ± 4	< 3 ± 0	0.8 ± 0.2
10600	10800	0		141	16 ± 1	< 2 ± 0	1.1 ± 0.3
10600	11200	0		142	31 ± 2	< 2 ± 0	0.9 ± 0.3
10600	11600	0		143	16 ± 1	< 2 ± 0	1.3 ± 0.3
10446	11063	0	158	591	139 ± 9	< 4 ± 0	< 0.6 ± 0.0

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
10400	8000	0		576	3 ± 1	5 ± 1	2.1 ± 0.2
10400	8200	0		307	24 ± 1	< 3 ± 0	0.9 ± 0.2
10400	8200	6		308	53 ± 3	< 3 ± 0	1.1 ± 0.3
10400	8200	12		309	39 ± 2	< 3 ± 0	0.9 ± 0.2
10400	8200	18		310	34 ± 2	< 3 ± 0	0.8 ± 0.2
10400	8400	0		306	2 ± 1	< 2 ± 0	1.0 ± 0.3
10400	8800	0		128	2 ± 1	9 ± 2	1.4 ± 0.4
10400	9000	0		129	3 ± 1	7 ± 1	1.3 ± 0.4
10400	9400	0		182	2 ± 1	6 ± 2	1.2 ± 0.3
10400	10000	0		138	3 ± 1	7 ± 2	1.1 ± 0.3
10400	10400	0		139	12 ± 1	9 ± 2	1.4 ± 0.3
10400	10800	0		140	28 ± 2	< 2 ± 0	1.1 ± 0.3
10400	11200	0		145	132 ± 6	< 4 ± 0	0.6 ± 0.2
10400	11600	0		147	37 ± 2	14 ± 4	1.4 ± 0.4
10350	8173	0	71	560	18 ± 1	9 ± 3	1.5 ± 0.3
10320	10788	0	157	590	81 ± 5	< 3 ± 0	< 0.6 ± 0.0
10263	10614	0	156	589	79 ± 5	22 ± 3	1.5 ± 0.2
10223	11088	0	159	592	226 ± 15	< 5 ± 0	< 0.6 ± 0.0
10200	8000	0		283	5 ± 1	< 1 ± 0	1.4 ± 0.3
10200	8100	0	72	562	8 ± 1	< 1 ± 0	0.8 ± 0.2
10200	8400	0		305	2 ± 1	9 ± 2	2.3 ± 0.5
10200	9000	0		126	3 ± 1	4 ± 1	1.3 ± 0.4
10200	9400	0		181	3 ± 1	5 ± 2	1.3 ± 0.3
10200	9800	0		136	4 ± 1	10 ± 2	1.7 ± 0.4
10200	10000	0		137	11 ± 1	18 ± 3	0.9 ± 0.4
10200	11600	0		149	38 ± 2	< 2 ± 0	1.2 ± 0.3
10200	11800	0		146	110 ± 6	< 3 ± 0	0.9 ± 0.3
10200	11800	6		148	166 ± 8	45 ± 9	0.9 ± 0.3
10200	11800	12		150	171 ± 8	< 4 ± 0	0.9 ± 0.3
10200	12000	0		154	12 ± 1	12 ± 3	1.8 ± 0.4
10200	12200	0		155	9 ± 1	< 2 ± 0	1.5 ± 0.4
10200	12400	0		156	4 ± 1	< 2 ± 0	1.2 ± 0.3
10200	12600	0		157	6 ± 1	< 2 ± 0	1.3 ± 0.3
10200	12800	0		158	8 ± 1	9 ± 2	0.6 ± 0.2
10159	10478	0	155	586	20 ± 1	8 ± 2	1.6 ± 0.2
10152	9290	0	125	605	369 ± 18	< 6 ± 0	0.8 ± 0.3
10109	10340	0	154	588	41 ± 1	13 ± 2	2.3 ± 0.2
10108	11416	0	161	594	22 ± 2	< 2 ± 0	1.3 ± 0.3
10107	11416	0	160	593	164 ± 8	< 5 ± 0	< 0.7 ± 0.0
10105	11302	0	177	613	167 ± 8	45 ± 9	< 0.3 ± 0.0
10050	8100	0	73	561	2 ± 1	5 ± 2	1.3 ± 0.3
10012	11622	0	179	597	168 ± 8	< 5 ± 0	< 0.7 ± 0.0
10000	7800	0		282	1 ± 1	3 ± 1	1.2 ± 0.3
10000	8100	0	73	559	19 ± 1	< 2 ± 0	1.2 ± 0.3
10000	8300	0		284	2 ± 1	7 ± 2	1.1 ± 0.3
10000	8500	0		281	3 ± 1	6 ± 1	1.2 ± 0.3
10000	8700	0		280	1 ± 1	4 ± 2	1.0 ± 0.3

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
10000	8900	0		127	3 ± 1	4 ± 1	1.1 ± 0.4
10000	9200	0		176	535 ± 21	< 5 ± 0	1.2 ± 0.2
10000	9200	6		177	437 ± 17	< 5 ± 0	1.0 ± 0.2
10000	9200	12		178	504 ± 18	< 5 ± 0	0.7 ± 0.1
10000	9200	18		179	458 ± 18	< 11 ± 0	0.9 ± 0.5
10000	9400	0		180	4 ± 1	8 ± 2	1.8 ± 0.4
10000	9600	0		134	11 ± 1	17 ± 3	1.5 ± 0.4
10000	9800	0		135	9 ± 1	22 ± 3	2.6 ± 0.5
9999	10095	0	153	585	7 ± 1	12 ± 2	3.2 ± 0.3
9998	11407	0	178	610	239 ± 12	< 5 ± 0	0.8 ± 0.3
9960	9246	0	124	604	676 ± 33	< 7 ± 0	< 0.4 ± 0.0
9957	11511	0	180	611	217 ± 10	52 ± 11	< 0.3 ± 0.0
9907	9847	0	152	587	15 ± 1	19 ± 2	2.3 ± 0.2
9900	8000	0	74	563	3 ± 1	4 ± 1	1.4 ± 0.4
9900	8100	0	75	558	31 ± 2	69 ± 7	1.3 ± 0.3
9818	11533	0	163	612	198 ± 9	< 5 ± 0	0.7 ± 0.3
9807	9149	0	102	550	50 ± 3	< 3 ± 0	1.4 ± 0.4
9801	9638	0	151	570	39 ± 3	17 ± 3	1.4 ± 0.5
9800	7700	0	76	609	1 ± 1	5 ± 1	1.0 ± 0.2
9800	8100	0	77	557	153 ± 7	51 ± 10	< 0.3 ± 0.0
9800	8198	0	78	564	3 ± 1	6 ± 2	1.8 ± 0.4
9800	8500	0		304	3 ± 1	8 ± 2	1.3 ± 0.3
9800	8700	0		303	1 ± 1	5 ± 1	1.4 ± 0.3
9800	8990	0	101	549	88 ± 5	324 ± 19	0.8 ± 0.2
9800	11800	0		201	34 ± 3	< 3 ± 0	0.8 ± 0.2
9800	12000	0		163	23 ± 1	12 ± 2	1.4 ± 0.2
9800	12200	0		161	22 ± 1	< 3 ± 0	1.0 ± 0.2
9800	12400	0		160	7 ± 1	10 ± 2	1.3 ± 0.3
9800	12600	0		159	3 ± 1	8 ± 2	1.3 ± 0.3
9762	9322	0	103	566	194 ± 11	47 ± 8	1.1 ± 0.4
9700	8100	0	79	565	3 ± 1	7 ± 1	1.1 ± 0.4
9700	8200	0	80	556	13 ± 1	10 ± 3	0.9 ± 0.2
9700	8300	0	81	555	37 ± 2	< 2 ± 0	1.1 ± 0.3
9700	8600	0	82	554	15 ± 1	11 ± 3	1.2 ± 0.3
9697	11614	0	164	595	21 ± 1	< 3 ± 0	1.9 ± 0.4
9652	9489	0	104	567	303 ± 17	85 ± 12	1.3 ± 0.5
9642	8775	0	123	572	12 ± 1	6 ± 2	1.5 ± 0.4
9600	8200	0	83	553	277 ± 13	< 5 ± 0	1.0 ± 0.4
9600	8300	0		577	3 ± 1	5 ± 1	1.5 ± 0.1
9600	8500	0		225	2 ± 1	5 ± 1	1.4 ± 0.1
9600	8700	0		302	3 ± 1	4 ± 2	1.4 ± 0.3
9538	11662	0	165	596	64 ± 5	38 ± 6	0.9 ± 0.3
9530	9648	0	105	568	300 ± 18	168 ± 17	0.6 ± 0.4
9410	8490	0	111	607	4 ± 1	6 ± 2	1.3 ± 0.3
9400	8300	0	87	551	3 ± 1	6 ± 2	1.0 ± 0.2
9400	8600	0		224	6 ± 1	6 ± 1	1.8 ± 0.2
9400	9799	0	106	569	49 ± 3	9 ± 3	1.7 ± 0.4

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
9400	11800	0		165	9 ± 1	10 ± 2	1.9 ± 0.2
9400	12200	0		167	7 ± 1	10 ± 2	2.7 ± 0.2
9400	12600	0		171	5 ± 1	8 ± 1	1.5 ± 0.2
9390	8200	0	86	552	482 ± 24	< 7 ± 0	< 0.4 ± 0.0
9373	8783	0	122	573	789 ± 29	< 13 ± 0	1.7 ± 0.6
9280	7520	0	88	548	1 ± 1	< 2 ± 0	0.7 ± 0.2
9240	7400	0		270	1 ± 1	5 ± 1	1.5 ± 0.4
9208	9849	0	107	571	199 ± 10	88 ± 11	1.4 ± 0.4
9200	7900	0	11	501	32 ± 2	< 3 ± 0	1.2 ± 0.3
9200	8500	0	14	504	29 ± 2	< 2 ± 0	0.6 ± 0.2
9200	12000	0		169	6 ± 1	7 ± 1	1.6 ± 0.2
9200	12400	0		170	5 ± 1	9 ± 1	2.2 ± 0.2
9199	11424	0	166	598	59 ± 4	15 ± 4	0.5 ± 0.2
9163	8790	0	121	574	9 ± 1	7 ± 2	2.9 ± 0.5
9104	11372	0	167	599	198 ± 11	< 5 ± 0	< 0.7 ± 0.0
9095	10924	0	170	602	241 ± 14	< 5 ± 0	< 0.7 ± 0.0
9014	8836	0	120	575	302 ± 17	< 9 ± 0	1.6 ± 0.5
9010	8100	0	12	502	5 ± 1	< 2 ± 0	1.0 ± 0.3
9008	8500	0	17	507	11 ± 1	< 2 ± 0	0.6 ± 0.2
9004	9074	0	119	580	5 ± 1	13 ± 2	1.8 ± 0.2
9000	7600	0		268	3 ± 1	5 ± 1	1.3 ± 0.4
9000	7800	0		221	4 ± 1	4 ± 1	0.9 ± 0.2
9000	7900	0	15	509	2 ± 1	4 ± 1	1.5 ± 0.4
9000	8100	0	16	508	16 ± 2	< 2 ± 0	0.9 ± 0.2
9000	8500	0	18	506	75 ± 5	< 3 ± 0	0.5 ± 0.2
9000	8700	0	19	505	87 ± 5	< 4 ± 0	< 0.6 ± 0.0
9000	11600	0		168	3 ± 1	9 ± 1	1.8 ± 0.2
9000	11800	0		266	11 ± 1	10 ± 2	1.1 ± 0.3
9000	12200	0		173	5 ± 1	8 ± 1	1.9 ± 0.2
8990	8300	0	13	503	15 ± 2	< 2 ± 0	0.5 ± 0.2
8978	11269	0	168	600	155 ± 8	< 5 ± 0	0.2 ± 0.1
8945	10732	0	171	603	321 ± 16	316 ± 21	< 0.7 ± 0.0
8922	11004	0	169	601	111 ± 5	223 ± 15	< 0.7 ± 0.0
8900	8100	0	20	510	11 ± 1	4 ± 1	1.0 ± 0.4
8900	8200	0	21	511	3 ± 1	6 ± 1	1.6 ± 0.4
8900	8425	0	22	512	30 ± 2	24 ± 4	1.7 ± 0.4
8852	8980	0	118	581	3 ± 1	10 ± 1	2.8 ± 0.3
8800	7200	0		222	1 ± 1	5 ± 1	1.1 ± 0.3
8800	7600	0		267	2 ± 1	7 ± 2	2.0 ± 0.4
8800	7800	0		220	2 ± 1	8 ± 2	1.6 ± 0.4
8800	7920	0	23	514	7 ± 1	6 ± 2	1.5 ± 0.4
8800	8100	0	24	513	11 ± 1	5 ± 1	1.5 ± 0.4
8800	8200	0	25	515	7 ± 1	8 ± 2	1.3 ± 0.4
8800	8420	0	26	516	126 ± 6	42 ± 7	2.0 ± 0.5
8800	8700	0	27	543	114 ± 8	< 4 ± 0	< 0.6 ± 0.0
8800	8900	0	28	542	10 ± 1	< 2 ± 0	1.7 ± 0.4
8800	10800	0		276	2 ± 1	8 ± 2	0.9 ± 0.2

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
8800	11000	0		230	2 ± 1	10 ± 2	2.1 ± 0.5
8800	11200	0		229	3 ± 1	7 ± 2	1.9 ± 0.4
8800	11400	0		226	7 ± 1	10 ± 1	1.3 ± 0.1
8800	11600	0		175	6 ± 1	7 ± 1	1.9 ± 0.2
8800	11800	0		265	5 ± 1	7 ± 2	0.9 ± 0.2
8790	7400	0		271	4 ± 1	8 ± 2	1.8 ± 0.4
8734	9097	0	117	582	7 ± 1	17 ± 2	2.3 ± 0.2
8700	7300	0	29	547	2 ± 1	< 2 ± 0	0.6 ± 0.2
8700	7700	0	30	608	1 ± 1	4 ± 1	0.8 ± 0.2
8700	8200	0	31	520	22 ± 2	6 ± 2	1.3 ± 0.4
8642	9559	0	110	606	3 ± 1	9 ± 2	1.1 ± 0.3
8600	7200	0		223	1 ± 1	4 ± 1	1.0 ± 0.1
8600	7400	0		272	1 ± 1	6 ± 1	1.5 ± 0.4
8600	7600	0		269	3 ± 1	6 ± 1	1.4 ± 0.4
8600	7800	0		219	2 ± 1	6 ± 2	1.3 ± 0.3
8600	7900	0	32	522	132 ± 10	< 7 ± 0	1.4 ± 0.4
8600	8100	0	33	521	127 ± 9	< 8 ± 0	1.3 ± 0.4
8600	8400	0	34	519	192 ± 15	32 ± 7	1.5 ± 0.5
8600	8500	0	35	518	76 ± 4	35 ± 6	1.6 ± 0.4
8600	8700	0	36	517	38 ± 2	8 ± 2	1.7 ± 0.4
8600	9008	0	116	583	20 ± 1	317 ± 16	1.9 ± 0.2
8600	10000	0		238	4 ± 1	5 ± 2	1.0 ± 0.2
8600	10400	0		239	5 ± 1	9 ± 2	< 0.5 ± 0.0
8600	10800	0		228	2 ± 1	14 ± 2	2.5 ± 0.5
8600	11200	0		227	4 ± 1	9 ± 2	1.9 ± 0.4
8590	8900	0	37	544	58 ± 4	194 ± 15	1.1 ± 0.3
8500	8200	0	39	523	103 ± 8	22 ± 3	1.7 ± 0.2
8490	7700	0	38	524	6 ± 1	7 ± 1	2.4 ± 0.2
8442	8964	0	115	584	50 ± 5	1384 ± 135	< 1.5 ± 0.0
8400	7400	0		273	43 ± 3	14 ± 3	1.2 ± 0.4
8400	7600	0		264	2 ± 1	5 ± 2	0.9 ± 0.2
8400	7800	0		218	37 ± 3	< 3 ± 0	< 0.6 ± 0.0
8400	7900	0	40	525	73 ± 5	< 3 ± 0	1.9 ± 0.2
8400	8100	0	41	526	120 ± 9	13 ± 3	1.7 ± 0.2
8400	8300	0	42	527	89 ± 6	109 ± 9	1.5 ± 0.2
8400	8500	0	43	528	40 ± 2	7 ± 2	1.6 ± 0.2
8400	8700	0	44	529	28 ± 1	10 ± 2	1.6 ± 0.2
8400	8800	0		210	112 ± 7	35 ± 7	1.3 ± 0.5
8400	8800	6		211	40 ± 3	10 ± 3	1.1 ± 0.4
8400	9600	0		241	3 ± 1	13 ± 2	1.3 ± 0.3
8400	10000	0		237	1 ± 1	6 ± 2	1.5 ± 0.4
8400	10400	0		234	2 ± 1	8 ± 2	1.6 ± 0.4
8300	7500	0	45	540	6 ± 1	< 2 ± 0	0.9 ± 0.2
8300	7500	0	45	541	2 ± 1	3 ± 1	1.3 ± 0.3
8300	7700	0	46	539	19 ± 1	< 2 ± 0	1.1 ± 0.3
8200	7200	0		278	1 ± 1	8 ± 2	1.3 ± 0.3
8200	7400	0		274	3 ± 1	8 ± 2	1.5 ± 0.4

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
8200	7600	0		263	2 ± 1	7 ± 2	1.1 ± 0.3
8200	7800	0		217	7 ± 1	< 2 ± 0	1.0 ± 0.2
8200	8100	0	47	533	363 ± 29	171 ± 16	1.2 ± 0.2
8200	8300	0	49	531	53 ± 3	37 ± 4	1.6 ± 0.2
8200	8500	0	50	530	127 ± 12	14 ± 3	0.9 ± 0.1
8200	8600	0		215	5 ± 1	6 ± 2	0.7 ± 0.2
8200	8750	0	51	545	70 ± 4	< 3 ± 0	0.7 ± 0.2
8200	8800	0		249	13 ± 1	< 2 ± 0	1.0 ± 0.3
8200	8800	6		212	13 ± 1	8 ± 1	1.4 ± 0.2
8200	8800	12		214	17 ± 1	6 ± 1	1.5 ± 0.2
8200	9200	0		243	1 ± 1	< 2 ± 0	0.8 ± 0.2
8200	9600	0		240	2 ± 1	< 2 ± 0	0.7 ± 0.2
8200	10000	0		236	1 ± 1	9 ± 2	1.5 ± 0.3
8200	10400	0		235	2 ± 1	11 ± 2	1.8 ± 0.4
8185	8100	0	48	532	47 ± 4	11 ± 2	1.8 ± 0.2
8000	7200	0		277	1 ± 1	5 ± 2	1.5 ± 0.3
8000	7400	0		275	2 ± 1	4 ± 1	1.1 ± 0.3
8000	7600	0		261	42 ± 3	< 2 ± 0	1.1 ± 0.3
8000	7600	6		262	49 ± 3	< 3 ± 0	1.2 ± 0.3
8000	7800	0		216	11 ± 1	11 ± 3	1.0 ± 0.3
8000	7900	0	52	534	75 ± 4	13 ± 3	1.6 ± 0.2
8000	8100	0	53	535	33 ± 2	< 3 ± 0	0.5 ± 0.1
8000	8300	0	54	536	47 ± 3	46 ± 6	1.4 ± 0.3
8000	8400	0		279	122 ± 6	< 4 ± 0	1.1 ± 0.3
8000	8600	0		202	17 ± 1	9 ± 2	1.2 ± 0.3
8000	8800	0		248	3 ± 1	8 ± 2	1.0 ± 0.3
8000	9000	0		247	6 ± 1	9 ± 2	1.2 ± 0.3
8000	9200	0		242	5 ± 1	7 ± 2	1.2 ± 0.3
7800	7400	0		258	1 ± 1	6 ± 2	1.1 ± 0.3
7800	7600	0		259	75 ± 4	< 3 ± 0	1.0 ± 0.3
7800	7600	6		260	27 ± 2	< 2 ± 0	1.2 ± 0.3
7800	7800	0		256	54 ± 3	< 3 ± 0	1.4 ± 0.3
7800	7800	6		257	8 ± 1	7 ± 2	1.6 ± 0.4
7800	7900	0	55	546	29 ± 2	31 ± 5	1.1 ± 0.3
7800	8000	0		255	3 ± 1	3 ± 1	1.0 ± 0.2
7800	8100	0	56	538	54 ± 4	< 3 ± 0	0.8 ± 0.2
7800	8200	0		252	106 ± 6	138 ± 11	< 0.7 ± 0.0
7800	8200	6		254	8 ± 1	< 2 ± 0	1.7 ± 0.4
7800	8300	0	57	537	252 ± 16	476 ± 33	< 0.7 ± 0.0
7800	8400	0		251	26 ± 2	16 ± 3	0.6 ± 0.2
7800	8600	0		253	71 ± 6	39 ± 6	1.7 ± 0.4
7800	8800	0		246	2 ± 1	< 2 ± 0	1.3 ± 0.3
7800	9000	0		245	1 ± 1	7 ± 2	0.8 ± 0.2
7800	9200	0		244	5 ± 1	7 ± 2	1.3 ± 0.3
7600	7635	0		207	3 ± 1	< 2 ± 0	1.2 ± 0.3
7600	7635	6		208	21 ± 2	< 6 ± 0	1.4 ± 0.4
7600	7635	12		209	10 ± 1	5 ± 1	1.5 ± 0.2

Table B-1 (continued)

Grid Coordinates North	Grid Coordinates East	Depth (in.)	Bore-hole No.	MHD No.	Concentration Ra-226 (pCi/g)	Concentration Thorium (ppm)	Concentration Potassium (%)
7600	7800	0		206	2 ± 1	< 2 ± 0	1.3 ± 0.3
7600	8000	0		205	2 ± 1	4 ± 1	1.1 ± 0.3
7600	8200	0		204	5 ± 1	12 ± 2	< 0.6 ± 0.0
7600	8400	0		250	285 ± 16	857 ± 51	< 0.7 ± 0.0
7600	8400	6		203	129 ± 10	399 ± 32	1.6 ± 0.4

Table B-2

Loss-On-Drying Results

Sample Number	LOD (%)	Sample Number	LOD (%)
MHD 101	1.21	MHD 191	0.62
MHD 102	0.57	MHD 199	0.63
MHD 103	1.21	MHD 212	1.13
MHD 104	1.71	MHD 227	1.38
MHD 105	2.52	MHD 238	0.84
MHD 106	5.08	MHD 249	1.23
MHD 107	4.21	MHD 260	2.65
MHD 108	3.66	MHD 268	1.24
MHD 109	4.15	MHD 277	0.68
MHD 110	3.47	MHD 304	1.61
MHD 111	2.33	MHD 504	2.46
MHD 112	3.06	MHD 512	5.04
MHD 113	6.96	MHD 524	2.08
MHD 114	3.06	MHD 535	1.48
MHD 115	2.34	MHD 538	1.33
MHD 117	2.48	MHD 552	3.27
MHD 126	2.01	MHD 560	1.24
MHD 129	0.52	MHD 574	2.43
MHD 143	1.12	MHD 583	5.09
MHD 155	0.80	MHD 589	0.89
MHD 178	6.26	MHD 599	0.68
MHD 183	0.95	MHD 608	1.91

APPENDIX C

DUPLICATE ANALYTICAL RESULTS

Table C-1 presents duplicate gamma-ray-spectroscopic analytical results for splits of approximately 10 percent of the soil samples collected. Radium, thorium, and potassium values represent equivalent concentrations. Table C-2 presents a comparison of the Ra-226 content in the soil sample (MHD) and the corresponding split (MBG). A less-than sign (<) indicates that the minimum detection limit based on Compton background was reached. A question mark (?) indicates that the analysis is semiquantitative due to a low count rate.

Table C-1

Duplicate Gamma-Ray-Spectroscopy Analytical Results

Sample Number	Ra-226 (pCi/g)		Error	Th (ppm)		Error	K (%)		Error
MBG-601	2.3	±	1.0	4.4	±	1.8	1.2	±	0.3
MBG-602	2.3	±	1.0	5.9	±	1.6	1.0	±	0.2
MBG-603	27.2	±	1.6	8.8	±	2.9	1.1	±	0.3
MBG-604	6.6	±	1.0	10.4	±	2.4	1.5	±	0.3
MBG-605	4.6	±	1.0	8.7	±	2.2	1.5	±	0.3
MBG-606	7.6	±	1.0	10.9	±	2.5	1.2	±	0.3
MBG-607	10.3	±	1.0	5.2	±	2.2	1.3	±	0.3
MBG-608	11.0	±	1.0	< 1.5	±	0.0	1.2	±	0.3
MBG-609	1.7	±	1.0	7.6	±	2.0	1.4	±	0.3
MBG-610	2.5	±	1.0	7.7	±	2.2	1.3	±	0.3
MBG-611	1.2	±	1.0	8.5	±	2.0	1.1	±	0.3
MBG-612	2.2	±	1.0	11.5	±	2.0	1.8	±	0.4
MBG-613	8.7	±	1.0	? 5.9	±	1.6	2.2	±	0.5
MBG-614	2.0	±	1.0	? 7.3	±	1.6	1.2	±	0.4
MBG-615	2.0	±	1.0	? 5.7	±	1.4	1.2	±	0.4
MBG-616	18.4	±	1.8	? 6.3	±	1.8	1.3	±	0.4
MBG-617	74.5	±	3.1	35.0	±	5.7	1.7	±	0.4
MBG-618	41.6	±	2.4	? 7.8	±	2.4	1.5	±	0.4
MBG-619	4.6	±	1.0	? 4.0	±	1.0	1.7	±	0.4
MBG-620	39.7	±	2.2	< 7.2	±	0.0	1.5	±	0.4
MBG-621	67.6	±	4.3	< 7.1	±	0.0	1.5	±	0.4
MBG-622	? 1.0	±	1.0	? 7.4	±	1.6	1.2	±	0.4
MBG-623	31.8	±	1.6	59.5	±	6.3	? 0.8	±	0.2
MBG-624	297.3	±	14.9	110.4	±	12.3	< 0.7	±	0.0
MBG-625	1.0	±	1.0	? 3.0	±	1.4	? 1.0	±	0.2
MBG-626	38.1	±	2.5	< 2.7	±	0.0	1.2	±	0.3
MBG-627	179.8	±	9.8	< 4.6	±	0.0	< 0.7	±	0.0

All errors reported in Table C-2 are expected analytical errors at 2σ. One sample showed a difference greater than expected. Re-analysis of this data set showed no significant change in either value. This difference is attributed to sample preparation.

Table C-2

Comparison of Radium Results Between Samples and Corresponding Splits

Sample Number	Ra-226 (pCi/g)	Duplicate Sample Number	Ra-226 (pCi/g)
MHD-126	2.5 ± 1.0	MBG-601	2.3 ± 1.0
MHD-132	2.2 ± 1.0	MBG-602	2.3 ± 1.0
MHD-140	28.3 ± 1.6	MBG-603	27.2 ± 1.6
MHD-160	6.5 ± 1.0	MBG-604	6.6 ± 1.0
MHD-173	4.8 ± 1.0	MBG-605	4.6 ± 1.0
MHD-189	7.4 ± 1.0	MBG-606	7.6 ± 1.0
MHD-199	9.6 ± 1.0	MBG-607	10.3 ± 1.0
MHD-209	10.1 ± 1.0	MBG-608	11.0 ± 1.0
MHD-219	1.9 ± 1.0	MBG-609	1.7 ± 1.0
MHD-229	2.8 ± 1.0	MBG-610	2.5 ± 1.0
MHD-245	.9 ± 1.0	MBG-611	1.2 ± 1.0
MHD-235	2.2 ± 1.0	MBG-612	2.2 ± 1.0
MHD-257	8.0 ± 1.0	MBG-613	8.7 ± 1.0
MHD-264	2.2 ± 1.0	MBG-614	2.0 ± 1.0
MHD-275	2.0 ± 1.0	MBG-615	2.0 ± 1.0
MHD-508	16.0 ± 1.6	MBG-616	18.4 ± 1.8
MHD-518	75.7 ± 3.7	MBG-617	74.5 ± 3.1
MHD-528	39.3 ± 2.2	MBG-618	41.6 ± 2.4
MHD-283	4.9 ± 1.0	MBG-619	4.6 ± 1.0
MHD-309	39.0 ± 1.0	MBG-620	39.7 ± 2.2
MHD-538	54.4 ± 3.7	MBG-621	67.6 ± 4.3
MHD-548	1.0 ± 1.0	MBG-622	1.0 ± 1.0
MHD-558	30.6 ± 1.0	MBG-623	31.8 ± 1.6
MHD-568	299.9 ± 18.4	MBG-624	297.3 ± 14.6
MHD-578	1.1 ± 1.0	MBG-625	1.0 ± 1.0
MHD-588	40.7 ± 1.4	MBG-626	38.1 ± 2.5
MHD-613	167.0 ± 7.8	MBG-627	179.8 ± 9.8

Appendix D

DELTA-GAMMA RADIUM MEASUREMENT DATA

Table D-1 presents results of the in-situ delta-gamma radium measurements. The two-standard-deviation (2σ) error reported in this table reflects only the uncertainty in the counting statistics; it does not include errors introduced through the use of a calibration factor and three correction factors. These data were generated using the computer program DELTCALC.BAS, Version 1.1. Radium values represent equivalent concentrations.

Table D-1

In-Situ Delta-Gamma Radium Measurement Results

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
11600	11600	0	2.3 ± 0.8
11600	11600	6	0.3 ± 0.6
11600	12000	6	0.9 ± 0.8
11400	12450	0	95.8 ± 3.0
11400	12450	6	131.5 ± 4.0
11400	12450	12	65.8 ± 3.6
11400	12450	15	28.1 ± 4.5
11275	12325	0	39.3 ± 1.8
11275	12325	6	2.4 ± 1.4
11202	11600	6	1.7 ± 0.7
11200	10800	6	0.6 ± 0.7
11200	11200	6	0.4 ± 0.7
11200	12000	6	2.3 ± 1.0
11090	12225	0	6.1 ± 1.4
11090	12225	6	1.1 ± 0.9
11000	10400	0	3.7 ± 0.8
11000	10400	6	0.7 ± 0.8
10925	12125	0	37.1 ± 2.4
10925	12125	6	4.2 ± 1.8
10900	11650	0	3.8 ± 1.2
10850	11475	0	31.4 ± 2.2
10850	11475	6	4.0 ± 1.7
10825	11825	0	22.8 ± 1.4
10825	11825	6	31.0 ± 1.9
10825	11825	12	39.8 ± 2.4
10825	11825	18	11.1 ± 2.3
10800	9400	6	0.5 ± 0.6
10800	10000	6	0.9 ± 0.8
10800	10800	6	0.3 ± 0.7
10800	11300	0	41.3 ± 2.7
10800	11300	6	2.9 ± 1.6
10800	11600	6	2.4 ± 1.3
10800	12000	0	10.8 ± 1.5
10800	12000	6	* 0.6
10800	12400	6	0.4 ± 0.7
10800	12800	6	0.6 ± 0.7
10775	11100	0	45.3 ± 1.9
10775	11100	6	41.3 ± 2.7
10775	11100	12	5.4 ± 1.9
10775	11100	14	1.8 ± 2.1
10775	12125	0	69.7 ± 3.0
10775	12125	6	4.6 ± 2.2
10725	10750	0	59.6 ± 2.3
10725	10750	6	38.8 ± 2.9
10725	10750	12	2.1 ± 1.7
10700	10575	0	55.4 ± 2.5
10700	10575	6	4.5 ± 1.9
10700	10575	12	2.2 ± 1.2
10700	10925	0	20.1 ± 1.5
10700	10925	6	1.5 ± 0.9
10650	12050	0	68.4 ± 3.1
10650	12050	6	32.0 ± 3.1
10600	8200	2	3.1 ± 0.9
10600	9000	6	2.6 ± 0.8
10600	9600	6	1.6 ± 0.9
10600	10400	6	15.8 ± 3.5
10600	10400	8	11.1 ± 3.3
10600	11200	6	0.7 ± 1.3
10550	10050	0	41.4 ± 2.1
10550	10050	4	6.7 ± 1.8
10525	9875	0	35.6 ± 2.2
10525	9875	6	16.0 ± 2.1
10525	9875	12	* 1.5
10525	11950	0	135.1 ± 3.9
10525	11950	6	78.4 ± 3.1

*There is at least 95 percent confidence that the true value is less than the measurement reported.

Table D-1 (continued)

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
10525	11950	10	10.8 ± 2.7
10500	10200	0	240.2 ± 4.5
10500	10200	6	278.1 ± 6.0
10500	10200	12	2.2 ± 4.1
10450	9700	0	12.8 ± 1.6
10450	9700	4	1.1 ± 1.2
10400	8000	6	0.7 ± 0.6
10400	8200	6	45.4 ± 2.1
10400	8200	12	24.1 ± 2.5
10400	8200	18	15.9 ± 2.6
10400	8200	24	4.1 ± 1.9
10400	8400	6	0.9 ± 0.8
10400	8800	6	0.7 ± 0.8
10400	9400	6	0.9 ± 0.7
10400	10400	6	1.5 ± 0.9
10400	10800	6	2.3 ± 1.3
10400	11600	6	3.6 ± 1.4
10325	11925	0	44.2 ± 2.5
10325	11925	6	59.0 ± 2.0
10325	11925	10	9.4 ± 2.3
10275	9650	0	143.6 ± 3.5
10275	9650	4	19.1 ± 2.5
10200	8000	6	0.8 ± 0.7
10200	8400	6	1.8 ± 0.9
10200	9000	6	1.0 ± 0.8
10200	10000	6	0.9 ± 1.0
10200	11600	6	2.3 ± 1.5
10200	11800	0	124.8 ± 3.8
10200	11800	6	224.1 ± 4.2
10200	11800	12	194.4 ± 5.4
10200	11800	15	115.8 ± 5.7
10200	12200	6	1.9 ± 1.0
10200	12600	4	* 0.3
10125	9575	0	155.9 ± 3.8
10125	9575	6	8.2 ± 2.4
10125	9575	10	5.4 ± 1.9
10059	12775	0	5.9 ± 1.1
10059	12775	6	0.7 ± 0.7
10010	12565	0	5.5 ± 1.2
10010	12565	3	0.6 ± 0.8
10000	7800	6	0.9 ± 0.7
10000	8300	6	2.2 ± 0.7
10000	8500	6	1.3 ± 0.8
10000	8700	6	1.1 ± 0.9
10000	8900	6	1.7 ± 0.9
10000	9200	6	510.8 ± 8.2
10000	9200	12	491.0 ± 7.2
10000	9200	18	493.3 ± 9.7
10000	9400	6	2.4 ± 0.8
10000	9600	6	2.7 ± 1.3
10000	9800	6	3.7 ± 1.4
9967	12390	0	16.6 ± 1.7
9967	12390	1	1.3 ± 1.3
9950	12150	0	13.5 ± 2.0
9950	12150	4	2.1 ± 1.2
9866	11994	0	19.1 ± 1.7
9866	11994	3	3.9 ± 1.5
9800	8500	6	1.8 ± 0.9
9800	8700	6	1.7 ± 0.9
9800	11800	0	11.2 ± 1.9
9800	11800	5	1.5 ± 1.1
9800	12200	5	0.5 ± 1.0
9800	12200	6	1.2 ± 1.0
9600	8300	2	1.2 ± 0.9
9600	8500	6	0.7 ± 0.7
9600	8700	6	0.4 ± 0.8
9600	12000	6	2.2 ± 1.2
9580	12580	0	23.3 ± 1.8
9580	12580	6	5.6 ± 1.4
9580	12580	8	2.0 ± 1.3
9450	12480	0	9.5 ± 1.3
9450	12480	6	1.8 ± 0.9
9400	8600	6	1.0 ± 0.9
9400	12000	6	1.0 ± 1.0
9400	12600	4	2.5 ± 0.8
9350	12350	0	6.3 ± 1.3
9350	12350	6	1.4 ± 0.8
9300	12175	0	13.7 ± 1.4
9300	12175	6	2.3 ± 1.2
9280	11980	0	20.4 ± 1.9
9280	11980	5	5.7 ± 1.3
9275	11800	0	4.0 ± 1.5
9240	7400	6	0.6 ± 0.7
9200	12000	6	* 0.2
9200	12400	6	3.0 ± 1.0
9000	7600	6	0.8 ± 0.7
9000	7800	6	0.7 ± 0.8
9000	11600	6	1.2 ± 0.8
9000	12200	6	0.3 ± 0.7
8800	7200	6	1.3 ± 0.7
8800	7600	6	2.0 ± 0.7
8800	7800	2	1.4 ± 0.7

*There is at least 95 percent confidence that the true value is less than the measurement reported.

Table D-1 (continued)

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)	Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
8800	11000	6	1.8 ± 0.9	8200	10000	6	1.0 ± 0.8
8800	11400	6	2.4 ± 0.9	8200	10400	6	3.0 ± 0.8
8800	11800	6	1.7 ± 0.9	8000	7200	6	1.0 ± 0.7
8790	7400	6	1.4 ± 0.9	8000	7400	6	0.4 ± 0.6
8600	7200	6	1.1 ± 0.7	8000	7600	6	21.6 ± 2.1
8600	7400	6	1.0 ± 0.8	8000	7600	12	3.1 ± 1.7
8600	7600	6	1.8 ± 0.9	8000	7800	6	2.5 ± 0.9
8600	7800	6	0.7 ± 0.7	8000	8400	6	3.5 ± 2.2
8600	10400	6	2.3 ± 1.3	8000	8600	6	2.9 ± 1.3
8600	10800	6	2.9 ± 1.0	8000	9000	6	0.1 ± 0.7
8600	11200	6	0.7 ± 0.7	8000	9600	6	1.1 ± 0.8
8400	7200	6	1.0 ± 0.7	7800	7400	6	1.0 ± 0.8
8400	7200	6	1.0 ± 0.8	7800	7600	6	14.0 ± 2.1
8400	7400	6	1.8 ± 1.3	7800	7600	12	3.3 ± 1.6
8400	7600	6	1.2 ± 0.8	7800	7800	6	5.7 ± 1.8
8400	7800	6	1.8 ± 0.9	7800	7800	12	1.3 ± 1.5
8400	8800	6	8.3 ± 1.7	7800	8000	6	0.2 ± 0.7
8400	8800	8	1.9 ± 1.5	7800	8200	6	4.2 ± 1.7
8400	9600	6	2.1 ± 1.0	7800	8200	12	2.7 ± 1.2
8400	10000	6	4.2 ± 0.9	7800	8400	6	2.7 ± 1.3
8400	10400	6	1.9 ± 0.7	7800	8800	6	1.7 ± 0.8
8200	7200	6	2.0 ± 0.8	7800	9200	6	3.1 ± 0.8
8200	7400	6	1.5 ± 0.9	7600	7635	6	13.7 ± 1.1
8200	7600	6	* 0.1	7600	7635	12	5.0 ± 1.4
8200	7800	6	1.3 ± 0.9	7600	7635	18	2.8 ± 1.4
8200	8600	4	1.4 ± 0.8	7600	7800	6	0.7 ± 0.6
8200	8800	6	14.3 ± 1.6	7600	8000	6	0.9 ± 0.8
8200	8800	12	13.2 ± 1.6	7600	8200	6	0.5 ± 0.7
8200	8800	18	1.6 ± 1.2	7600	8400	6	16.4 ± 4.2
8200	9200	6	2.2 ± 1.0	7600	8400	12	* 0.1

*There is at least 95 percent confidence that the true value is less than the measurement reported.

Table D-2

In-Situ Delta-Gamma Radium Measurement Results for Approximate Locations (N99999)

North	East	Depth (in.)	eRa-226(pCi/g)	Remarks
99999	1	0	2.2 ± 0.7	Background location BG-1
99999	2	0	1.6 ± 0.7	Background location BG-1
99999	3	0	1.0 ± 0.7	Background location BG-2b
99999	4	0	1.5 ± 0.7	Background location BG-2b
99999	5	0	1.3 ± 0.7	Background location BG-3
99999	6	0	1.1 ± 0.7	Background location BG-3
99999	7	0	1.1 ± 0.7	Background location BG-4
99999	8	0	1.2 ± 0.7	Background location BG-4
99999	9	0	11.7 ± 1.4	Arroyo- 200 ft downstream from N11400, E12450
99999	10	6	1.4 ± 0.9	Arroyo- 200 ft downstream from N11400, E12450
99999	11	0	13.2 ± 1.4	Arroyo- 400 ft downstream from N11400, E12450
99999	12	6	0.2 ± 0.9	Arroyo- 400 ft downstream from N11400, E12450
99999	13	0	14.7 ± 1.8	Arroyo- 600 ft downstream from N11400, E12450
99999	14	6	0.5 ± 0.9	Arroyo- 600 ft downstream from N11400, E12450
99999	15	0	8.6 ± 1.2	Arroyo- 800 ft downstream from N11400, E12450
99999	16	6	1.4 ± 0.9	Arroyo- 800 ft downstream from N11400, E12450
99999	17	0	0.6 ± 0.7	Arroyo-1000 ft downstream from N11400, E12450
99999	18	0	1.3 ± 0.7	Arroyo-1200 ft downstream from N11400, E12450
99999	19	0	10.0 ± 1.2	Arroyo-1400 ft downstream from N11400, E12450
99999	20	2	1.9 ± 0.9	Arroyo-1400 ft downstream from N11400, E12450
99999	21	0	2.9 ± 0.9	Arroyo-1600 ft downstream from N11400, E12450
99999	22	0	1.6 ± 0.8	Arroyo-1800 ft downstream from N11400, E12450
99999	23	0	51.7 ± 2.1	Arroyo- 200 ft downstream from N10600, E8200
99999	24	6	2.9 ± 1.6	Arroyo- 200 ft downstream from N10600, E8200
99999	25	0	2.9 ± 0.8	Arroyo- 400 ft downstream from N10600, E8200
99999	26	0	0.5 ± 0.6	Arroyo- 600 ft downstream from N10600, E8200
99999	27	0	0.8 ± 0.7	Arroyo- 800 ft downstream from N10600, E8200
99999	28	0	10.5 ± 1.3	Arroyo- 400 ft downstream from N10059, E12775
99999	29	6	4.8 ± 1.1	Arroyo- 400 ft downstream from N10059, E12775
99999	30	12	2.2 ± 1.0	Arroyo- 400 ft downstream from N10059, E12775
99999	31	0	4.4 ± 0.9	Arroyo- 600 ft downstream from N10059, E12775
99999	32	0	15.9 ± 1.3	Arroyo- 200 ft downstream from N9967, E12390
99999	33	5	2.1 ± 1.1	Arroyo- 200 ft downstream from N9967, E12390
99999	34	0	9.2 ± 1.0	Arroyo- 800 ft downstream from N9967, E12390
99999	35	6	3.3 ± 1.1	Arroyo- 800 ft downstream from N9967, E12390
99999	36	0	8.9 ± 1.4	Arroyo- 200 ft downstream from N9580, E12580
99999	37	6	1.1 ± 0.8	Arroyo- 200 ft downstream from N9580, E12580
99999	38	0	7.1 ± 1.2	Arroyo- 400 ft downstream from N9580, E12580
99999	39	6	0.5 ± 0.7	Arroyo- 400 ft downstream from N9580, E12580
99999	40	0	3.2 ± 1.0	Arroyo- 600 ft downstream from N9580, E12580
99999	41	0	2.9 ± 0.8	Arroyo- 800 ft downstream from N9580, E12580
99999	42	0	1.2 ± 0.8	Arroyo- 925 ft downstream from N9580, E12580
99999	43	0	39.2 ± 1.6	Arroyo- 43 ft north of U.S. Highway 163 (Area D)
99999	44	6	13.8 ± 1.6	Arroyo- 43 ft north of U.S. Highway 163 (Area D)
99999	45	8	15.8 ± 1.6	Arroyo- 43 ft north of U.S. Highway 163 (Area D)

Appendix E

BOREHOLE GEOPHYSICAL LOGS AND DATA

Two logging systems were used at the Mexican Hat, Utah, site, a spectral system (Compulogger) and a total-count system (PRS-1 RASCAL). Borehole data from each system are presented in Tables E-1 and E-2, respectively. Equipment characteristics and calibration information are included to document the parameters used in data reduction.

Uncertainties for the total-count system were calculated at a 95 percent confidence level (2σ). Water was encountered in only two boreholes. Logs for all other boreholes have an indicated fluid-level depth of 99.0 ft which is a default value. The auger height shown on each log indicates the distance measured from the top of the auger to the ground surface.

Radiometric logs for each of the boreholes are presented on microfiche in the pocket below. The percent sign (%) preceding data entries signifies an overflow in the data field which occurs after an apparent radium-226 concentration greater than 999.9 is reached.

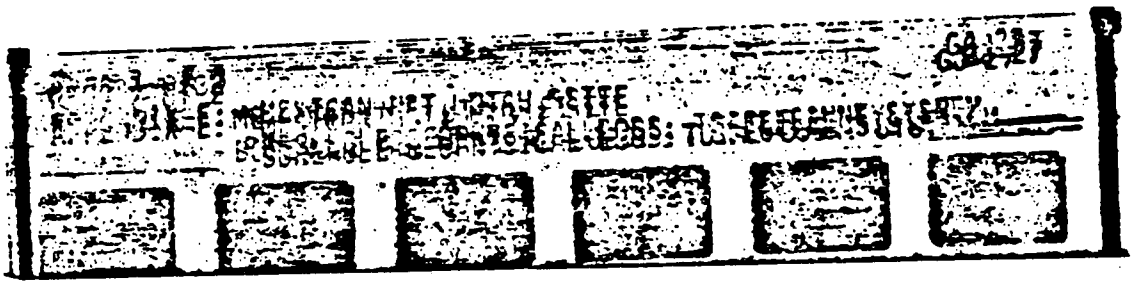

Table E-1

Borehole Data from Spectral System

EQUIPMENT DATA

INSTRUMENT	COMPULOGGER	CASING THICKNESS	0.1875 in.
GJO NUMBER	1815	CASING FACTOR	1.238 ± 0.012
SERIAL NUMBER	231-03	FLUID FACTOR	1.220 ± 0.154
DETECTOR	NaI(Tl)	MOISTURE FACTOR	1.069 ± 0.007
DETECTOR SIZE	2 in. x 6 in.	K FACTOR	7.00 ± 0.18 g-cps/pCi(eRa-226)
PROBE DIAMETER	2.5 in.	BACKGROUND	21.04 ± 3.24 cps
HOLE DIAMETER	6.87 in.	ALPHA FACTOR	3.0 ± 0.3
		CALIBRATION DATE	4 September 1984

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
HAT-014	9200	8500	4335.1	7.5
HAT-021	8900	8200	4345.5	3.5
HAT-022	8900	8400	4339.7	6.0
HAT-023	8800	7900	4347.6	3.5
HAT-026	8800	8500	4340.4	4.0
HAT-029	8700	7300	4332.8	3.5
HAT-031	8700	8200	4342.1	3.5
HAT-035	8600	8500	4350.3	4.0
HAT-045	8300	7500	4340.1	5.5
HAT-047	8200	7900	4353.4	4.0
HAT-071	10350	8150	4313.8	4.0
HAT-073	10000	8100	4315.0	3.0
HAT-074	9900	8000	4316.8	8.0
HAT-075	9900	8100	4318.4	9.5
HAT-080	9700	8200	4321.0	7.5
HAT-081	9700	8300	4323.6	11.0
HAT-083	9600	8200	4322.4	8.0
HAT-086	9400	8200	4328.3	18.5
HAT-088	9300	7500	4330.8	4.5
HAT-102	9807	9148	4312.1	5.0
HAT-103	9762	9321	4305.1	4.0
HAT-105	9530	9647	4315.6	8.5
HAT-110	8642	9559	4336.0	27.5
HAT-120	9014	8836	4331.3	8.5
HAT-121	9163	8789	4331.2	14.0
HAT-151	9801	9637	4305.6	5.5
HAT-153	9999	10095	4292.2	8.0
HAT-157	10320	10788	4268.3	9.0
HAT-159	10223	11088	4267.7	7.0
HAT-161	10108	11630	4233.5	12.5
HAT-166	9199	11424	4300.7	9.0
HAT-169	8922	11004	4295.6	9.0

Table E-2

Borehole Data from Total-Count System

EQUIPMENT DATA

INSTRUMENT	PRS-1 RASCAL	CASING THICKNESS	0.1875 in.
GJO NUMBER	C-3572S	CASING FACTOR	1.555 ± 0.095
SERIAL NUMBER	753	FLUID FACTOR	1.112 ± 0.078
DETECTOR	NaI(Tl)	MOISTURE FACTOR	1.069 ± 0.007
DETECTOR SIZE	2 in. x 2 in.	K FACTOR	77.14 ± 2.24 g-cps/pCi(eRa-226)
PROBE DIAMETER	2.5 in.	BACKGROUND	135.51 ± 94.20 cps
HOLE DIAMETER	6.87 in.	ALPHA FACTOR	3.0 ± 0.3
		CALIBRATION DATE	04 September 1984

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
HAT-011	9200	7900	4331.6	1.5
HAT-012	9200	8100	4343.6	1.3
HAT-013	9200	8300	4337.6	2.9
HAT-015	9000	7900	4342.1	3.8
HAT-016	9000	8100	4348.9	4.4
HAT-017	9000	8300	4342.1	2.8
HAT-018	9000	8500	4335.2	4.2
HAT-019	9000	8700	4330.3	2.5
HAT-020	8900	8100	4348.3	3.6
HAT-021	8900	8200	4345.5	4.4
HAT-024	8800	8100	4346.1	3.6
HAT-025	8800	8200	4343.4	1.0
HAT-027	8800	8700	4344.2	1.5
HAT-028	8800	8900	4338.7	1.0
HAT-030	8700	7700	4355.0	4.1
HAT-032	8600	7900	4350.6	2.7
HAT-033	8600	8100	4344.6	1.0
HAT-034	8600	8400	4342.6	3.7
HAT-036	8600	8700	4345.1	1.6
HAT-037	8590	8900	4.41.7	3.8
HAT-038	8500	7700	4351.5	2.2
HAT-039	8500	8200	4343.8	2.0
HAT-040	8400	7900	4350.8	1.3
HAT-041	8400	8100	4348.1	3.9
HAT-042	8400	8300	4347.4	2.8
HAT-043	8400	8500	4352.1	2.4
HAT-044	8400	8700	4359.3	0.7
HAT-046	8300	7700	4351.6	3.2
HAT-048	8185	8100	4351.6	2.8
HAT-049	8200	8300	4354.9	0.8
HAT-050	8200	8500	4357.4	0.3
HAT-051	8200	8750	4352.9	1.9
HAT-052	8000	7900	4353.2	3.5

Table E-2 (continued)

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
HAT-053	8000	8100	4358.7	1.4
HAT-054	8000	8300	4357.6	3.5
HAT-055	7800	7900	4353.2	3.5
HAT-056	7800	8100	4360.1	2.0
HAT-072	10200	8100	4312.5	1.0
HAT-076	9800	7700	4328.4	4.3
HAT-078	9800	8200	4321.7	4.0
HAT-079	9700	8100	4318.6	1.4
HAT-082	9700	8600	4332.1	2.9
*HAT-085	9500	8200	4332.5	2.7
HAT-087	9400	8300	4336.8	0.8
HAT-101	9800	8990	4332.6	2.9
HAT-104	9652	9489	4315.0	4.0
HAT-106	9400	9769	4312.3	1.8
HAT-107	9208	9849	4300.0	14.5
*HAT-108	9023	9802	4315.0	2.7
*HAT-109	8825	9720	4296.8	2.0
*HAT-112	8299	9223	4329.5	2.8
*HAT-113	8388	9135	4332.2	7.5
*HAT-114	8241	8895	4329.1	3.5
HAT-115	8442	8964	4332.9	9.5
HAT-116	8600	9008	4336.4	1.9
HAT-117	8734	9097	4334.5	0.8
HAT-118	8852	8979	4338.4	0.8
HAT-119	9003	9074	4334.9	2.8
HAT-122	9373	8783	4330.1	2.0
HAT-123	9642	8775	4332.7	3.2
HAT-124	9960	9246	4313.7	7.1
HAT-125	10151	9290	4317.3	7.0
HAT-152	9907	9847	4295.7	4.7
HAT-154	10109	10340	4282.0	3.4
HAT-155	10159	10478	4287.3	0.9
HAT-156	10263	10614	4268.0	2.5
HAT-158	10446	11062	4257.3	4.5
HAT-160	10107	11416	4236.8	3.0
*HAT-163	9818	11533	4245.8	7.9
HAT-164	9697	11614	4272.7	2.7
HAT-165	9538	11662	4271.8	11.8
HAT-167	9103	11372	4304.3	3.3
HAT-168	8978	11269	4300.5	1.6
HAT-171	8944	10732	4293.5	4.5
*HAT-173	8903	10319	4284.5	1.3
*HAT-174	8898	10249	4280.2	5.3

*Boreholes logged without casing. Data were reduced for these boreholes using a hole diameter of 5.5 in., a casing thickness of 0 in., and a casing factor of 1.000 ± 0.000. All other equipment data were the same for all boreholes.

Table E-2 (continued)

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
*HAT-175	8876	10100	4281.9	1.9
*HAT-176	8728	9768	4289.7	2.1
*HAT-177	10105	11302	4242.0	2.5
*HAT-178	9998	11407	4239.9	9.5
HAT-179	10011	11622	4230.7	2.7
*HAT-180	9957	11511	4237.2	4.6

*Boreholes logged without casing. Data were reduced for these boreholes using a hole diameter of 5.5 in., a casing thickness of 0 in., and a casing factor of 1.000 ± 0.000. All other equipment data were the same for all boreholes.

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Appendix F

BUILDING-SURVEY DATA

Tables F-1 through F-8 present results of exposure-rate and alpha measurements made in buildings at the Mexican Hat site. Figures F-1 through F-8 identify the approximate locations of the measurements. Locations identified by the letter X indicate locations of PIC measurements. Locations identified by a black dot followed by a number indicate locations of alpha-survey measurements.

Table F-1

Survey Data for Building 1/Ore-Crushing Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			64.0	63.1
1	Floor	370	345		
2	Floor	1000	1030		
3	Floor	625	600		
4	Floor	395	320		
5	Floor	1400	1300		
6	Floor	1100	1400		
7	Footer	1100	1100		
8	Pit	800	800		

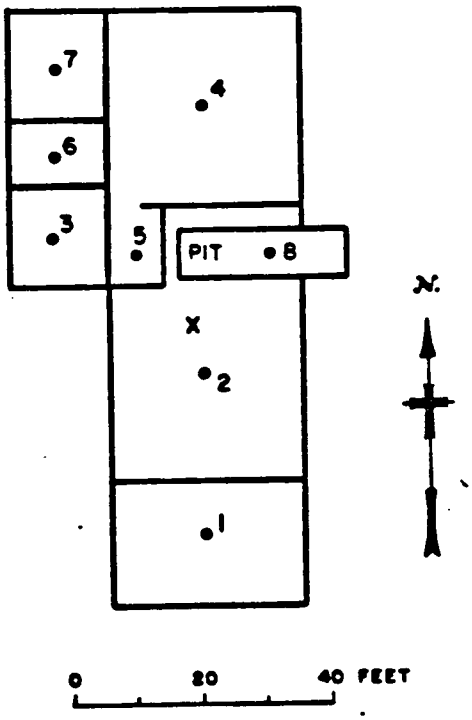

Figure F-1. Measurement Locations in Building 1/Ore-Crushing Building

Table F-2

Survey Data for Building 2/Sheet Metal Shop

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			20.7	20.7
1	Wall	20	0		
2	Floor	20	2		
3	Light Fixture	25	5		
4	Wall	40	0		
5	Floor	20	4		
6	Brick Wall	75	0		
7	Wall		2		
8	Floor		8		
9	Fuse Box		8		
10	Wall		0		

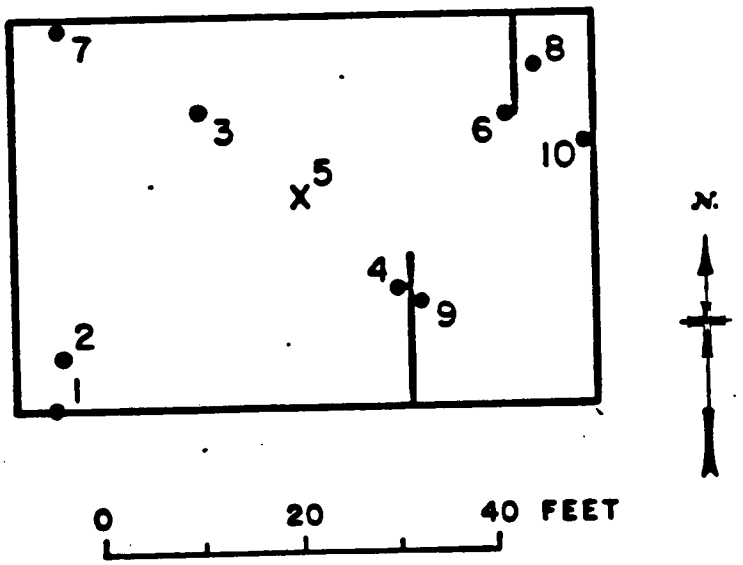

Figure F-2. Measurement Locations in Building 2/Sheet Metal Shop

Table F-3

Survey Data for Building 3/Empty Metal Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			33.1	32.1
1	Floor	135	65		
2	Floor	220	40		
3	Floor	140	70		
4	Floor	180	90		

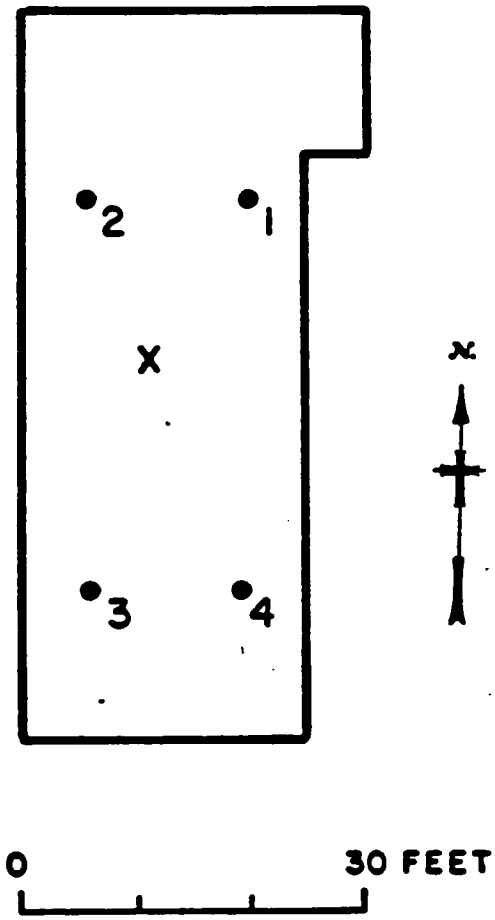

Figure F-3. Measurement Locations in Building 3/Empty Metal Building

Table F-4

Survey Data for Building 4/Generator Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			17.2	16.0
1	Floor	100	95		
2	Floor	100	95		
3	Floor	50	110		
4	Floor	160	140		
5	Generator Support	120	140		
6	Generator Support	110	80		
7	Floor	75	75		
8	Floor	100	120		

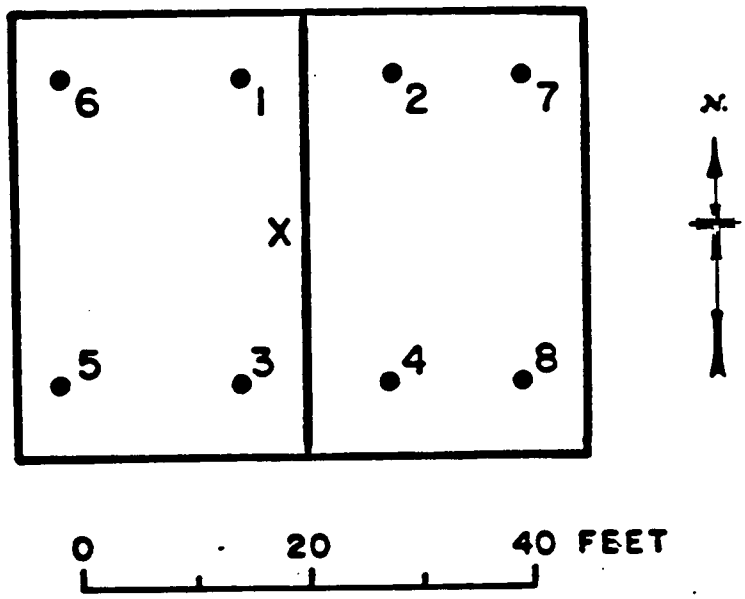

Figure F-4. Measurement Locations in Building 4/Generator Building

Table F-5

Survey Data for Building 5/Trade School Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			18.0	17.4
1	Floor	80	60		
2	Floor	55	80		
3	Floor	130	100		
4	Floor	55	60		
5	Floor	55	55		
6	Floor	70	30		
7	Floor	60	50		
8	Floor	80	60		
9	Floor	30	80		
10	Wall	40	30		
11	Floor	55	35		
12	Wall	40	35		
13	Floor	10	10		
14	Floor	35	30		
15	Wall (Brick)	20	20		
16	Floor	40	30		
17	Floor	30	25		
18	Wall	50	20		
19	Floor	20	5		
20	Floor	50	40		
21	Floor	35	50		
22	Floor	50	25		
23	Heater Duct	90	55		
24	Floor	35	35		
25	Floor	90	70		
26	Floor	80	60		
27	Floor	90	60		
28	Floor	60	30		
29	Floor	80	40		
30	Wall	30	15		

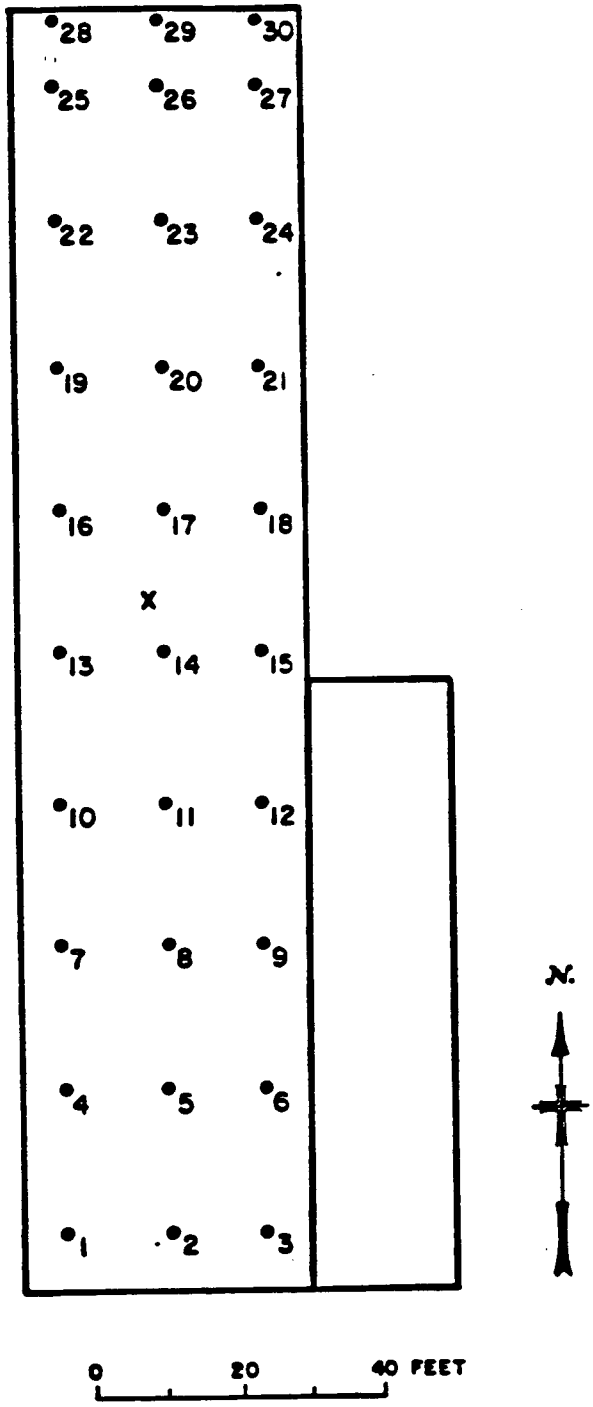

Figure F-5. Measurement Locations in Building 5/Trade School Building

Table F-6

Survey Data for Building 6/Brick Building

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			18.0	18.6
1	Floor	80	50		
2	Floor	35	80		
3	Wall	40	20		
4	Floor	50	20		

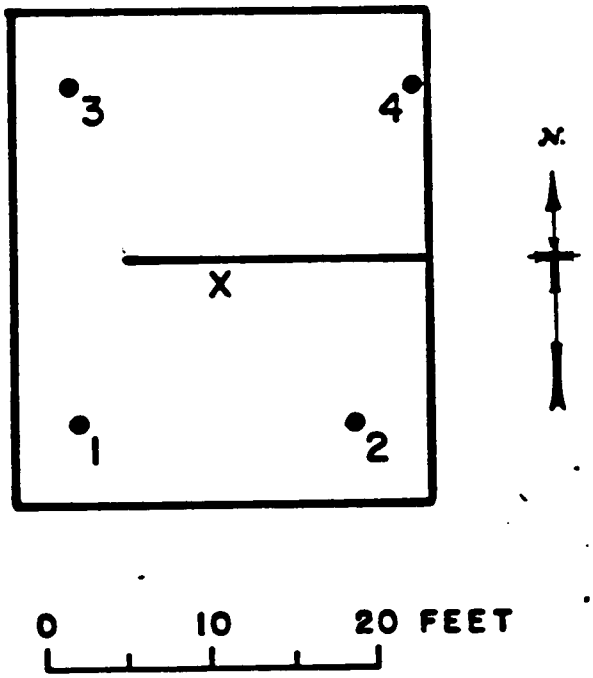

Figure F-6. Measurement Locations in Building 6/Brick Building

Table F-7

Survey Data for Building 7/Scale House

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			67.7	67.9
1	Floor	330	280		
2	Floor	260	255		
3	Floor	235	400		
4	Floor	250	310		

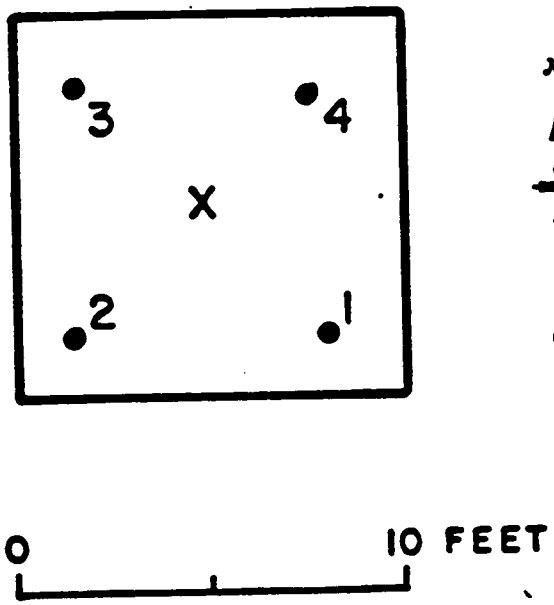

Figure F-7. Measurement Locations in Building 7/Scale House

Table F-8

Survey Data for Building 8/Health Clinic

Measurement Location No.	Area Surveyed	Alpha Survey (cpm) Direct	Alpha Survey (cpm) Clean Surface	PIC Exposure-Rate (μR/h) First Reading	PIC Exposure-Rate (μR/h) Second Reading
X	3 ft/Center of Bldg.			13.7	13.5
1	Waiting Room	40	0		
2	Dark Room	40	1		
3	Screening Room	40	1		
4	Exam Room	30	0		
5	Lab Room	30	0		
6	Pharmacy Room	10	0		
7	CHN Room	20	1		
8	ABE Room #1	20	0		
9	ABE Room #2	10	0		
10	RD Room	30	0		
11	Adult Ed. Room	20	0		
12	Sewing Room	15	0		
13	Womens Restroom	40	0		
14	Mens Restroom	30	0		
15	ABE Room #3	30	0		
16	ER Room	20	0		
17	Storage Room	25	0		
18	Furnace Room	50	0		

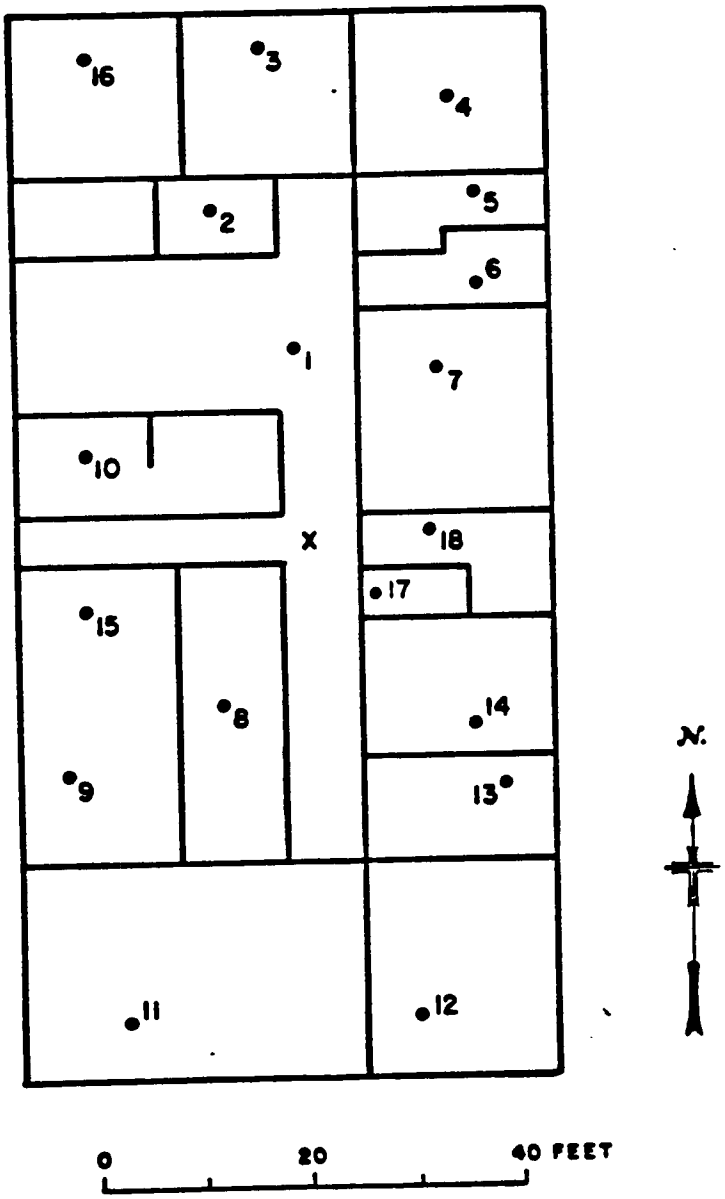

Figure F-8. Measurement Locations in Building 8/Health Clinic

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Appendix G

BACKGROUND MEASUREMENT DATA

Table G-1 presents analytical and measurement data obtained at four background locations indicated in Figure 1. Radium, thorium, and potassium values represent equivalent concentrations. All measurements were surface measurements. Soil samples were collected at a depth of 0 to 6 in.

Table G-1

Background Location Analytical and Measurement Data

Area	PIC Exposure-Rate (μR/h) Reading 1/Reading 2	Delta-Gamma Results pCi(Ra-226)/g Inst. C-1114 C-1130	Soil Sample Laboratory Results				
			Sample No.	Moisture (%)	Radium (pCi/g)	Thorium (ppm)	Potassium (%)
BG-1	11.5 / 11.4	2.0 ± 0.7 1.4 ± 0.7	MHD 101 MHD 301	1.2	1.0 ± 1.0 0.9 ± 1.0	6.0 ± 2.0 9.9 ± 2.0	1.3 ± 0.4 1.3 ± 0.3
BG-2b	11.7 / 11.4	1.3 ± 0.7 0.8 ± 0.7	MHD 213 MBG 625 MHD 578		1.4 ± 1.0 1.0 ± 1.0 1.1 ± 1.0	5.6 ± 1.4 3.0 ± 1.4 6.3 ± 1.0	1.8 ± 0.4 1.0 ± 0.2 1.8 ± 0.2
BG-3	10.7 / 10.9	1.1 ± 0.7 0.9 ± 0.7	MHD 103 MHD 151	1.2	1.0 ± 1.0 0.7 ± 1.0	7.0 ± 2.0 1.7 ± 0.0	1.3 ± 0.2 1.4 ± 0.3
BG-4	12.7 / 12.4	1.0 ± 0.7 0.9 ± 0.7	MHD 114 MHD 579	3.0	2.0 ± 1.0 1.3 ± 1.0	1.0 ± 1.0 5.6 ± 1.4	1.3 ± 0.4 1.6 ± 0.4

ADDENDUM D2

FINAL RADIUM CONCENTRATIONS AND VOLUMES OF TAILINGS AT MEXICAN HAT

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TABLE OF CONTENTS

Section		Page
D2.1	Final radium concentrations and volumes at the upper pile at Mexican Hat	D2-1
D2.2	Final radium concentrations and volumes at the lower pile at Mexican Hat	D2-10

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D2.1 FINAL RADIUM CONCENTRATIONS AND VOLUMES AT THE UPPER PILE AT MEXICAN HAT

Pages D2-2 through D2-5 of this addendum present the concentrations of each grid cell by row, column, and layer. Each page contains two rows and all columns and layers for those rows. The layer by layer concentrations are printed down the page, while the columns are organized across the page. Pages D2-6 and D2-7 give the depths to the 15 pCi/g and physical interfaces, respectively. In these tables, the values are organized according to row and column. Page D2-8 presents the volume summary and the layer by layer averages with depth into the pile.

TAILINGS PILE ACTIVITY ANALYSES - BY ROGER A. NELSON
IRREGULAR BOUNDARY MODIFICATION PROGRAM EXECUTION - TueJun 4198515_ 61 15.52.06
MEXICAN HAT (UPPER PILE) - HTU - MSRD & SNL DATA
FILES: HTU001/DAT - ENTERED 5/21/85 (RANELSON)
FILE DATA FROM (8 by 8) GRID - GRID SPACING : (160 by 179 by 2.5) FEET

DATA FOR ROW : 1

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5			582	594	647	419	460	
2.5 - 5.0			773	462	428	387	361	
5.0 - 7.5			506	503	949	326	464	
7.5 - 10.0			435	505	743	757	411	
10.0 - 12.5			685	444	622	365	536	
12.5 - 15.0			655	872	584	676	730	
15.0 - 17.5			598	842	427	361	703	
17.5 - 20.0			981	1472	480	565	619	
20.0 - 22.5			816	872	928	705	828	
22.5 - 25.0			350	1008	662	941	578	
25.0 - 27.5						315	417	
27.5 - 30.0						215	316	
30.0 - 32.5						290	605	
32.5 - 35.0						777	30	
35.0 - 37.5							776	
37.5 - 40.0								
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DATA FOR ROW : 2

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5		417	911	409	516	127	242	432
2.5 - 5.0		489	544	670	705	357	496	353
5.0 - 7.5		3	655	855	737	484	473	377
7.5 - 10.0			522	287	609	232	636	913
10.0 - 12.5			612	926	531	665	702	581
12.5 - 15.0			266	811	504	564	1752	1268
15.0 - 17.5				38	575	704	957	677
17.5 - 20.0					849	643	717	442
20.0 - 22.5					467	792	581	1067
22.5 - 25.0					703	586	1083	734
25.0 - 27.5					681	242	874	377
27.5 - 30.0					700	739	742	436
30.0 - 32.5						941	546	396
32.5 - 35.0							1715	839
35.0 - 37.5							1157	1225
37.5 - 40.0							612	776
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DATA FOR ROW : 3

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5		633	1434	327	312	180	212	1018
2.5 - 5.0		478	1248	882	299	746	384	808
5.0 - 7.5		455	1040	910	436	237	835	580
7.5 - 10.0		141	1173	767	994	856	1040	824
10.0 - 12.5			689	1031	485	574	884	909
12.5 - 15.0			14	314	674	552	560	626
15.0 - 17.5				152	515	757	883	771
17.5 - 20.0					597	911	946	642
20.0 - 22.5						342	909	991
22.5 - 25.0						1105	626	1024
25.0 - 27.5						766	1071	490
27.5 - 30.0						813	992	
30.0 - 32.5							705	
32.5 - 35.0							1597	
35.0 - 37.5							645	
37.5 - 40.0								
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DATA FOR ROW : 4

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5		282	1084		316	230	182	158
2.5 - 5.0		1488	1397		213	394	327	284
5.0 - 7.5		736	214		274	218	317	326
7.5 - 10.0		170	405		961	1517	804	810
10.0 - 12.5		210			684	1189	787	734
12.5 - 15.0					342	636	652	793
15.0 - 17.5					1105	672	1664	526
17.5 - 20.0					39	961	924	552
20.0 - 22.5					278	768	836	917
22.5 - 25.0						1016	825	924
25.0 - 27.5						805	1224	1145
27.5 - 30.0						278	743	450
30.0 - 32.5							302	474
32.5 - 35.0								398
35.0 - 37.5								83
37.5 - 40.0								
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DATA FOR ROW : 5

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5		430	851		325	305	118	
2.5 - 5.0		236	231		306	249	239	
5.0 - 7.5		405	485		365	214	526	
7.5 - 10.0					373	1664	552	
10.0 - 12.5					373	514	926	
12.5 - 15.0					974	682	924	
15.0 - 17.5					215	895	1529	
17.5 - 20.0					10	1136	914	
20.0 - 22.5						391	1030	
22.5 - 25.0						11	1294	
25.0 - 27.5							276	
27.5 - 30.0								
30.0 - 32.5								
32.5 - 35.0								
35.0 - 37.5								
37.5 - 40.0								
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DATA FOR ROW : 6

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5					719	171	128	
2.5 - 5.0					206	187	137	
5.0 - 7.5					373	190	945	
7.5 - 10.0					263	533	1153	
10.0 - 12.5					130	596	1365	
12.5 - 15.0					582	771	597	
15.0 - 17.5					113	881		
17.5 - 20.0						412		
20.0 - 22.5								
22.5 - 25.0								
25.0 - 27.5								
27.5 - 30.0								
30.0 - 32.5								
32.5 - 35.0								
35.0 - 37.5								
37.5 - 40.0								
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DATA FOR ROW : 7

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5					295	64	127	
2.5 - 5.0					130	214	295	
5.0 - 7.5					126	230	588	
7.5 - 10.0					17	130	642	
10.0 - 12.5						1229	1297	
12.5 - 15.0						342	585	
15.0 - 17.5								
17.5 - 20.0								
20.0 - 22.5								
22.5 - 25.0								
25.0 - 27.5								
27.5 - 30.0								
30.0 - 32.5								
32.5 - 35.0								
35.0 - 37.5								
37.5 - 40.0								
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DATA FOR ROW : 8

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
0.0 - 2.5						263		
2.5 - 5.0						130		
5.0 - 7.5						678		
7.5 - 10.0						17		
10.0 - 12.5								
12.5 - 15.0								
15.0 - 17.5								
17.5 - 20.0								
20.0 - 22.5								
22.5 - 25.0								
25.0 - 27.5								
27.5 - 30.0								
30.0 - 32.5								
32.5 - 35.0								
35.0 - 37.5								
37.5 - 40.0								
40.0 - 42.5								
42.5 - 45.0								
45.0 - 47.5								

DEPTHS TO 15 pCi/g INTERFACE TABLE

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
I = 1			23.4	24.8	23.1	35.0	35.5	
I = 2		7.5	14.4	15.5	27.8	31.2	39.3	39.8
I = 3		8.9	13.7	17.5	18.3	29.5	35.6	26.8
I = 4		10.8	10.0		22.0	28.8	31.8	36.8
I = 5		6.9	6.0		19.8	24.0	25.8	
I = 6					16.9	19.5	14.0	
I = 7					8.8	13.8	14.2	
I = 8						9.1		

DEPTHS TO PHYSICAL INTERFACE TABLE

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
I = 1			21.6	23.0	21.3	33.0	34.6	
I = 2		5.5	12.6	15.0	26.0	29.4	37.5	38.0
I = 3		7.1	12.2	15.7	16.5	27.7	33.8	25.0
I = 4		9.0	8.5		19.0	27.0	30.0	35.0
I = 5		5.1	3.9		17.0	22.0	24.0	
I = 6					15.1	17.6	12.5	
I = 7					7.0	12.0	12.4	
I = 8						7.3		

DEPTHS FROM PHYSICAL TO 15 pCi/g INTERFACE TABLE

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8
I = 1			1.8	1.8	1.8	2.0	0.9	
I = 2		2.0	1.8	0.5	1.8	1.8	1.8	1.8
I = 3		1.8	1.5	1.8	1.8	1.8	1.8	1.8
I = 4		1.8	1.5		3.0	1.8	1.8	1.8
I = 5		1.8	2.1		2.8	2.0	1.8	
I = 6					1.8	1.9	1.5	
I = 7					1.8	1.8	1.8	
I = 8						1.8		

	ABOVE PHYSICAL INTERFACE	ABOVE 15 pCi/g INTERFACE
TOTAL VOLUME (cy)	763580	834528
TOTAL VOLUME (ft3)	2.06167E+07	2.25322E+07
DEPTH (ft)	19.4556	21.2633
TOTAL ACTIVITY (Ci)	561.687	597.203
AVERAGE ACTIVITY (pCi/g)	641.322	623.904

AVERAGE DEPTH FROM PHYSICAL INTERFACE TO 15 pCi/g INTERFACE IS 1.80769 FEET (BASED ON 13 VALUES)

AVERAGE PILE ACTIVITY PROFILE

DEPTH (FT)	ABOVE PHYSICAL INTERFACE VOLUME	ABOVE PHYSICAL INTERFACE ACTIVITY	ABOVE 15 pCi/g INTERFACE VOLUME	ABOVE 15 pCi/g INTERFACE ACTIVITY	TOTAL PILE VOLUME	TOTAL PILE ACTIVITY
0.0 - 2.5	98,119	430	98,119	430	98,119	430
2.5 - 5.0	96,952	479	98,119	476	98,119	476
5.0 - 7.5	89,633	503	95,899	487	98,119	485
7.5 - 10.0	79,556	712	86,785	665	98,119	592
10.0 - 12.5	75,896	719	77,760	718	98,119	576
12.5 - 15.0	63,751	728	71,678	687	98,119	523
15.0 - 17.5	54,952	775	68,909	718	98,119	453
17.5 - 20.0	46,779	782	53,151	715	98,119	407
20.0 - 22.5	42,324	778	47,203	756	98,119	373
22.5 - 25.0	33,944	869	40,120	837	98,119	372
25.0 - 27.5	27,049	720	31,945	694	98,119	244
27.5 - 30.0	20,791	577	25,858	584	98,119	184
30.0 - 32.5	15,911	503	19,118	512	98,119	127
32.5 - 35.0	12,092	869	15,911	893	98,119	157
35.0 - 37.5	5,304	1191	8,396	870	98,119	118
37.5 - 40.0	530	776	4,365	704	98,119	52
40.0 - 42.5	0	0	0	0	98,119	15
42.5 - 45.0	0	0	0	0	98,119	15

D2.2 FINAL RADIUM CONCENTRATIONS AND VOLUMES AT THE LOWER PILE AT MEXICAN HAT

Pages D2-10 through D2-17 of this addendum present the concentrations of each grid cell by row, column, and layer. Each page contains one row and all columns and layers for that row. The layer by layer concentrations are printed down the page, while the columns are organized across the page. Pages D2-18 and D2-19 give the depths to the 15 pCi/g and physical interfaces, respectively. In these tables, the values are organized according to row and column. Page D2-20 presents the volume summary and the layer by layer averages with depth into the pile.

TAILINGS PILE ACTIVITY ANALYSES - BY ROGER A. NELSON
IRREGULAR BOUNDARY MODIFICATION PROGRAM EXECUTION - TueJun 41985155 61 16.04.54
MEXICAN HAT (LOWER PILE) - HTL - MSRD & SNL DATA
FILES: HTL001/DAT - ENTERED 5/22/85 (RANELSON)
FILE DATA FROM (8 by 12) GRID - GRID SPACING : (149 by 171 by 2.5) FEET PAGE NO. 1

DATA FOR ROW : 1

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
0.0 - 2.5						263	668	280	278	314	254	
2.5 - 5.0						671	482	227	252	932	213	
5.0 - 7.5						269	263	218	261	269	298	
7.5 - 10.0						379	671	278	278	379	244	
10.0 - 12.5						403	269	388	388	278	42	
12.5 - 15.0						609	379	290	290	194		
15.0 - 17.5						784	323	314	314	260		
17.5 - 20.0						1235	416	932	932	223		
20.0 - 22.5						163	503	269	269	23		
22.5 - 25.0							745	379	379			
25.0 - 27.5							9	242	266			
27.5 - 30.0								223	204			
30.0 - 32.5								221	247			
32.5 - 35.0								254	233			
35.0 - 37.5								9	18			
37.5 - 40.0												
40.0 - 42.5												
42.5 - 45.0												
45.0 - 47.5												
47.5 - 50.0												
50.0 - 52.5												
52.5 - 55.0												
55.0 - 57.5												
57.5 - 60.0												
60.0 - 62.5												

DATA FOR ROW : 2

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
0.0 - 2.5					493	947	900	541	388	233	719	559
2.5 - 5.0					353	673	659	850	275	239	667	366
5.0 - 7.5					699	211	291	666	277	225	491	224
7.5 - 10.0					643	410	319	547	304	247	680	255
10.0 - 12.5					314	381	388	355	347	291	769	229
12.5 - 15.0					196	379	290	388	388	273	572	
15.0 - 17.5					22	583	314	290	290	253	254	
17.5 - 20.0						745	932	314	314	384	359	
20.0 - 22.5						787	269	932	932	347	355	
22.5 - 25.0						822	379	269	269	742	280	
25.0 - 27.5						22	403	379	301	541	232	
27.5 - 30.0							609	511	301	432		
30.0 - 32.5							784	639	175	764		
32.5 - 35.0							1235	590	222	254		
35.0 - 37.5							233	757	201	254		
37.5 - 40.0								157	4	254		
40.0 - 42.5										213		
42.5 - 45.0										298		
45.0 - 47.5										244		
47.5 - 50.0										42		
50.0 - 52.5												
52.5 - 55.0												
55.0 - 57.5												
57.5 - 60.0												
60.0 - 62.5												

DATA FOR ROW : 3

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12 ..
0.0 - 2.5			611	763	762	1680	1926	1255	883	903	299	571
2.5 - 5.0			484	443	977	1485	1339	774	663	748	276	290
5.0 - 7.5			528	326	922	489	1329	868	460	630	274	203
7.5 - 10.0			232	1008	493	392	407	830	1312	1061	270	330
10.0 - 12.5			123	1128	326	658	833	591	357	543	228	212
12.5 - 15.0				900	902	767	530	416	589	387	228	245
15.0 - 17.5				682	1049	381	263	388	746	490	567	119
17.5 - 20.0				22	314	379	671	290	627	513	719	
20.0 - 22.5					196	699	269	314	647	253	667	
22.5 - 25.0					22	643	379	932	765	384	491	
25.0 - 27.5						314	762	269	448	420	680	
27.5 - 30.0						196	880	379	416	719	769	
30.0 - 32.5						22	1262	870	742	667	572	
32.5 - 35.0							1036	1295	541	491	559	
35.0 - 37.5							457	771	432	680	366	
37.5 - 40.0								1414	764	769	224	
40.0 - 42.5								457	602	572	255	
42.5 - 45.0									849	785	229	
45.0 - 47.5									849	585		
47.5 - 50.0									649	542		
50.0 - 52.5									280	341		
52.5 - 55.0									399	425		
55.0 - 57.5									232			
57.5 - 60.0												
60.0 - 62.5												

DATA FOR ROW : 4

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
0.0 - 2.5	468	611	393	600	1537	2172	1292	980	614	567	782	203
2.5 - 5.0	413	484	326	561	1175	1895	1730	1205	1195	789	567	330
5.0 - 7.5	123	528	1008	393	1131	1588	1295	676	843	759	719	200
7.5 - 10.0		232	911	326	805	763	1598	451	355	669	667	234
10.0 - 12.5		123	920	1207	452	1418	1340	1189	796	582	491	9
12.5 - 15.0			621	1165	326	745	1818	1126	995	633	567	
15.0 - 17.5			254	1117	997	482	2048	1062	917	423	571	
17.5 - 20.0				816	1472	678	912	1142	693	782	290	
20.0 - 22.5				204	868	847	851	855	492	567	622	
22.5 - 25.0					639	1100	932	717	670	719	544	
25.0 - 27.5					22	1176	932	792	716	667	430	
27.5 - 30.0						867	440	966	444	491	430	
30.0 - 32.5						535	1385	854	792	680	291	
32.5 - 35.0							547	1541	966	769		
35.0 - 37.5							532	1366	854	572		
37.5 - 40.0								1448	1304	1219		
40.0 - 42.5								1371	892	414		
42.5 - 45.0								468	1399	328		
45.0 - 47.5									943	348		
47.5 - 50.0									486	428		
50.0 - 52.5												
52.5 - 55.0												
55.0 - 57.5												
57.5 - 60.0												
60.0 - 62.5												

DATA FOR ROW : 5

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
0.0 - 2.5	461	1416	553	1261	1850	1294	812	792	617	768	332	
2.5 - 5.0	123	1164	997	1517	2220	1631	619	966	782	618	275	
5.0 - 7.5		1366	1166	509	1898	1825	1174	854	567	538	259	
7.5 - 10.0		1263	867	471	2048	1142	1831	851	670	567	258	
10.0 - 12.5		385	369	553	1031	1260	785	596	716	571	8	
12.5 - 15.0			199	1365	917	1341	1712	1125	444	290		
15.0 - 17.5				1456	827	1149	1142	1508	660	732		
17.5 - 20.0				1244	1147	1117	348	275	747	290		
20.0 - 22.5				980	1778	953	633		555	420		
22.5 - 25.0				13	1424	1224	971		913	454		
25.0 - 27.5					1351	1303	1067		1449	266		
27.5 - 30.0					531	1493	863		1024			
30.0 - 32.5						1205	1389		1141			
32.5 - 35.0						1048	1481		782			
35.0 - 37.5							1270					
37.5 - 40.0							1167					
40.0 - 42.5							90					
42.5 - 45.0												
45.0 - 47.5												
47.5 - 50.0												
50.0 - 52.5												
52.5 - 55.0												
55.0 - 57.5												
57.5 - 60.0												
60.0 - 62.5												

DATA FOR ROW : 6

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
0.0 - 2.5				949	1482	902	757	348	692	484	325	312
2.5 - 5.0				1645	1780	1893	874	633	458	590	637	290
5.0 - 7.5				1231	1524	1926	1056	1149	758	650	752	290
7.5 - 10.0				1136	779	2029	1413	1477	703	742	790	263
10.0 - 12.5				1182	1222	1570	1434	1031	861	686	455	
12.5 - 15.0				560	1442	1420	1236	972	387	516	537	
15.0 - 17.5					1235	1304	386	1012		779	703	
17.5 - 20.0					1135	1058		1032		773	385	
20.0 - 22.5					13	1452		1114		1254	730	
22.5 - 25.0						1647		410		1214	687	
25.0 - 27.5						1547				488	1136	
27.5 - 30.0						1220					926	
30.0 - 32.5						531					363	
32.5 - 35.0												
35.0 - 37.5												
37.5 - 40.0												
40.0 - 42.5												
42.5 - 45.0												
45.0 - 47.5												
47.5 - 50.0												
50.0 - 52.5												
52.5 - 55.0												
55.0 - 57.5												
57.5 - 60.0												
60.0 - 62.5												

DATA FOR ROW : 7

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
0.0 - 2.5		57	1229	253	927	544	351	523	521	364	434	
2.5 - 5.0			1497	547	1275	1110	740	989	569	502	329	
5.0 - 7.5			895	1190	1522	2143	1932	1269	831	438	545	
7.5 - 10.0				1388	828	1953	2492	1575	620	1527	2327	
10.0 - 12.5				1202	1657	1274	795	969		1252	1753	
12.5 - 15.0				1600	1560	1092	1010	824		1778	228	
15.0 - 17.5				948	1443	1086	1403	911		1139		
17.5 - 20.0					772	1564	1622	1112		533		
20.0 - 22.5						1758	1470	1429				
22.5 - 25.0						1435	28	19				
25.0 - 27.5						430						
27.5 - 30.0												
30.0 - 32.5												
32.5 - 35.0												
35.0 - 37.5												
37.5 - 40.0												
40.0 - 42.5												
42.5 - 45.0												
45.0 - 47.5												
47.5 - 50.0												
50.0 - 52.5												
52.5 - 55.0												
55.0 - 57.5												
57.5 - 60.0												
60.0 - 62.5												

DATA FOR ROW : 8

DEPTH	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
0.0 - 2.5		1497	1338	1584	1980	393	744	1118				
2.5 - 5.0		476	1682	1948	1349	322	1592	1582				
5.0 - 7.5			795	1281	1923	384	2072	1952				
7.5 - 10.0					2125	745	28	37				
10.0 - 12.5					1814	2094						
12.5 - 15.0					847	1768						
15.0 - 17.5						634						
17.5 - 20.0						847						
20.0 - 22.5												
22.5 - 25.0												
25.0 - 27.5												
27.5 - 30.0												
30.0 - 32.5												
32.5 - 35.0												
35.0 - 37.5												
37.5 - 40.0												
40.0 - 42.5												
42.5 - 45.0												
45.0 - 47.5												
47.5 - 50.0												
50.0 - 52.5												
52.5 - 55.0												
55.0 - 57.5												
57.5 - 60.0												
60.0 - 62.5												

DEPTHS TO 15 pCi/g INTERFACE TABLE

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
I = 1						21.6	26.6	37.0	36.6	21.6	11.6	
I = 2					16.6	27.5	36.6	38.2	39.8	48.8	26.6	11.6
I = 3			11.6	19.8	23.2	31.2	36.3	41.7	56.1	54.1	42.6	16.6
I = 4	6.1	12.0	15.0	21.6	25.6	30.8	35.6	44.2	47.9	48.6	30.8	11.0
I = 5	2.6		11.0	13.5	22.8	27.6	35.0	41.1	19.6	34.0	26.6	11.5
I = 6				13.8	21.0	30.6	16.3	24.8	13.0	26.1	30.6	9.9
I = 7		1.8	6.1	16.6	18.4	26.5	23.6	23.0	8.8	20.0	14.8	
I = 8		3.9	7.0	6.6	15.0	18.0	9.1	9.0				

DEPTHS TO PHYSICAL INTERFACE TABLE

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
I = 1						20.0	25.0	35.0	35.0	20.0	10.0	
I = 2					15.0	25.9	35.0	36.6	37.0	47.0	25.0	10.0
I = 3			10.0	18.2	22.0	29.6	34.7	40.1	54.5	52.5	41.0	15.0
I = 4	4.5	11.6	13.5	20.0	24.0	29.2	34.0	42.6	46.3	47.0	29.2	10.0
I = 5	1.0		9.4	11.5	21.2	26.0	33.4	39.5	18.0	32.4	25.0	10.7
I = 6				12.2	19.5	29.0	14.7	23.2	11.4	24.5	29.0	8.3
I = 7		0.2	4.5	15.0	16.8	25.0	22.0	22.2	7.2	18.4	13.2	
I = 8		2.4	5.4	5.0	13.0	15.1	7.5	7.0				

DEPTHS FROM PHYSICAL TO 15 pCi/g INTERFACE TABLE

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	J = 8	J = 9	J = 10	J = 11	J = 12
I = 1						1.6	1.6	2.0	1.6	1.6	1.6	
I = 2					1.6	1.6	1.6	1.6	2.0	1.8	1.6	1.6
I = 3			1.6	1.6	1.2	1.6	1.6	1.6	1.6	1.6	1.6	1.6
I = 4	1.6	0.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.0
I = 5	1.6		1.6	2.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	0.8
I = 6				1.6	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6
I = 7		1.6	1.6	1.6	1.6	1.5	1.6	0.8	1.6	1.6	1.6	
I = 8		1.6	1.6	1.6	2.0	2.9	1.6	2.0				

	ABOVE PHYSICAL INTERFACE	ABOVE 15 pCi/g INTERFACE
TOTAL VOLUME (cy)	1.51524E+06	1.623E+06
TOTAL VOLUME (ft3)	4.09116E+07	4.38211E+07
DEPTH (ft)	21.9959	23.5601
TOTAL ACTIVITY (Ci)	1366.28	1420.96
AVERAGE ACTIVITY (pCi/g)	786.129	763.304

AVERAGE DEPTH FROM PHYSICAL INTERFACE TO 15 pCi/g INTERFACE IS 1.56429 FEET (BASED ON 14 VALUES)

AVERAGE PILE ACTIVITY PROFILE

DEPTH	ABOVE PHYSICAL INTERFACE		ABOVE 15 pCi/g INTERFACE		TOTAL PILE	
(FT)	VOLUME	ACTIVITY	VOLUME	ACTIVITY	VOLUME	ACTIVITY
0.0 - 2.5	168,492	788	171,525	780	172,219	777
2.5 - 5.0	164,198	860	166,537	857	172,219	833
5.0 - 7.5	155,337	835	161,053	838	172,219	801
7.5 - 10.0	146,457	837	152,584	816	172,219	729
10.0 - 12.5	129,660	808	139,339	770	172,219	631
12.5 - 15.0	117,345	785	125,029	771	172,219	573
15.0 - 17.5	103,237	784	111,798	764	172,219	512
17.5 - 20.0	95,877	751	102,064	733	172,219	457
20.0 - 22.5	82,476	753	90,302	721	172,219	387
22.5 - 25.0	72,379	739	77,657	713	172,219	330
25.0 - 27.5	56,054	706	66,326	654	172,219	270
27.5 - 30.0	50,486	631	54,321	643	172,219	220
30.0 - 32.5	42,371	799	46,071	761	172,219	231
32.5 - 35.0	37,369	761	41,454	769	172,219	201
35.0 - 37.5	24,630	691	32,516	583	172,219	132
37.5 - 40.0	20,761	946	23,275	872	172,219	132
40.0 - 42.5	15,181	650	19,077	576	172,219	80
42.5 - 45.0	11,890	730	13,427	699	172,219	73
45.0 - 47.5	9,720	563	11,796	578	172,219	57
47.5 - 50.0	4,718	596	7,293	470	172,219	42
50.0 - 52.5	4,718	311	4,718	311	172,219	23

ADDENDUM D3

GEOLOGIC DATA

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CONTENTS

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Table D3.1 Faults in the Mexican Hat site region, source, method of study, and comments

Fault/ lineament number	Source	Examined by: Aerial recon.	Low-sun-angle Aerial recon.	Ground recon.	Comments
1	Witkind and others, 1957	X	X		Shorter than mapped. No late Quaternary offset.
2	this study	X	X		Not faulted - lineament from exposure by erosion of resistant stratigraphy.
3	Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
4	Cooley and others, 1969	X			No Late Quaternary offset.
5	Haynes and Hackman, 1978	X			No Late Quaternary offset.
6	Haynes and Hackman, 1978	X			No Late Quaternary offset.
7	Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
8	Hackman and Wyant, 1973 and this study	X	X		No Late Quaternary offset.
9	Cooley and others, 1969	X	X	X	No Late Quaternary offset.
10	Hackman and Wyant, 1973	X	X	X	No Late Quaternary offset.
11	Cooley and others, 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
12	Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
13	Hackman and Wyant, 1973 Haynes and Hackman, 1978 this study	X	X	X	No Late Quaternary offset.
14	this study	X	X		No Late Quaternary offset.
15	Hackman and Wyant, 1973 Haynes and Hackman, 1978 Cooley and others, 1969	X	X		No Late Quaternary offset.
16a	Haynes and others, 1972	X	X	X	No Late Quaternary offset.
16b	Haynes and others, 1972	X	X		No Late Quaternary offset.
17	Haynes and others, 1972	X	X	X	No Late Quaternary offset.
18	Haynes and others, 1972	X	X		No Late Quaternary offset.
19	Cooley and others, 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.

Table D3.1 Faults in the Mexican Hat site region, source, method of study, and comments (Concluded)

Fault/ lineament number	Source	Examined by: Aerial recon.	Low-sun-angle Aerial recon.	Ground recon.	Comments
20	Cooley and others, 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
21	Cooley and others, 1969 Hackman and Wyant, 1973	X	X		No Late Quaternary offset.
22	this study	X	X	X	Not a fault - dike emplacement.
23	Haynes and others, 1972 and this study	X	X	X	Excavated scarps in resistant Rico Fm.
24	this study	X	X	X	Excavated scarps in resistant Rico Fm.
25	this study	X	X		Possible Quaternary displacement but probably erosion-exposed fault line. Not critical as length is only about 12 km (7.5 mi).

Table D3.2

PAUL[illegible] SMITH
SERGENT, HAUSKINS & BECKWITH

200-KM RADIUS OF ME[illegible]N HAT, UT, 37.13 N, 109.89W

05 08 [illegible] 03:41:00

NGDC EARTHQUAKE DATA FILE

SOURCE	DATE YR	MO	DA	TIME HR	MN	SEC	LOCATION LAT	LONG	DEPTH KM	MAGNITUDES Mb	Ms	OTHER	LOCAL		INT MAX	GTSVNO	F-E	CE	Q/N	DISTANCE KM
USN	1967	05	08	19	31	28.4	37.7 N	110.2 W	33								478		A	69
PDE	1981	09	10	07	55	09.3U	37.511N	110.542W	7G				3.1	ML SLC			479		7	72
1***PDE	1967	05	08	19	31	28.5*	37.726N	110.239W	33N								478		5	73
PDE	1971	05	01	02	11	20.4	36.601N	110.431W	5G				2.	ML NOS			495		7	79
PDE	1971	03	14	18	14	12.2*	36.472N	110.437W	5G				2.2	ML NOS			495		5	82
PDE	1973	02	09	17	38	37. *	36.43 N	110.425W	5G				3.2	ML ERL			495		6	92
1***USN	1973	02	09	17	33	37.	36.4 N	110.4 W	5								495		A	93
ISS	1931	07	28	08	39	06.	36.4 N	111. W									495			129
PDE	1979	04	30	02	07	10.3U	37.883N	111.016W	7				3.9	ML GS	IV		478	F	21	131
USN	1894	02	05	03	30		37.1 N	111.4 W							IV		478		G	135
USN	1894	02	06	15			37.1 N	111.4 W							III		478		G	135
USN	1935	10	06	03			37.6 N	111.3 W							IV		478		G	136
USN	1963	09	30	09	17	40.3	38. N	111. W	15								478		C	138
PDE	1941	02	28	06	19	48.	37.8 N	108.5 W									479			143
PDE	1983	05	03	12	43	38.1U	38.258N	110.592W	7G			3.2	3.	ML SLC			478		24	143
PDE	1966	03	24	20	10	59.3	36.8 N	108.3 W	5								496		6	145
2***USN	1966	03	24	20	10	59.3	36.8 N	105.3 W	5								496		C	145
1***STO	1966	03	24	20	10	59.3G	36.8 N	108.3 W	5								496		CX	145
PDE	1966	09	09	17	43	58.4	36.7 N	108.3 W	33								496		5	148
1***STO	1966	09	09	17	43	58.4G	36.7 N	108.3 W	33								496		CX	148
PDE	1967	02	01	20	15	19.3*	38.47 N	109.929W	5G	3.8							478		6	149
USN	1955	03	27	12	13		38.1 N	111.1 W							IV		478		H	152
STO	1964	01	17	22	00	42.8G	36.71 N	108.25 W	33								496		CX	152
1***USN	1967	02	01	20	15	19.3	38.5 N	109.9 W	5	3.8					IV		478		A	152
EQH	1912	09	18	21	12	Z	36.5 N	111.5 W							VII	F	495	D		160
1***USN	1912	08	18	21	12		36.5 N	111.5 W							VIII		495		H	160
USN	1950	01	17	00	53		35.7 N	109.6 W							VI		495		G	161
USN	1896	10	14	14			38.4 N	110.8 W							II		478		G	163
2***USN	1970	02	03	05	59	35.6	37.9 N	108.3 W	33	4.					V		479		A	164
PDE	1970	02	03	05	59	35.6*	37.918N	108.311W	33N	4.							479		5	164
1***STO	1970	02	03	05	59	35.6G	37.92 N	108.31 W	33	4.							479		C	164
EQH	1910	09	24	04	05	Z	36. N	111.1 W							VI		495	F		165
1***USN	1910	09	24	04	05		36. N	111.1 W							VIII		495		G	166
USN	1943	08	14	04	40		38.2 N	111.3 W									478		G	173
1***USN	1970	04	18	10	42	11.9	37.9 N	111.6 W	10	4.4					V		478		A	174
PDE	1970	04	18	10	42	11.9	37.858N	111.645W	10G	4.4							478		10	176
1***STO	1967	02	12	10	11	52.4G	37.67 N	108. W	5								479		5	177
PDE	1967	02	12	10	11	52.4	37.673N	108.002W	5G								479		5	177
PDE	1971	12	15	12	55	14.5*	36.791N	111.324W	5G				3.	ML ERL			495		8	177
2***USN	1967	02	12	10	11	52.4	37.7 N	108. W	5								479		A	178
USN	1926	10	01	15	15		37.3 N	111.9 W							III		478		G	180
USN	1926	10	04	20	30		37.3 N	111.9 W							III		478		G	180
USN	1926	10	23	07			37.3 N	111.9 W							III		478		G	180
USN	1926	11	12	03	40		37.3 N	111.9 W							III		478		G	180
USN	1926	11	16	14	15		37.3 N	111.9 W							III		478		G	180
USN	1948	01	24	02	57		35.9 N	111.2 W									495		I	181
PDE	1945	01	07	22	25	32.	36.5 N	111.8 W				5.1 PAS			VI		495	D		185
2***USN	1967	01	16	09	22	45.9	37.7 N	107.9 W	33	4.1					V		479		A	186

N*** BEFORE A RECORD MEANS IT IS A POSSIBLE DUPLICATE

Table D3.2 (Concluded)

NGDC EARTHQUAKE DATA FILE

SOURCE	DATE YR	MO	DA	TIME HR	MN	SEC	LOCATION LAT	LONG	DEPTH KM	MAGNITUDES Mb	Ms	OTHER	LOCAL			INT MAX	DTSVNO	F-E	CE	S/N	DISTANCE KM
USN	1895	12	17	03	20		38.3 N	111.4 W								III		478		G	187
1***STO	1967	01	16	09	22	45.9G	37.67 N	107.86 W	33	4.1								479		B	188
PDE	1967	01	16	09	22	45.9	37.672N	107.86 W	33N	4.1								479		9	188
USN	1966	05	30	22	20	41.9	37.7 N	111.9 W	5									478		C	189
PDE	1967	09	04	23	27	44.7	36.2 N	111.7 W	33									495		6	192
1***USN	1967	09	04	23	27	44.7	36.2 N	111.7 W	33									495		A	192
USN	1881	08	04	18	30		38.3 N	111.5 W										479		G	193
STO	1941	08	29	11	34	G	37.3 N	107.7 W								V		479		G	194
STO	1962	06	23	17	11	04. G	38.5 N	105.5 W	33									479		C	195
1***STO	1977	03	05	03	00	54.7G	35.91 N	106.29 W	22	4.6			4.2	ML	GS	VI		496		A	196
PDE	1977	03	05	03	00	54.7	35.915N	108.286W	22	4.6			4.2	ML	GS	VI	PDE	496	D	47	196
PDE	1976	01	05	06	23	32.9	35.844N	108.341W	25G	5.			4.6	ML	GS	VI		496	D	95	198
USN	1935	12	03	21	15		37.4 N	112.1 W										478		E	199
1***STO	1976	01	05	06	23	32.9G	35.84 N	108.34 W	25	5.			4.6	ML	GS	VI		496		A	199
1***STO	1976	05	20	19	43	21.9G	35.47 N	109.04 W	5				2.5	ML	GS	IV		495		C	199
PDE	1976	05	20	19	43	21.9*	35.474N	109.039W	5G									495	F	12	199

N*** BEFORE A RECORD MEANS IT IS A POSSIBLE DUPLICATE

TOTAL NUMBER OF EVENTS RETRIEVED IS 64
TOTAL NUMBER OF SUSPECTED DUPLICATES IS 19

NATIONAL GEOPHYSICAL DATA CENTER/NOAA BOULDER, COLORADO 80303

PAGE 2

Table D3.3 FIELD NOTES FOR GROUND RECONNAISSANCE

Andrew F. Hanney, III
2/24/86

Mexican Hat, UT
Monument Valley, AZ

Geomorphic Layard inspection
1/6 - 1/10/86

San Juan Inn - Mexican Hat, Utah
(801) 683-2220 day
(801) 683-2261 night

MON. 1/7/86
Office - 8-10 am
Travel - Phx → Mexican Hat 10am-5pm
Arrive San Juan Inn - 5:00 pm.
TUES. 1/7/86
Field work 8am - 5pm - Mex. Hat.
Wed. 1/8/86
Field work - Mon. Valley
8am - 5pm
Thurs. - 1/9/86 - Mon. Valley
Field work 8am - 5:30pm
Fri. 1/10/86
Travel to Phoenix 8am - 5pm

Mexican Hat tailings site -
1/2/86 - start work 8:00 am

1. inspect & measure channel bed cuts.
Possible erosion hazard to pile
Aggradation?
2. attitude of local beds -
back & measure expansive area

Left side of upper tailings pile
east of O.H. 933. -
dike/berm has been constructed along
downslope side (NW) of small drainage
channel which heads in a small
~~[illegible]~~ depression (loc. 1). Berm
is composed of S.S. blocks ~ 6-8"
thick, ranging from 10" - 3' across.
Berm is intact, but the S.S. blocks
are nothing to have used natural.
Ht. of berm range from 3' - 5'.
Seems appropriate to channel water from
a large drainage basin between the
low hills to the south of the upper pile

Numerous deeply-incised gullies occur
at S end of upper & lower piles. These
channel surface runoff directly onto

the surface of both piles. Some sediment
deposition has occurred where these
gullies open onto the pile surfaces.

Gullies to east & northeast of lower
tailings pile are actively eroding
headward toward the perimeter
road and the pile boundary. Rate
of erosion appears to be slow. Erosion
is into moderately-resistant S.S.
bedrock.

Gully heads at LOC. 2 are aggrading.
Material from elevated perimeter road
is being deposited in gully heads.
Slope of road is being slowly gullied.
No distinct gully erosion has yet occurred.
No breaching of road seems likely
in near future. Possible breach of road
by gully heads could cause gully
to extend to pile boundary.
It is recommended berm armor between
pile edge & road. On armor E.
side of road at present gully heads

↓ to p.6.

PHOTOS

Roll MEX. 1

1. - loc. P-1 .. Headward erosion in gully ~ 200 yds east of lower pile. In S.S. bedrock.

2. - View to west from east side of pile perimeter road. Lower pile, east side. View of gully heads at road bem. Net aggradation is occurring from erosion of material used for road bed. Minor erosion of slope of road bed. No deep gullies. Location P-2.

3-5 - loc. P-3. View of NE side of lower pile. Area of slope erosion & deposition in depression between pile & road. Breaching of road could cause gully head cutting.

6 - loc. P-4. View of NE side of lower pile. Erosion of pile slope. Possible breach of road & future gully headward erosion.

7. View to W. along N side of lower pile. Shows location of tailings in former drainage channel. - P-4

PHOTOS

8 - loc. P-5 : View to south showing drainage channel exiting from NE side of lower pile. Note extent of headcut into S.S. bedrock at lower left of photo. Area is now one of net aggradation.

9-10 - loc. P-6. View upstream of main drainage channel from NE side of lower pile

11 - View up channel to NE side of lower pile. loc. P-7.

12 - View upstream in channel. Note gully in road embankment. Boreholes 907 & 906 in wash downstream from road. Area of net aggradation. Location P-8

13-17. Panorama view from W to N over tailings pile & upper drainage basin. From water tower hill to E of housing area. ~~Location P-9~~

18 - MONUMENT VALLEY -
View to NE showing drainage thru old tailings pile. Location P-1

19 - View upstream at Map LOC. 2. Flow channel benchat rock outcrop on right.

20. View to N toward pile along trend of wash flow. Wash to left flows to 5 in Cove Wash. LOC. P-2

Location 3. Very minor gully extending from edge of road to NE. Incised "3". No expected headcut erosion problem. Rock ledge ~15' high occurs on west side of road. Resistant sandstone.

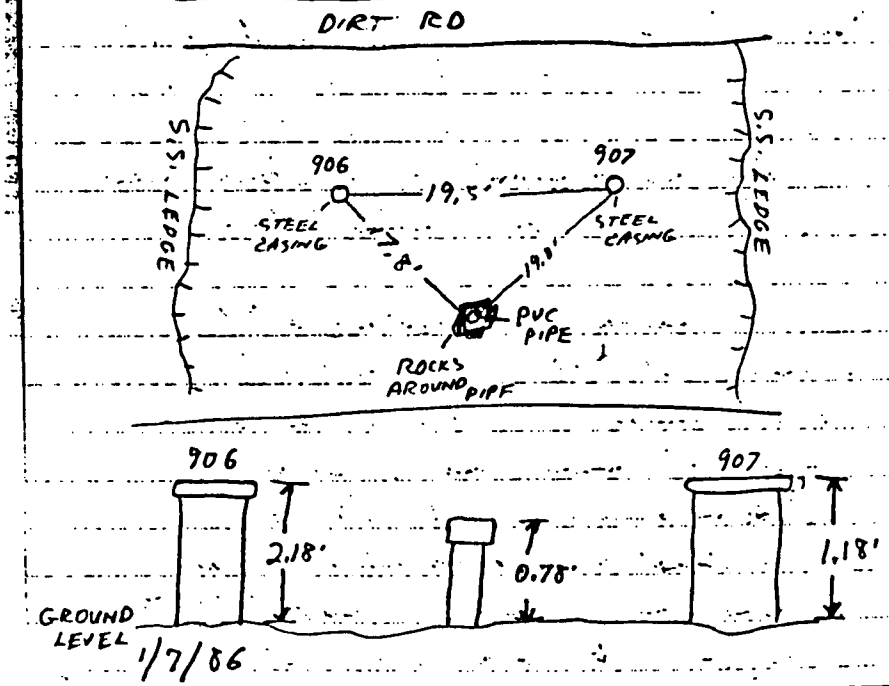
Location 4. Erosion between edge of pile & perimeter road. Not associated with road (tailings). Very little erosion of side slopes of road embankment. Possible breaching of road could occur. No incised gully is currently present to east of road. Breaching of road would probably result in gully development. Heavy cover of tailings slope would be good protection here. Area to NE of road (downslope) appears to have been bulldozed to depth of 2' below original surface! See photo 3-5.
At Loc. 4. - Headward erosion is occurring in shallowly-incised gullies on outer slope of tailings pile. Recent (?) erosion has lowered pile slope surface about 1' at gully heads. Gully heads are currently

1/3 up slope from base of pile embankment. Gullies are deepening between pile & area of deposition in basin next to road. (See photos 3-6).

Location 5. Main drainage channel going NE from NE side of lower tailings pile. Pile is placed ~~out~~ ~~on top~~ within the channel. A small basin occurs between pile slope base and perimeter road. This is an area of net deposition of f.g. tailings material eroded from outer face of pile. Pile slope is extensively gullied. ~~&~~ Eolian dunes composed of tailings are present in this area. Perimeter road is being breached by a gully ~1' deep & 1' wide forming on the NE road embankment.
* Major gully appears to have had net aggradation since construction of tailings pile & perimeter road. No incised channel is present in wash. Edges of wash are cut into moderately resistant S.S. bedrock. Breaching of perimeter road embankment would probably result in gully extension to edge of pile slope. →

Headcut in lower wash does not appear to have extended upstream past point shown on blue-line photo copy. (dated ?) Headcut is into resistant, firmly cemented sandstone bedrock.

Location 6 : Borehole sites 906 & 907, just downstream of road, in wash from NE side of lower tailings pile.
Baseline measurement of wash ground surface in relation to top of well casing cap. Measurements taken on upstream side of casing



Location 7 : Gully eroded into S.S. bedrock across outer road at N side of lower tailings pile. Slight amount of erosion of loose surficial material appears to be occurring. Gully head does not reach upper perimeter road. Deposition is occurring at upper end of gully from material eroded from upper perimeter road. No apparent headcut forced to pile. Gully could deepen if a large amount of runoff water was channeled from tailings pile to this wash, across upper dirt road.
Bottom of wash is on S.S. bedrock. Flows appear to be slowly removing any sediment which accumulates in wash. Therefore, net degradation in downstream channel below lower perimeter road.

Borehole casing baseline height measurement. Map location 8.
Channel scour has lowered surface about 4" from edge of concrete pad poured around PVC pipe. 3 vertical S.S. slabs were set into edge of concrete pad. Height (1/7/86) from PVC cap top to wash surface = 2.13'

Map LOC. 9 ... Headward gully erosion stops at rock ledge of resistant sandstone, ~12' high. Minor scour down to shallow rock surface between levee + boreholes 905+906. No hazard to tailings pile. Very remote possibility of headward erosion to pile over a long time period. Probably not within 1000 years in present climate. Possible increased scour rate if road is breached near depression + increased surface runoff occurs.
Minor gullies are present in dirt road embankment. Will enlarge to breach road.

Possible solutions for routing surface runoff from drainage basin above (to South) of tailings piles: See routes suggested by R.E.W. in site study. Best route seems to be Option 2. Divert drainage basin runoff to channel along west side of site, then across highway to San Juan River. Flow would be through existing pond on SW side of site. Existing berned channel along east side of site would have to be

extended + reinforced to carry runoff along east side of pile to the main wash leading to the San Juan River. Flow in this east side channel would be less than in the SW side channel. SW side channel would collect all runoff from upper basin near housing area.
Existing rock berm along road at east side of the pile may be sufficient to channel runoff from hills to east.

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ADDENDUM D4

LITHOLOGIC LOGS

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This addendum contains borehole logs and test pit logs. When referring to the DOE boring and test pit ID numbers, please note that the numbers used in the text refer to the numbering system as used in the DOE computerized Database Management System (DBMS). The numbering system used on the field boring logs and tailings test pit logs does not match that used in the text. Therefore, when referring to the following DOE boring logs and test pit logs in conjunction with the text of this document it may be necessary to convert the field and laboratory numbers via Table D4.1.

Table D4.1

	Field or lab number	DBMS ID number
Piezocone data:	HAT01-01 through 40	HAT01-200 through 240
Boring and lab data:		
	HAT01-01	HAT01-126
	HAT01-03	HAT01-127
	HAT01-06	HAT01-128
	HAT01-07	HAT01-129
	HAT01-09	HAT01-130
	HAT01-11	HAT01-131
	HAT01-15	HAT01-132
	HAT01-17	HAT01-133
	HAT01-19	HAT01-134
	HAT01-20	HAT01-135
	HAT01-23	HAT01-136
	HAT01-26	HAT01-137
	HAT01-32	HAT01-138
	HAT01-33	HAT01-139
	HAT01-35	HAT01-181
	HAT01-41-47	HAT01-182-188
	HAT01-50-56	HAT01-189-195
Test pits:	HAT01-TP1-TP5	HAT01-001-005

Table D4.2 Summary of geotechnical subsurface explorations at Mexican Hat, Utah (DOE)

Boring or test pit number[a]	Coordinates Northing	Coordinates Easting	Completion date	Total depth (feet)
Borings:				
(On the pile)				
HAT01-126	9111.3	9644.9	10/11/84	34.0
HAT01-127	9310.0	9445.0	10/11/84	27.0
HAT01-128	8710.0	9441.5	10/11/84	20.0
HAT01-129	8516.0	9241.0	10/11/84	12.5
HAT01-130	8910.5	9239.0	10/11/84	18.0
HAT01-131	9510.0	9245.0	10/12/84	17.0
HAT01-132	9710.6	10490.0	10/12/84	27.0
HAT01-133	9710.0	10890.0	10/12/84	45.0
HAT01-134	9708.5	11232.0	10/12/84	46.5
HAT01-135	9909.5	10891.6	10/16/84	41.0
HAT01-136	9508.7	10485.0	10/16/84	25.0
HAT01-137	9310.0	10890.0	10/13/84	22.5
HAT01-138	9510.9	10890.0	10/16/84	42.0
HAT01-139	9511.1	11090.8	10/16/84	34.0
HAT01-181	9310.3	11291.7	10/15/84	34.0
HAT01-911[b]	(9310)	(11090)	01/06/85	98.0
HAT01-912[b]	(9520)	(11160)	03/28/85	84.0
(Off the pile)				
HAT01-182	8370.6	9343.2	10/10/84	5.0
HAT01-183	8304.5	10066.6	10/10/84	3.3
HAT01-184	8727.1	10830.5	10/10/84	12.0
HAT01-185	9670.4	11617.7	10/10/84	14.0
HAT01-186	10482.4	11221.2	10/10/84	3.0
HAT01-187	10199.4	10345.6	10/10/84	3.0
HAT01-188	9885.5	9540.9	10/10/84	6.0
HAT01-189	(10850)	(10930)	10/23/84	5.0
HAT01-190	10781.3	11109.9	10/23/84	5.0
HAT01-191	(11050)	(12270)	10/23/84	2.5
HAT01-192	11683.1	12321.9	10/23/84	2.5
HAT01-193	10935.2	12126.8	10/23/84	1.5
HAT01-194	10152.6	11711.0	10/23/84	2.0
HAT01-195	10019.3	9538.7	10/23/84	3.0
HAT01-905	10006.3	9544.2	12/11/84	9.0[d]
HAT01-906[b]	10137.5	11703.1	12/12/84	11.8[d]
HAT01-907[b]	10154.1	11692.4	12/19/84	125.0[d]
HAT01-908[b]	(10000)	(9580)	01/11/85	196.9[d]
HAT01-909[b]	(7780)	(7510)	01/19/85	215.0[d]
HAT01-910[b,c]	(8400)	(10400)	01/22/85	236.0[d]

Table D4.2 Summary of geotechnical subsurface explorations at Mexican Hat, Utah (DOE) (Concluded)

Boring or test pit number	Coordinates Northing	Coordinates Easting	Completion date	Total depth (feet)
Borings (Cont.):				
(Off the pile) (Cont.)				
HAT01-930[b]	10550.337	7732.998	10/10/85	116
HAT01-931	12083.029	9971.036	10/12/85	177
HAT01-932	13167.679	12636.319	10/14/85	193
HAT01-933	7782.264	8444.656	10/15/85	175
HAT01-934[b]	9221.312	11989.935	10/18/85	200
HAT01-935[b]	10023.747	12468.284	10/20/85	187
HAT01-936	11391.741	10912.259	10/21/86	142
Test Pits:				
(Tailings)				
HAT01-001	(9710)	(11090)	10/17/84	7.0
HAT01-002	(10600)	(11200)	10/23/84	0.5
HAT01-003	(9510)	(10690)	10/23/84	5.5
HAT01-004	(9110)	(9445)	10/23/84	7.5
HAT01-005	(9310)	(9445)	10/23/84	4.5

[a]DBMS numbering system (See Table D4.1).
[b]These borings were cased and completed as monitoring wells.
[c]Two borings were advanced. One encountered hydrogen sulfide gas and was grouted to its full depth and another drilled nearby.
[d]Indicates that all or part of the boring was advanced using rock coring techniques.

() Coordinates enclosed in parentheses are field estimates and were not surveyed.

Table D4.3 Summary of borings at Mexican Hat (MSRD/CSU)

Boring number	Date completed	Total depth (feet)
A1	01/08/82	5.0
A2	01/08/82	3.0
A3	01/08/82	2.5
A4	01/08/82	4.5
A5	01/08/82	3.9
A6	01/08/82	7.3
A7	01/08/82	10.9
A8	01/08/82	13.7
A9	--	9.0
A10	01/08/82	7.5
A11	--	5.0
A13	--	5.5
A25	01/09/82	8.9
A27	01/09/82	5.0
A29	01/09/82	10.3
A36	01/09/82	22.5
A37	01/09/82	14.5
A38	01/09/82	14.8
B12	01/09/82	15.3
B14	01/08/82	26.5
B15	--	20.0
B16	01/08/82	36.0
B17	--	23.9
B18	01/08/82	22.6
B19	01/08/82	25.2
B20[a]	01/08/82	2.0
B21	01/08/82	13.5
B22	01/09/82	17.5
B23	01/08/82	19.5
B24	01/09/82	28.2
B26	01/09/82	34.3
B28	01/09/82	13.8
B30	01/09/82	31.5
B31	01/09/82	27.5
B32	01/09/82	37.9
B33	01/09/82	21.4
B34	01/09/82	23.4
B35	01/09/82	31.0
B86	01/20/82	39.9
B88	--	35.9
B93	01/20/82	35.5

Table D4.3 Summary of borings at Mexican Hat (MSRD/CSU) (Continued)

Boring number	Date completed	Total depth (feet)
C39	01/10/82	1.9
C40	01/10/82	4.8
C41	01/10/82	10.7
C42	01/10/82	12.0
C43	01/10/82	14.9
C44	01/10/82	23.2
C45	01/10/82	22.7
C46	01/10/82	9.7
C47	01/10/82	27.5
C48	01/10/82	35.4
C49	01/11/82	35.0
C54	01/11/82	34.8
C56	01/11/82	30.0
C58	01/11/82	24.4
C60	01/11/82	29.7
C62	01/11/82	34.4
C65	01/12/82	29.9
C67	01/12/82	22.5
C69	01/12/82	7.5
C71	01/12/82	3.4
C73	01/12/82	0.9
C75	01/12/82	6.1
C77	01/12/82	17.4
C79	01/12/82	19.8
C81	01/18/82	26.4
C83	01/18/82	24.9
C87	01/18/82	16.3
C89	01/19/82	14.5
C90	01/19/82	6.0
C94	01/20/82	21.0[b]
C95	01/20/82	26.0[b]
C96	01/20/82	19.0[b]
C97	01/20/82	7.5
D50	01/10/82	54.8
D51	--	42.4
D52	01/11/82	41.3
D53	01/11/82	18.4
D55	01/11/82	33.1
D57	01/12/82	26.1
D59	01/12/82	29.3
D61	01/12/82	13.6
D63	01/12/82	24.1
D64	01/12/82	46.9

Table D4.3 Summary of borings at Mexican Hat (MSRD/CSU) (Continued)

Boring number	Date completed	Total depth (feet)
D66	01/12/82	47.3
D68	01/12/82	3.9
D70	01/12/82	14.2
D72	01/12/82	1.3
D74	01/12/82	1.8
D76	01/12/82	7.9
D78	01/12/82	19.1
D80	01/12/82	18.4
D82	01/12/82	22.7
D84	01/19/82	50.0
D85	01/19/82	8.9
D91	01/19/82	9.9
D92	01/19/82	12.0
D98	01/22/82	25.0
D99	01/22/82	11.8
D100	01/22/82	46.2
D101	01/22/82	48.9
D102	01/22/82	39.7
D103	01/22/82	37.9
D104	01/22/82	35.9
D105	01/22/82	54.8
CSU 200	01/23/82	1.5
CSU 201	01/23/82	4.0
CSU 202	01/23/82	19.7
CSU 203	01/23/82	34.5
CSU 204	01/23/82	39.6
CSU 205	01/23/82	25.5[b]
CSU 206	01/23/82	16.0
CSU 207	01/23/82	24.8
CSU 208	01/22/82	47.0[b]
CSU 209	01/22/82	12.0
CSU 210	01/22/82	5.0
CSU 211	01/23/82	30.9
CSU 212	01/23/82	37.9
CSU 214	01/23/82	29.8
106[c]	--	0.9
107[c]	01/23/82	1.1
108[c]	01/23/82	1.4
109[c]	01/23/82	4.9

Table D4.3 Summary of borings at Mexican Hat (MSRD/CSU) (Concluded)

Boring number	Date completed	Total depth (feet)
Piezometers		
HG2[d]	01/23/82	20.0[b]
HG3[d]	01/23/82	60.0[b]

[a]This boring is marked as A20 on original maps but appears as B20 in borehole logs.
[b]All or part of the boring was advanced using rock coring techniques.
[c]Off-pile holes (not shown on location map).
[d]Boring logs missing.

DOE BORING LOGS

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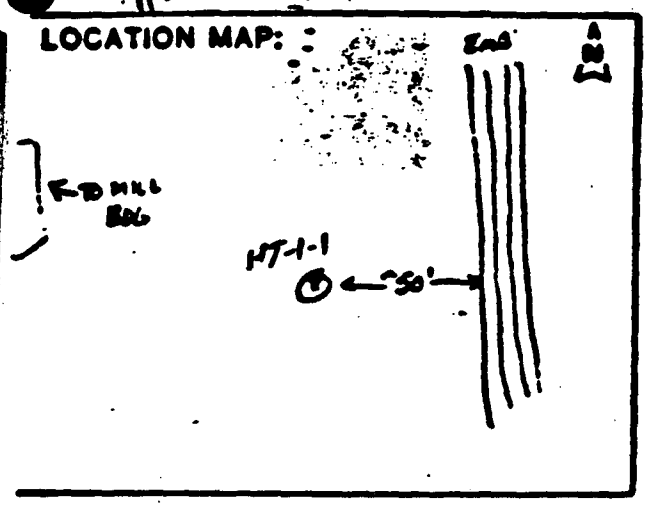
JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: HT-1-1
APPROX. SITE COORDINATES (ft.):
N 9110 E 9645
GROUND ELEVATION (ft. MSL): 4330 T.31
DRILLING METHOD: HSA CONTINUOUS
DRILLER: TCATT
DATE STARTED: 10-11-84
DATE COMPLETED: 10-11-84
FIELD REP.: GIWA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: UPPER ALF TOWARDS FAC
SITE CONDITION: SUNNY DAY - POWDERY SURFACE

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
5	X	X	X	S	1	1,1,1	2	SM	SAND F G WHITE D-D V.SILTY SLIGHTLY TRANSITION INTO CLAY
7	X	X	X	S	2	1,2,3	4	CL	CLAY V MOIST GRAY-BROWN F,D AND HA LAYERS SOFT = WHITE & LT BROWN
	X	X	X	T	3	C200PSI			
5.5-6	X	X	X	S	4	2 3 4	7	SP/CL	SAND F G SL CLAY GREY
7 7.5	X	X	X	S	5	3,2,4	6		OCAS. CLAY LAYER GREY - DARK GREY
8.5 9	X	X	X	S	6	3,2,2	4		
10 10.5	X	X	X	S	7	3,2,4	6		OCAS CLAY OR V.SILTY LAYERS
11.5 12	X	X	X	S	8	3,3,4	7	CL	CLAY LENS SOFT
13 13.5	X	X	X	S	9	3 2 4	6		
15	X	X	X	T	10				
17.5	X	X	X	S	11	1,2,3	5		CLAY VARIES GREY BROWN LAYER
19	X	X	X	S	12	3,4,5	9	SP	SAND SOME SILT SLIGHTLY
20.5	X	X	X	S	13	4,4,4	8		SAND F G SILTY OCAS CLAY LAYER - GREY
22 22.5									
	X	X	X	T	14	C200PSI		CH	CLAY HYD MOIST GREY TO LIGHT BROWN
25									

See Next pg.

COMMENTS: + 6" @ 1st SHELBY END OF PUSH 6 (3-6)
ENTIRE PUSH DEPTH BY SLOUGH

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. Split sample
U - 3" O.D. 2.42" I.D. Tube sample
T - 3" O.D. Thin-walled Shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: HT-1-1
APPROX. SITE COORDINATES (ft.):
N 9110 E 9605
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA CONTINUOUS
DRILLER: TCATT
DATE STARTED: 10-11-84
DATE COMPLETED:
FIELD REP.: SRW

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
	X	X	X	S	15	1,3,4	7	CL-ML	CLAY-SILT SANDY SILTY CLAY MOIST MOISTLY CL-ML
1.5	X	X	X	S	16	2,2,4	6	CL	SOME SANDY LAYERS
28	X	X	X						CLAY V MOIST SOFT
29.5	X	X	X	S	17	3,5,7	12	SP SM	SAND FG SILTY GREY MOIST MD
31	X	X	X	S	18	7,5,5	10		
32.5	X	X	X	S	19	3,4,4	8	CL	CLAY MOIST SILTY SANDY MP/GREY SOFT
	NO RECOVERY				20				TRANSITION INTO REDBROWN SILTSTONE
34 34.5									REFUSAL ON SANDSTONE 34' = TD
									TD = 34'
									SAMPLE REFUSAL @ 34 ON ROCK - BOUNCING SAMPLE N/R

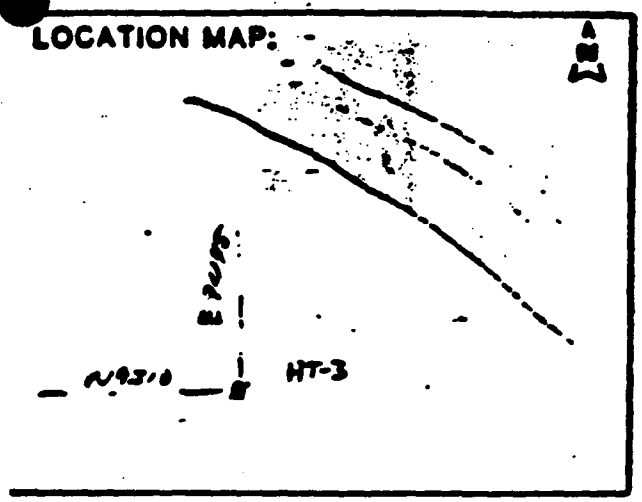
COMMENTS:

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: HT-1-3
APPROX. SITE COORDINATES (ft.):
N 9210 E 9445
GROUND ELEVATION (ft. MSL): 4330
DRILLING METHOD: HSA - CONTINUOUS
DRILLER: TCATT
DATE STARTED: 10-11-90
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION NORTH PART OF VANCE PIT
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
				T	1	EASY		CL	CLAY - MPI GREY TO WHITE SOFT BROWN
2.5				S	2	2,2,3	5	SM-SP	SAND F.G. SILTY-LOOSE, SLMOIST GREY
4				S	3	3,2,3	5		1/4" LAYERS OF GREY & BROWN CL CLAY
5.5				S	4	3,3,3	6		WITH 1/16" LAYERS OF FINE SAND-SP
7				S	5	3,2,3	5		
8.5				S	6	3,3,3	6	SP	SAND. FG GREY SLMOIST
10				S	7	3,3,4	7	MCL	OCAS CLAY LAYERS
11.5				S	8	3,3,2	5		
13				S	9	2,2,3	5		
14.5				S	10	3,2,2	4		
16				T	11	EASY PUSH		SP	SAND @ 18.5
18.5				S	12	3,3,4	7		
20.5				S	13	6,5,2	7		CLAYEY - SOFT WET TO MOIST BROWN
22				S	14	3,4,4	8		GRAY LAYER @ 24'
23.5				S	15	3,3,2	6		
25				S	16	3,3,9	11		26.5 SAND OVER SANDY CLAY
26.5								SS	SANDSTONE @ 27 = TD

COMMENTS: CAVEDE 15'

SAMPLE TYPE
A - Auger cuttings
B - 2" O.D. 1.38" I.D. Drive sampler
C - 3" O.D. 2.42" I.D. Tube sampler
T - 3" O.D. Thin-walled Shelby tube

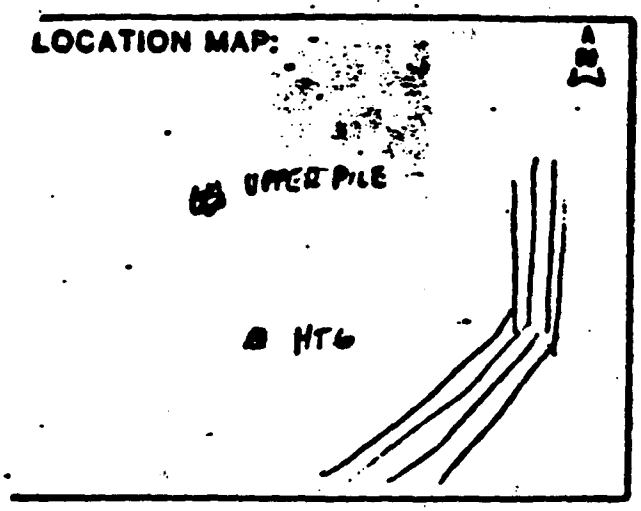
JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT6
APPROX. SITE COORDINATES (ft.):
N 8710 E 9445
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TEXAS CME 55
DATE STARTED: 10-11-88
DATE COMPLETED: 10-11-88
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/

LOCATION DESCRIPTION SOUTH SIDE UPPER PILE
SITE CONDITION WINDY SUNNY

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
	X	X	X	S	1	1,1,1	2	SM	SAND F.G. ORANGE & WHITE
1.5	X	X	X	S	2	1,2,1	3		OCC SL SILTY LAYERS
3	X	X	X	U	3	6/12	6		BROWN YELLOW WHITE YELLOW CLAY CLAY
4	X	X	X	S	4	1/12" 2 2	4	SP-SM	90% FINE GRAINED SAND CLAY CLAYEY SANDS
	X	X	X	S	6	2 2 3			
7.5	X	X	X	S	7	1 2 2	5		
9	X	X	X	S	8	1,1,2	4		
10.5	X	X	X	S	9	2,2,3	5		SL CLAYEY LAYER @ 11
12	X	X	X	S	10	3,3,3	6		YELLOW BROWN SAND W/ CLAY SEAMS
13.5	X	X	X	S	11	2,1/12"	1	CH	CLAY SOFT MOIST @ 14 LAYERED
	X	NR	R	U	12	4/12" NR	0		COLORS GREY-BROWN CLAY THIN SAND LENS MOIST-SOFT
16.5	X	X	X	S	13	1,1,1	2		
18	X	X	X	S	14	1,1,1	2		
19.5	X	X	X	S	15	? 1,1,50/3	~	Ss	PEBLES AND SANDSTONE RED-BROWN SAND F.G. GRAVELLY TR GREEN SHALE & SILTSTONE IN - JOINTED & FRACTURED SS ROCK
20									TD=20'

COMMENTS:

SAMPLE TYPE
A - Auger cuttings
B - 3" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

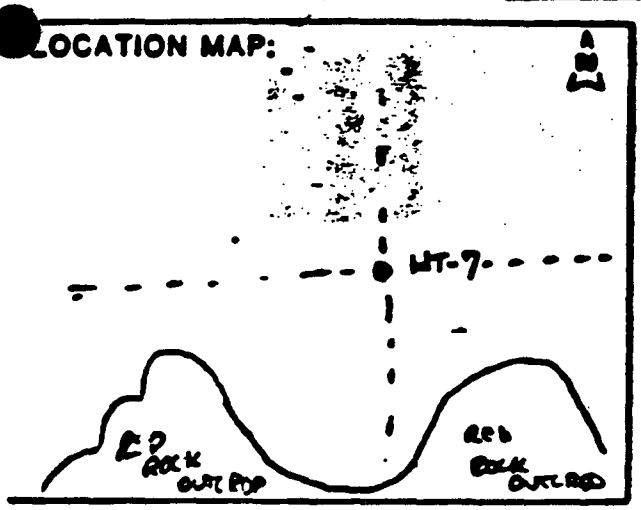
JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page ___ of ___

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: HT-7
APPROX. SITE COORDINATES (ft.):
N 8510 E 9215
GROUND ELEVATION (ft. MSL): 4953.?
DRILLING METHOD: HSA - CONTINUOUS SPT-SSR
DRILLER: T CATT
DATE STARTED: 10-11-94
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: SOUTH SIDE UNDER PILE
SITE CONDITION: LOOSE DRY POWDERY SAND TOP

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	1	1,2,1	3	SM	SAND F. & SILTY BROWN LIGHT - DRY
1.5	X	X	X	S	2	1,1,1	2		WHITE
	X	X	X	U	RINGS	17/12	17	SM	SAND F & SILTY WHITE DRY MED
4	X	X	X	S	4	1,2,1	3	CL	CLAY - SL SANDY - SLIMEY
5.5	X	X	X	S	5	2/18"	1	ML	OLIVE BROWN - SILTY
7.0	X	X	X	S	6	1,1,1	2		"ICE CREAM SHERBERT"
8.5	X	X	X	U	RING	2/18"	1	SM-SC	SANDY CLAY WITH LENSES OF SILT VERY GREY SLIMEY BROWN SANDS "FRETTER"
9.5	X	X	X	S	8	2,1,1	2	CL	SLIMEY CLAY SOFT WET BROWN - ½ CLAYCE
11	X	X	X	S	9	1,1,1	2	ML	DRY SANDY SILT VERY FINE BROWN - OLIVE BROWN SLIMEY CLAY
12.5	X	X	X	S	10	11,13,19	30		WET SOFT "FRETTER" WET SANDSTONE 13.8
14	X	X	X	S	11		30	SS	SANDSTONE BROWN SANDSTONE
									TD = 14'
									SPOOLY PILE OF MESSY STUFF LEFT AFTER FILLING IN HOLE CAVED @ 12.5'

COMMENTS:

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.87" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

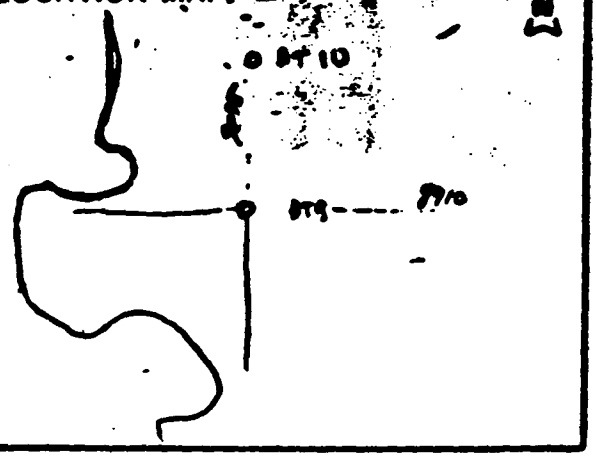
JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT9
APPROX. SITE COORDINATES (ft.):
N 8910 E 9245
GROUND ELEVATION (ft. MSL): 4530
DRILLING METHOD: USA-CONTINOUS
DRILLER: TLATT
DATE STARTED: 10-11-84
DATE COMPLETED: "
FIELD REP.: SRJ

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: UPPER PILE WESTSIDE
SITE CONDITION: DAY WINDY - DUSTY

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									MILL TAILINGS
0	X	X		S	1	1,1,1	2	SM	SAND & SILTY GREY WHITE DRY LOOSE
1.5	X								
3	X			S	2	2,2,1	3	SM-SC	SAND TRANSITION
4	X			U	3	17/12	17	CL-SC	SANDSLIMEY-CLAYEY ORANGE-BROWN @ 3.5 FG SOFT M PL
				S	4	3,4,6	10		
5.5	X			U	5	0,3,2	5		1cm LAYERED SAND ORANGE BROWN 2"-3" CLAY SLIMES MOIST SOFT
7	X			S	6	2,2,3	5		0.2cm SAND LAYER
8.5	X			S	7	1,1,1	2	SP	
10	X			S	8	1,1,1	2	CL-CH	AS ABOVE CLAY M PL SLIMEY BROWN
11.5	X			S	9	1,1,2	3	SP	SAND LAYER - GREY 6"
13.5	X	X		S	10	0,1,2	3	CL-CH	CLAY A.B. LAYERED BROWN-DR BR
13.5	X	X		S	11	1,2,2	4		SL SANDY LAYERS
15.5	X	X		S	12	1,1,2	3	S_S @ 18'	SANDSTONE RED P-Br. SLCLAYEY PEA GRAVELLY CHIPS
17.5	X	X							18' SANDY FD.

TOP LAYER OF SANDSTONE IS WEATHERED LAYERED - SANDY GRAVELLY MAY HAVE BEEN PUSHED BY CA PAVNOT DRILL TO REFUSAL

COMMENTS: LAST 3 SAMPLES DRIVEN 2' TO SINKING. IN SOFT SLIMES WT OF SAMPLER OR 1 HIT & SAMPLER WOULD SINK

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.87" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

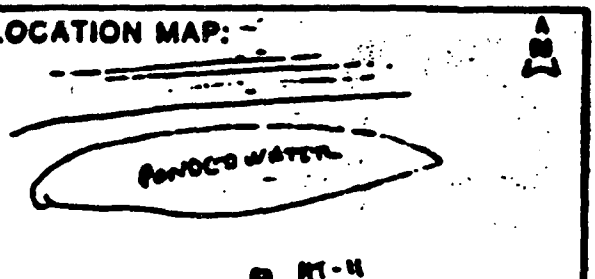
JEG-AL-ENG-28 (3/84)

0-5 SPT

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HATOI LOCATION ID: HT-11
APPROX. SITE COORDINATES (ft.):
N 9510 E 9245
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: JCET
DATE STARTED: 10-12-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: N SIDE UNDERBRIDGE AT SOURCE AREA
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									FILL TAILINGS
				S	1	1,6,8	14	SM-ML	LAYERS SILTS BROWN & WHITE LPM - TRACE YELLOW - SOFT GREY
1.5									
				S	2	7,7,7	14	. .	SAND & SILTS. W/ LAYERS GREY LPM TRACE CLAY & LAYERS MOIST
4.5				S	3	3,3,5,6	11		
				T	4	HARD			SANDS & SILT LAYERS
				S	5				
								GL	
				T	6			CL	CLAY MPM SOFT MOIST - BROWN TO GREY
12.5				S	7	222	4		
				S	8	322	4	SC	LAYER SAND - SILT & CLAYES & MOIST GREY SOFT
16.5				S	9	3.2.2	4	CL	CLAY - V. MOIST PPL GEL 1
17					10	7,27,50/6		SS	SANDSTONE PIECES @ 16.5 MOIST AND CHIPS WS
					11	16.5-17			CLAYEY LAYER @ 17 - INTIP
									TD=17'

COMMENTS:

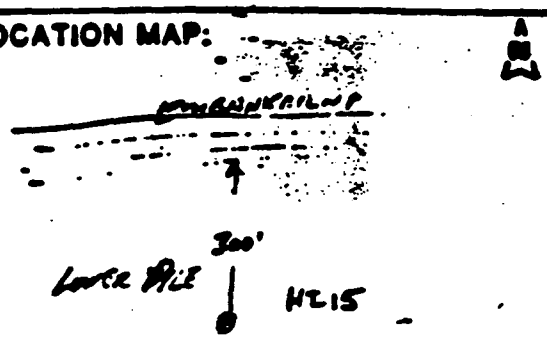
SAMPLE TYPE
A - Auger cuttings
B - 3" O.D. 1.38" I.D. drive sampler
C - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT-15
APPROX. SITE COORDINATES (ft.):
N 9710 E 10492
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA CONTINUOUS
DRILLER: TEATT
DATE STARTED: 10-12-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/

LOCATION DESCRIPTION: LOWER PILE NORTH SIDE
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0				S	1	1,2,2	4	SC	SANDY CLAY MOIST FG. MPL BROWN TO GREY LAYERED SANDY LAYERS
1.5				T	2	MEDIUM PUSH			
4				S	3	1,2,3	5	CL	CLAY SL SANDY SOFT OCAS SANDY LAYERS LT GREY
5.5				S	4	4,4,4	8		
7				S	5	3,3,3	6		
8.5				S	6	3,4,5	9	SP	SANDS SL SILTY GREY MOIST
10				S	7	4,3,4	7	CL	CLAY LAYER 10.5-11.0
11.5				T	8	MEDIUM HARD PUSH		SP	SAND FG SILTY GREY MOIST OCAS CLAYEY
14				S	9	3,4,5	9	SC SM	LAYERED SANDS & CLAYEY SANDS
15.5				S	10	4,4,4	8		
17				S	11	4,6,5	11		
18.5				S	12	4,4,4	8		
20				S	13	5,5,6	11		
21.5				S	14	3,4,5	9	CL	22.5 CLAY FM MOIST DARK BROWN SL SANDY
23				S	15	3,4,4	8		
24.5				S	16	3,4,5	9		
26.5					17				FORMATION @ 27'
27 30				U	RING 17	37/12	D	SM	SAND FG V SILTY TRACE CLAY - SLIGHTLY MOIST REDDISH BROWN

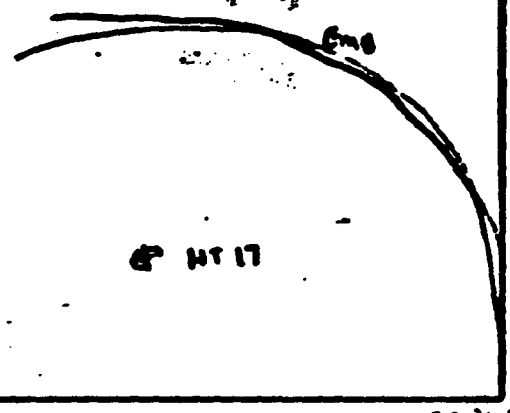
COMMENTS: 18 - SAMPLE FROM THIN RING SAMPLER

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: HT-17
APPROX. SITE COORDINATES (ft.):
N 9715 E 10870
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: 4SA/w SPT & SHELBY
DRILLER: TLATT
DATE STARTED: 10-12-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: LOWER DIKE NORTH CENTRAL TRIANGLE FAT
SITE CONDITION: PARTLY CLOUDY WINDY PM - TO EAST EXCEPT FOR 1-2

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0				S	001	1,2,2	4	SM	DRY SAND FG SILTY LOOSE WHITE TO TRANSLUCENT SOME OLIVE BROWN MOIST
				T	2	HARD TRACH			SANDY LAYERS OCASTE CLAY GREYWHITE
4				S	3	2,3,4	7		
5.5				S	4	3,3,3	6		
7				S	5	3,3,3	6		
8.5				T	6			SP-SM	SANDS - FG GREY SL SILTY
11				S	7	4,3,4	7		
12.5				S	8	4,3,4	7		
14				S	9	454	9		
15.5				S	10	4,5,4	9		
				S	11	455	10		
				S	12	445	9		
					13	4,4,4	8		22.5 CLAY SANDY TRANSITION
				S	14	4,5,4	9		
				S	15	445	9		
				S	16	454	9	CL	CLAY MOIST SOFT DK BN SL SANDY M/PL OCAS LAYERS OF FG SP SAND
25.5				S	17	4,5,6	11	CH	MOIST & HI PL - DARK GREY-BROWN & GREY
28½						454	9		

COMMENTS:
30 NO SAMPLE
30-31½ 456
32½-34 454

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:

SITE ID: HATOI LOCATION ID: HT-17
APPROX. SITE COORDINATES (ft.):
N 9710 E 10890
GROUND ELEVATION (ft. MSL):
DRILLING METHOD:
DRILLER:
DATE STARTED: 10-12-84
DATE COMPLETED:
FIELD REP.:

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X				18	4,5,6	11	SM IN CLCH	SAND LAYERS IN CLAY
1.5									
2.5		X			19	4,5,4	9		CLAY MA-HPI MOIST BROWN
5				S	20	5,6,9	15		SM LAYERS IN CLAY-P
25.5				S	21	5,6,7	13		
27				S	22	2,3,4	7		BOULDERS AND THICKNESS ~ MIDDLE OF DRIVE @ 38.5-40'
38.5									
40									CALL HOLE GOOD @ 40' AND REDEPTHED AND TRIED TO RETRIEVE 30' ROD SAMPLER BY PUMPING THE AUGER (Pumping mat'l) PUMP OVER. RETRIEVE IN 60 PER INCHES. DRILL DOWN TO 45'. SAMPLED ON END OF AUGER
45									

COMMENTS:

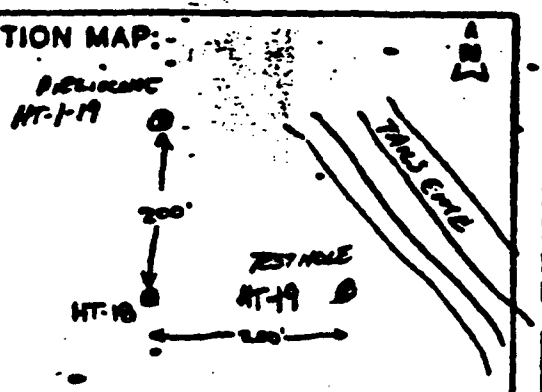
SAMPLE TYPE
A - Auger cuttings
B - 3" O.D. 1.25" I.D. drive sample
C - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT-1-19 B
APPROX. SITE COORDINATES (ft.):
N 9710 E 11290
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: PSA CONTINUOUS
DRILLER: TCATT
DATE STARTED: 10-12-84
DATE COMPLETED: 10-12-84
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: LOWER PILE NE CORNER
SITE CONDITION: DEEP SUNNY PM - WET IN MORNING CLEAR

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION TAILINGS
0	X	X		S	1	1,2,3	5	SP-SM	SAND F6 SL SILTY SL MOIST BROWN .62PM
1.5	X	X		S	2	1,1,2	3		CLAY LAYER @ 1.5,3
3	X	X		S	3	3,4,4	8	SP	SAND AND SL SILTY SL MOIST LOOSE LAYERED
4.5	X	X		S	4	2,3,4	7		
6	X	X		S	5	4,4,4	8		
7.5	X	X		S	6	3,4,4	8		
9	X	X		T	7	PUSH: MEDIUM HARD			
11.5	X	X		S	8	4,5,3	8		
13	X	X		S	9	2,3,5	8		
16	X	X		S	10	3,4,3	7		TRACE CLAY LAYER @ 16.5'
18	X	X		S	11	2,3,3	6		
	X	X		T	12	PSA MEDIUM HARD			
20.5	X	X		S	13	4,5,6	11		
22	X	X		S	14	5,6,7	13		
23.5	X	X		S	15	7,8,8	16		2 CLAY LAYER
25	X	X		S	16	5,7,7	14		
26.5									

COMMENTS: NOTE HT-1-19 PIEZOMETER IS LOCATED AT N9910 E11090.

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. Split sample
B - 3" O.D. 2.42" I.D. Tube sample
T - 3" O.D. Thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:

SITE ID: HATCH LOCATION ID: HT-19B
APPROX. SITE COORDINATES (ft.):
N 9710 E 11290
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TCATT
DATE STARTED: 10-12-84
DATE COMPLETED: 10-13-84
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									FG SANDS SLMOIST BRFH M-DENSE
5									
28				S	17	7,8,7	15		
24.5				S	18	7,5,6	11		
31				S	19	9,9,7	16		
32.5				S	20	5,7,7	14		
						MEDIUM HARD			10-13-84
				T	21				
37.5									
39				S	22	7,8,10	18		
40.5						10,12,11	22		
42				S	23	9,9,11	20		
43.5				S	24	10,11,14	25		
45				S	25	10,9,9	18		
46.5				S	26	11,11,14	25		TD=46.5'

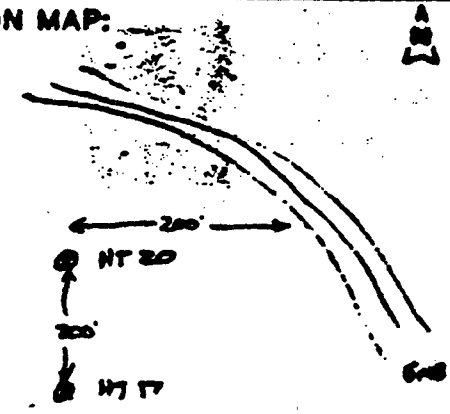
COMMENTS: COULDN'T SAMPLE PAST 46.5 - NOT GROUND RED (30' LOST IN LAST HOLE)

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.87" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HATOI LOCATION ID: HT 20
APPROX. SITE COORDINATES (ft.):
N 9910 E 10890
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: NSA
DRILLER: TCATT
DATE STARTED: 10-16-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/

LOCATION DESCRIPTION NORTH CENTER PORTION OF LOWER PILE
SITE CONDITION COLD GROUND FROZEN

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0									TAILINGS
				S	1	1,1,1	2	SM	SAND FG SLNTY SL MOIST GRAY LOOSE
1.5									
				S	2	1,1,2	3		OCCS CLAY LAYERS
3				T	3	EASY PUSH			
6.5									
7				S	4	1,2,2	4		
				S	5	1,2,2	4		
8.5									
10				S	6	3,3,3	6		
				S	7	2,4,5	9		
11.5									
13				S	8	4,3,4	7		
				S	9	4,4,4	8		
14.5									
16				S	10	3,2,2	4		16' CLAY MOIST BROWN SOFT CLAYEY
						DRILL TO 20'			
20									
				T	11	EASY			
22.5									
24				S	12	3,5,5	10		
				S	13	5,8,8	16		
25.5						6,6,7	13		OCCS SAND LAYERS
27				S	14				
				S	15	5,7,8	15		SAND @ 26.-27
28.5									

COMMENTS: 28.5 30 S 16 8,9,8 CLAY AA
30-32.5 T 17 MED-HARD
32.5-34 18 35G

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sampler
B - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:

SITE ID: HAT01 LOCATION ID: HT-20
APPROX. SITE COORDINATES (ft.):
N 9910 E 10890
GROUND ELEVATION (ft. MSL):
DRILLING METHOD:
DRILLER:
DATE STARTED:
DATE COMPLETED:
FIELD REP.:

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
								SM	SAND FG M.D. GREY-BROWN TO GREY SL MOIST TO MOIST
28.5				S	16	8,9,8	17		
30				T	17	MED HARD			
32.5									SL SANDY
				S	R	5,5,6	11		5" CLAYEY LAYER MOIST BROWN 33-33.5
34				S	19	8 7 8	15		V MOIST @ 35'
35.5				S	20	5,7,9	16	CL-SC	CLAY SL SANDY MPL-MOIST DARK GREY BROWN
37				S	21	8,8,7	15		VERY MOIST
38.5				S	22	5,6,7	13		
40					23	29,50/1½"		WS	WEATHERED SANDSTONE
								SM	SM FG SAND RED TRACE CHIPS
								WS	SILTSTONE GREY BLUE-COMPETENT

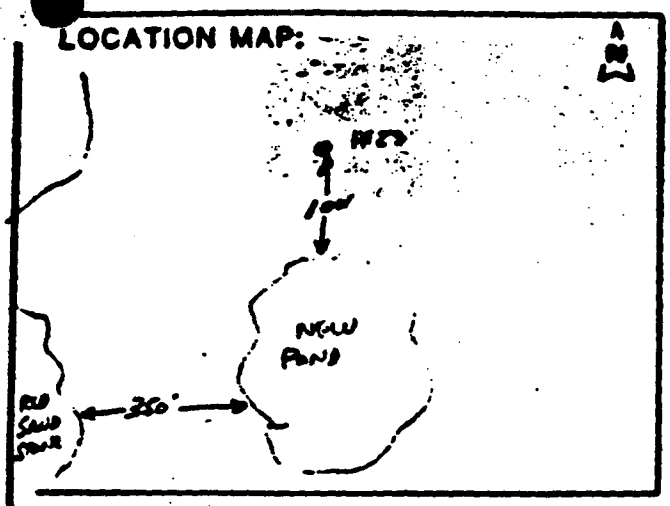
COMMENTS:

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT 23
APPROX. SITE COORDINATES (ft.):
N 9500 E 10490
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TCATT
DATE STARTED: 10-16-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/

LOCATION DESCRIPTION: NORTH OF NEW POND LOWER DIKE - TOWARDS WEST SIDE
SITE CONDITION: GROUND SLIGHTLY FROZEN - POND TO SOUTH OF HOLE

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0									TAILINGS
				S	1	2,3,3	6	SM	SAND MOIST
1.5								CL	6" CLAY SANDY BROWN MOIST MPI
				S	2	1,1,1	2		CLAY SANDY LAYERS IN MOIST CLAY
				T	3	EASY PUSH			
5.5									
7				S	4	2 3 4 1,7	4		GRAY TO BROWN
				S	5	4 3 3 2 3 4	7		
8.5									
10				S	6	2 3 4 4 3 3	6		
				S	7	4 5 4 2 3 4	7		CLAY SAND LAYERS
11.5									
13				S	8	4 5 4	9		
				T	9	EASY PUSH			CLAY
15.5									
17				S	10	3 4 4	8		12" SAND LAYER @ 16-17'
				S	11	2 3 4	7	CH	CLAY SL SANDY MPI MOIST MED STIFF BROWN MOTTLED
18.5									
20				S	12	4,4,5	9		
				T	13	REFUSAL			
22.5									
24				S	14	5,5 50/6"	10	WSS	WS SANDSTONE CHIPS SL CLAYEY SANDY
									TD=25'

COMMENTS: 24' AUGER TO REFUSAL @ 25

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

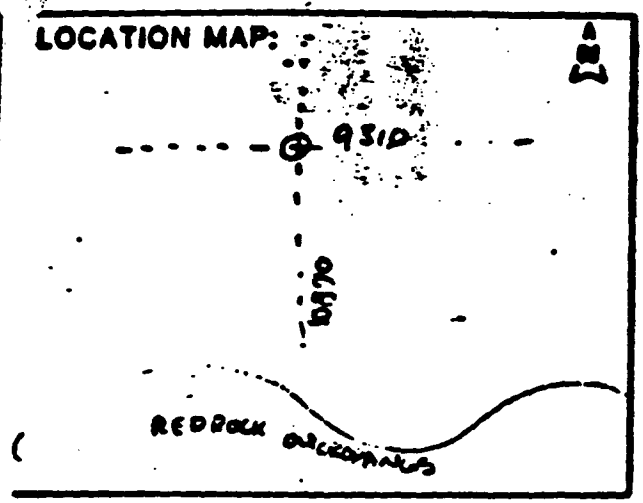
JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page ___ of ___

LOCATION MAP:



SITE ID: HATOI LOCATION ID: HT 26
APPROX. SITE COORDINATES (ft.):
N 9310 E 10790
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TRATT CME 55
DATE STARTED: 10-13-84
DATE COMPLETED: 10-13-84
FIELD REP.: SRVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: LOWER PILE MIDDLE SOUTH
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N-VALUE	USCS	VISUAL CLASSIFICATION TAILINGS
5				S	1	1,1,1	2	SM	SAND F-C SILTY SL MOIST, GREY LOOSE
3				S	2	2,2,3	5		
4.5				S	3	2,2,3	5	(CL)	TRACE CLAY LAYERS
6				S	4	3,3,4	7		
6.5								CL	1/4 CLAYEY LAYER INSERTED 6.5-7.2
				T	5				
9								SM	SAND F-C SILTY SL MOIST GREY LOOSE BLAS CLAY LAYERS
10.5				S	6	3,2,3	5		- @ 12'
12				S	7	4,5,5	10		
13.5				S	8	3,4,6	10		CL @ 13' CLAY SOFT MOIST & SANDY
15				S	9	4,5,3	8	CL	CLAY @ 16' SOFT MPL
16.5				S	10	3,4,3	7	CH	CLAY & SANDY LAYER (THIN)
18				S	11	4,7,6	13		
19.5				S	12	7,6,9	15		
21				S	13	4,7,12	19	SM-SW	SANDSTONE CHIPS & SAND STONE
21.5					14	21 S.	1 DRIVE 2 SAMPLES		SAND V. SILTY PEBLES CLAYE- REDBROWN
22.5				U	15	49/12"	49		

COMMENTS:

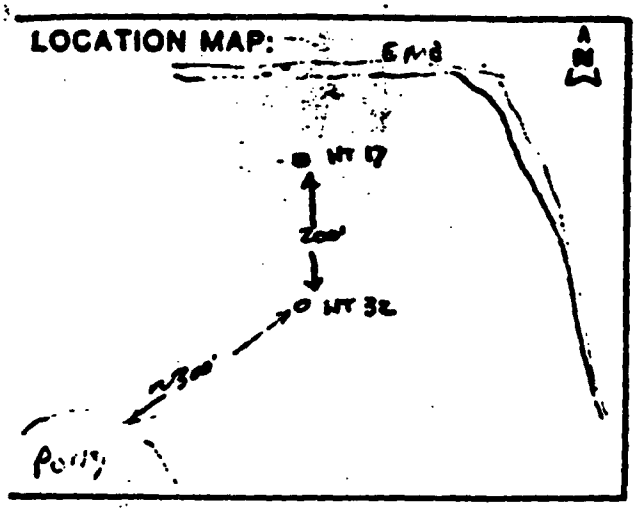
SAMPLE TYPE
A - Auger cuttings
B - 3" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HATO1 LOCATION ID: HT32
APPROX. SITE COORDINATES (ft.):
N 8510 E 10890
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TCATT
DATE STARTED: 10-16-84
DATE COMPLETED:
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION MOUT MIDDLE OF LOWER PILE
SITE CONDITION 50° SLIGHT BREEZE SUNNY

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0									TAILINGS
				S	1	1,1,1	2	SM	SAND FG LT BN-BR DRY TO SL MOIST
1.5								CL	LAYER 6" CLAY-SANDY MOIST-BROWN
3				S	2	1,2,3	5	SM-	SAND FG LT BRN-GREY & WHITE SL MOIST OCAS SAND.
				T	3	EASY			
5									OCAS LAYERS OF CLAY IN SAND 3-8.5
5.5				S	4	2,2,2			
7				S	5	2,3,3			
8.5							7	CL	CLAY MOIST GREY TO BROWN MPL
10				S	6	2,4,3			OCAS SANDY & HYCAS ASSNDIC @ 13,16
				S	7	4,5,4	9		
11.5									
13				S	8	3,4,4	8	LAYER SM	SAND LAYERS IN CLAY
				S	9	3,3,4	7		
14.5									
15					10	3,4,3	7	LAYER SM	CLAY AA LAYER SAND @ 16-17
16				S	11	1,2,4	6		CLAY AA
17.5									
19				S	12	3,5,6	11	SM	SAND FG SLSILTY GREY TO BROWN M
20					13	7,7,7	14		MIXED SAND AND CLAY LAYERS @ 19'-23.5 (PREDOMINANTLY SAND) FROM 8-22
20.5									
22				S	14	7,6,6	12		
23.5				S	15	7,6,6	12		
				T	16	MEDIUM HARD		CL-CH	24' CLAY MPL MOIST BROWN SL SANDY
26				S	17	3,4,5	9		
27.5									SEE NEXT PAGE

COMMENTS: Walcom Young 3.25

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:

Pg 1

SITE ID: HATOI LOCATION ID: HT 32
APPROX. SITE COORDINATES (ft.):
N 9510 E 10890
GROUND ELEVATION (ft. MSL):
DRILLING METHOD:
DRILLER:
DATE STARTED: 10-16-84
DATE COMPLETED:
FIELD REP.:

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									CLAY - MOIST MPL SL SANDY STIFF GREY BROWN
								CLCH	
27.5									
29				S	18	3,4,5	9		
					19	5,6,8	14		VERY MOIST - HPL
30 30.5									
				S	20	5 5 6	11		
32				S	21	6,7,7	14		
33.5									
35				S	22	6 6,7	13		
									PALE GREY
				T	23	HARD			
37.5				S	24	3,3,4	7		
39				S	25	6,5,4	9		
40.5									WET CLAY SL SANDY
42				S	26	5 7 9	16		42'
					27			Ss	SANDSTONE WEATHERED V. SILTY SL CLAYEY RED BROWN MOIST
45									
									AUGER TO REFUSAL @ 45' COMPETENT SANDSTONE OR POSS SILTSTONE

COMMENTS:

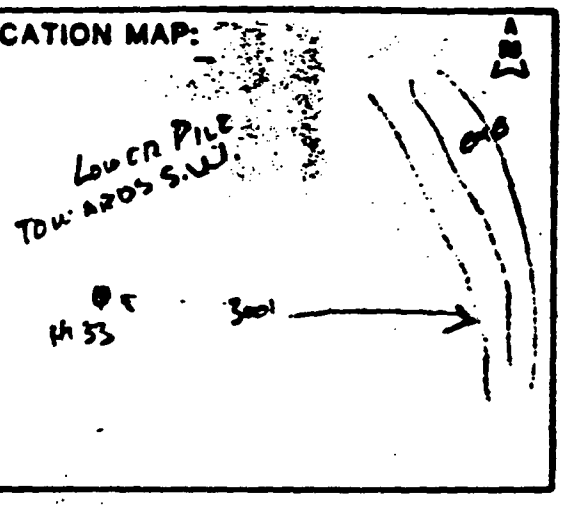
SAMPLE TYPE
A - Auger cuttings
B - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT 32
APPROX. SITE COORDINATES (ft.):
N 9510 E 11090
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA - CONTINOUS
DRILLER: TRATT
DATE STARTED: 10-15-84
DATE COMPLETED: -
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION TOWARDS MIDDLE OF THE LOWER PILE
SITE CONDITION 40° COLD & WET

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0									TH. LINGS
				S	1	1,1,2	3	SM	SAND, FG SL. SILTY LOOSE WHITE TO GREY SLMOIST
1.5									
3				S	2	1,1,2	3		YELLOW CLAYEY
4.5				S	3	1,2,2	4		
6				S	4	2,2,3	5		TOUGH CLAY
				S	5	3,3,4	7		
7.5									
9				S	6	4,4,6	10		
				S	7	2,2,3	5		
10.5								CL	CLAYEY SILT DRY SANDY CLAY CLAY
12				S	8	3,5,5	10		
				S	9	3,3,5	8		
13.5								CH	CLAY WET SOFT SANDY HPI
15				S	10	4,4,5	9		
				S	11	4,5,6	11		
16.5				S	12	4,5,7	12		
18				S	13	4,5,7	12		
19.5									
				7	14	MCD			
22									DRY SANDY CLAYEY
				S	15	3,5,6	11		
23.5									
25				S	16	6,6,7	13		
				S	17	6,7,6	14		
26									
28				S	18	5,6,6	12		→ CLAY · RUDDY · MOIST
29				S		19 34 50/2.5"	29	WSC	SANDSTONE CHIPS
30									
31									

COMMENTS:
29': AUGER TO REFUSAL @ 34 SANDSTONE
REFUSAL ON SS @ 34'

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

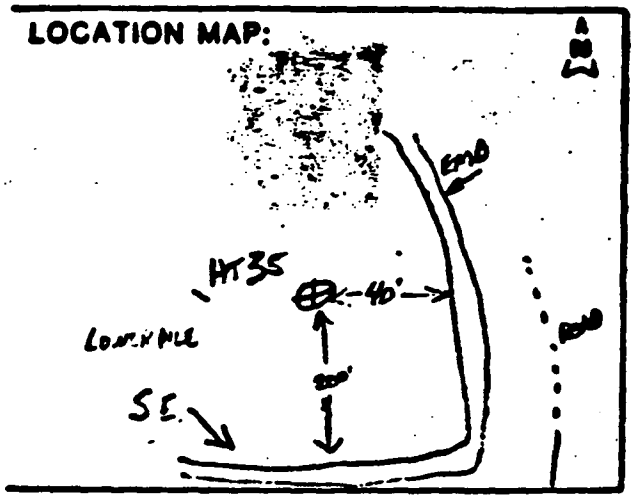
JEG-AL-ENG-28 (3/84) 20 AUGER FROM 29-34'

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page ___ of ___

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT 35
APPROX. SITE COORDINATES (ft.):
N 4510 E [illegible]
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TCAT
DATE STARTED: 10-15-94
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: SW BRD POINT OF LOW-X PILE
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION TAILINGS
				S	1	1,1,2.	3	SP-SM	SAND F. SILTY SL MOIST AT GREY BROWN
1.5									MOIST
				S	2	5,3,4.	7		
3				S	3	3,4,5.	9		
4.5									
				T	4	EASY TORQUE			
7									
				S	5	2,2,2	4		
8.5									
				S	6	3,4,5	9		
10				S	7	5,5,6	11		
11.5									
				S	8	3,3,4	7		
13				S		3,4,4	8		
14.5									
				T	10				
17									
				S	11	3,3,4	7		
18.5									
20				S	12	5,6,6	12		
				S	13	5,5,5	10		
21.5									
				S	14	6,6,7	13		
23				S	15	5,5,6	11		
24.5									
				S	16	6,5,5	10		
26				S	17	6,5,5	10		
27.5				S	18	5,6,7	13	SM-GM	29' BGS SANDSTONE F. & SAND SILTY SAND & GRAVELLY SX CHIPS RED SLLCAVEIN-

COMMENTS: 11-23-50 / 2" Sx

AUGER TD @ 34'

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

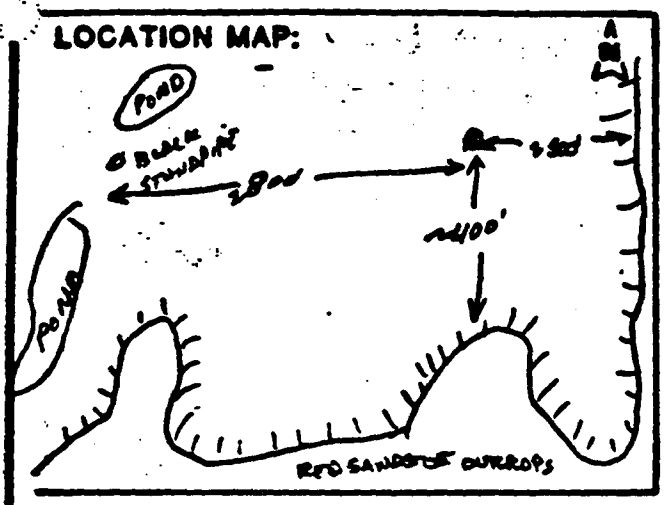
JEG-AL-ENG-28 (3/84)

3:57

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: 911-
APPROX. SITE COORDINATES (ft.):
N 9310 E 11090
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: 12" HSA 10" PVC CASING
DRILLER: J. CARTER ED ADAMS CME 75
DATE STARTED: 1-5-85
DATE COMPLETED: GROUTED ON 1-6-85
FIELD REP.: SILVA B. SCHOENFELDER

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
1-5-85	DRILLING	DRY - VMOIST

LOCATION DESCRIPTION HAT ON PILE 10" CASING INSTALLATION
SITE CONDITION ON TAILING - LOWER PILE TOWARD EAST - SOUTH

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
						NOT SAMPLED		SM	TAILINGS GREY FINGRAINED SAND LOOSE SURFACE & DRY
								CL	SL CLAYEY TRANSITION
5									
7								CL	COLOR CHANGE TO BROWN - V CLAYEY SLIMES MOIST
10						TAILS		SM	FINE GRAINED SANDY GREY-BROWN
15								15 SM CL	GREY DRY
								CL	VERY MOIST BROWN CLAY-SLIMES-TAILINGS
								SS	DARK REDDISH BROWN SANDSTONE CHIPS & GRAVELLY FOUNDATIONMATIC SANDSTONE - HALGAITO FORM.
									REFUSAL TO 12" HSA @ 21' WOUND AUGER TIGHT
									TD=21'
									SEE ROCK CORE LOG THIS HOLE

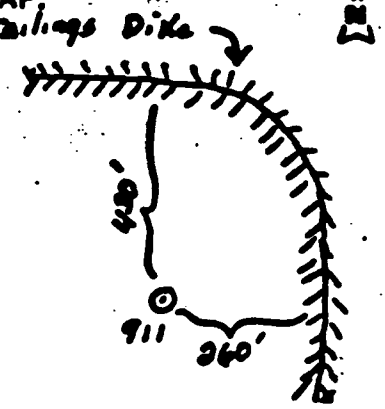
COMMENTS: INSTALLED 10" SCH 40 PVC CASING TO 21'

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: 911
APPROX. SITE COORDINATES (ft.):
N 9510' E 10280'
GROUND ELEVATION (ft. MSL): Est 4990'
DRILLING METHOD: ~~SH~~ NQ WIRELINE
DRILLER: ~~Adams~~/Williams - SHB
DATE STARTED: 2/19/85
DATE COMPLETED:
FIELD REP.: R. Holland

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION On-Pile - NE corner lower pile
SITE CONDITION Dry/Dust

DEPTH (FT)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	DISCONTINUITIES: SPACING (WIDE — CLOSE) 1	2	3	4	5	ORIENTATION (HORIZ. — VERT.) H		60°		V	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
39	NQ	[illegible]	0	100						X	—					Smo	WS	St	Siltstone reddish brown, with minor lt. gray mottling, highly calc., very hard to med hard
40																	WS		
41																	WS		
42																	WS		
43																	WS		
44																	WS		
45	NQ	90%	46							X	—						WS	St	Siltstone, reddish brown, highly calc, with angular to subround lime cl. clast, lt gray. very minor alteration noted at 48'
46																	WS		
47																	WS		
48																	WM		
49	NQ	86%	0							X						R	WM	St	Siltstone as ab only softer and becoming clayey. Lost circulation @ 51' Soft to Hard
50			0							X	X					R	WM	St	
51			0	0%						X		X				R	WM	St	
52			0	0						X	X					R	WM	St	
53			0	0						X	X					R	WM	St	

Run 1 39-44.5
Run 2 44.5-49.5
Run 3 49.5-53

COMMENTS: 2 Water Hauls

BORING OPERATION
HS - 6 1/2 HOLLOW STEM AUGER
CS - 6 1/2 CONTINUOUS FLIGHT AUGER
DB - DEAD BIT
RC - RS ROCK CORING
RW - RS WIRELINE ROCK CORING

JEG-AL-ENG-2A (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:

SITE ID: MAT-01 LOCATION ID: 911
APPROX. SITE COORDINATES (ft.):
N ____ E ____
GROUND ELEVATION (ft. MSL): ____
DRILLING METHOD: No Wire Line
DRILLER: Adams/Williams - SHB
DATE STARTED: 2/19/85
DATE COMPLETED: ____
FIELD REP.: Roger Holland

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION On Tailing Pile - N E Corner of Lower Pile
SITE CONDITION Dry and Dusty

DEPTH (FT)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	DISCONTINUITIES: SPACING (WIDE — CLOSE) 1	2	3	4	5	ORIENTATION (HORIZ. — VERT.) H		50°		V	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
54	NR	96%	0	0	X					X	X					R	WM	St	
55			0	0	X					X	X					SMO	WM	St	Siltstone, reddish brown, highly calc. very hard, argillaceous,
56			40	75	X				X		X					SMO	WS	St	
57			40	75	X				X		X					SMO	WS	St	
58			65	50	X				X		X					SMO	WS	St	
59			85	50	X				X		X					SMO	WS	St	
60			70	50	X				X		X					SMO	WM	St	
61	NR	92%	55	50	X				X		X						WM	St	2/26/85 cold & cloudy 60.0-61.1 silty clay stone, reddish brown highly calc. @ 61.1 siltstone, M. pinkish gray to M. reddish brown, highly calc. with angular to sub round limestone clast. v. hard.
62			50	50	X				X		X					SMO	WS	St	
63			70	50	X				X		X					SMO	WS	St	
64			60	50	X				X		X					SMO	WS	St	
65	NR	94%	0	50	X			X		X	X					SMO	WS	St	
66			80	50	X					X	X					SMO	WS	St	
67			0		X					X	X					SM	WS	St	
68			45		X					X	X					SM	WS	St	

Run 4 64.5-60.1
Run 5
Run 6
Run 7

COMMENTS: ____

BORING OPERATION
B - 6 1/2 HOLLOW STEM AUGER
C - 6 1/2 CONTINUOUS FLIGHT AUGER
CB - CLEAN OUT
RC - 2 1/2 ROCK CORING
RR - NO WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:

SITE ID: HAT-01 LOCATION ID: 911
APPROX. SITE COORDINATES (ft.):
N ____ E ____
GROUND ELEVATION (ft. MSL): ____
DRILLING METHOD: NQ wire line
DRILLER: Adams / Williams - SNOB
DATE STARTED: 2/19/85
DATE COMPLETED: ____
FIELD REP.: R. Holland

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION ____
SITE CONDITION ____

	DEPTH (FT)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	DISCONTINUITIES: SPACING (WIDE — CLOSE) 1	2	3	4	5	ORIENTATION (HORIZ. — VERT.) H		50°		V	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
	68	NQ		100		X			X			—					sm	f	st	Decrease in lime-stone frags. becoming OB at 67.0'
	69	NQ		80		X				X		—					sm	f	st	
Run 7	70			80		X			X			—					sm	f	st	
	71			50		X					X	—					sm	sw	st	Note: core lost from 73.9 - 74.5
	72			40		X					X	—					sm	wm	st	
	73			0		X					X	—					R	wm	st	at 73.5 siltstone, reddish brown with red sandy siltstone clast. clast water wear readily.
	74						Lost Core													
	75	NQ	100%	40		X					X	—					sm	ws	st	
	76			50		X				X		—					sm	f	st	Note: 74.5-78.5 7 min/ft.
	77			100		X			X			—	—	—			sm	f	st	
Run 8	78			100		X			X	X		—					sm	f	st	Siltstone, reddish brown, to red, varying amts. of clay fraction highly calc.
	79			70		X					X	—					sm	wm	st	
	80			80		X				X		—					sm	f	st	at 81.6 approaching limestone.
	81			60		X			X			—					sm	ws	st-ls	
	82			0		X					X	—					sm		st-ls	Satin spar gyp stringers at 80.5 to 81.8'
	83			60		X			X			—					sm		st-ls	

COMMENTS: ____

BORING OPERATION
B - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - CLAM BIT
RC - RC ROCK CORING
DC - DC WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:

SITE ID: HAT-01 LOCATION ID: G11
APPROX. SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLER: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	DISCONTINUITIES: SPACING (WIDE — CLOSE) 1	2	3	4	5	ORIENTATION (HORIZ. — VERT.) H	50°	V	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
84			100		X			X			—			sm	sw	sl	Siltstone, to claystone, red to reddish brown, highly calc., micaceous, with sandy light gray, limestone clast. Fracturing is essentially horiz. Some fractures are filled with calcite spar gyp. Core becoming more competent @ 89.2 ft.
85			0		X				X		—			sm	sw	sl	
86	NQ	89		0	X					X	—			sm	sw	sl	
87			40	0	X				X		—			sm	sw	sl	
88			0	0	X					X	—			sm	sw		
89			40	0	X				X		—			sm	sw		
90			0	0	X					X	—			sm	sw		
91			60	0	X				X		—			sm	f		
92			90	0	X			X			—			sm	f		
93			0	0	X					X	—			sm	f		
94			100	0	X		X				—			sm	f		
95			100	0	X		X				—			sm	f		
96				0	X						—			sm	f		
97	NQ	100%	40	0	X					X				sm	f	sl	Core as above. Core has fract. than above. Hard @ 99.6 core becomes clayey, soft and no fracturing.
98			98	0	X				X		—			sm	f	sl	
99			70	0	X				X		—			sm	f	sl	
100			100	0	X		X				—			sm	f	sl	

COMMENTS: _____

BORING OPERATION
- 4 - 8 1/2 HOLLOW STEM AUGER
- 5 - 6 1/2 CONTINUOUS FLIGHT AUGER
- 00 - DEAD OIT
- 00 - 00 ROCK CORING
- 00 - 00 WIRELINE ROCK CORING

JEG-AL-ENG-2A (8/84)

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TAC TEST PITS:

ON PILE

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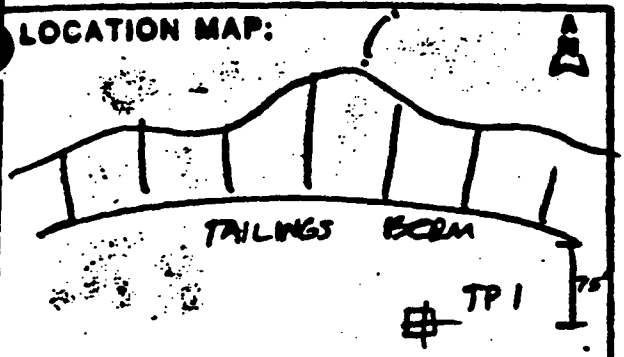
JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: TP 1
APPROX. SITE COORDINATES (ft)
N 9710 E 11090
GROUND ELEV. (FT. MSL)
DATE EXCAVATED: 10-17-84
BACKHOE TYPE: CASE 580
CONTRACTOR: BLACK ENTERPRISES
FIELD REP: P.S. DARR
REHAB. DATE: 10-17-84

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)
		None	

LOCATION DESCRIPTION Lower tailings pile.
SITE CONDITION

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
1.5		X	001	SM	Silty Sand, very fine, dry, light brown
7.0				CL w/ ML & SM	Silty Clay, medium to high plastic, interbedded with thin 0-3m. seams of silty sand & clayey silt, wet, brown.

COMMENTS: Stopped backhoe @ 7.0 ft. Collected 3-1 gal soil samples, 2-5 gal soil samples sent to Earth Tech. Corp and 1-5 gal sent to Vern Rogers.

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: TP-2
APPROX. SITE COORDINATES (ft)
N ~~10600~~ 11600 E ~~10000~~ 10200 (?)
GROUND ELEV. (FT. MSL)
DATE EXCAVATED: 10-23-84
BACKHOE TYPE: CASE 580
CONTRACTOR: BLAKE ENTERPRISES
FIELD REP: P.S. DARR
REHAB. DATE:

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)
		NONE	

LOCATION DESCRIPTION Down gradient ≈ 300ft of lower tailings pile.
SITE CONDITION Moderately sloping into drainage.

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
0.5				ML	Clayey Silt with windblown sand (tailings) non plastic to slight plastic, very fine sand, moist, rootlets, reddish brown to light brown (tailings).

Samples taken are of windblown contaminants mixed with natural topsoil materials.

COMMENTS: Stopped backhoe at 0.5 ft. Collected 3-5gal soil samples. 2-5gal samples sent to Quad Assoc. and 1-5gal sample sent to Vera Rogers.

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

Page 1 of 1

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: TP 3
APPROX. SITE COORDINATES (ft)
N 9510 E 10690
GROUND ELEV. (FT. MSL)
DATE EXCAVATED: 10-23-84
BACKHOLE TYPE: CASE 580
CONTRACTOR: BLAKE ENTERPRISES
FIELD REP: P.S. DARR
REHAB. DATE: Not Applicable

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)
		None	

LOCATION DESCRIPTION Lower tailings pile
SITE CONDITION

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
3.0		D	001	CL	Silty Clay, low plastic, wet, light brown,
4.0		D	002	SP-CL	Sand with thin lenses of silty clay, fine, moist, white.
5.5				CL-SP	Silty Clay with thin lenses of sand low plastic, wet, light brown.

COMMENTS: Stopped backhoe at 5.5 ft. Collected 4-5 gal soil samples, 2-5 gal samples to Chem & Assoc & 2-5 gal samples to Kern Lyons

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: TP-4
APPROX. SITE COORDINATES (ft)
N ~~9110~~ 9112.0 E 9445.0
GROUND ELEV. (FT. MSL)
DATE EXCAVATED: 10-23-84
BACKHOE TYPE: CASE 580
CONTRACTOR: BLAKE ENTERPRISES
FIELD REP: P.S. DAER
REHAB. DATE: Not applicable

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)
		None	

LOCATION DESCRIPTION Upper Tailings Pile
SITE CONDITION

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
2.5		D*		ML	Silt with thin sand stringer, non-plastic, fine sand, white.
6.0		D	001	ML	Silt, non plastic (?), wet to very wet (?), yellowish brown with laminations of dark brown.
7.5		D	002	CL-SP	Silty Clay with thin sand stringers, low plastic (?), fine sand, wet, gray.

D* - small bag sample taken for miscellaneous testing.

COMMENTS: Collected 4-5gal. soil samples. 2-5gal sample shipped to Chen & Assoc and 2-5gal sample shipped to Vera Rogers. Stopped backhoe at 7.5 ft.

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

Page 1 of 1

LOCATION MAP:

SITE ID: HAT 01 LOCATION ID: TP 5
APPROX. SITE COORDINATES (ft)
N 9310 E 9445
GROUND ELEV. (FT. MSL)
DATE EXCAVATED: 10-23-84
BACKHOLE TYPE: CASE 580
CONTRACTOR: BLAKE ENTERPRISES
FIELD REP: P.S. DARR
REHAB. DATE: Not Applicable

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)
		None	

LOCATION DESCRIPTION Upper Tailings Pile
SITE CONDITION

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
				ML	Silt, non-plastic, dry, white
3.0		X	001	SP	Sand, fine, moist, gray.
4.5					

COMMENTS: Stopped backhoe at 4.5 ft. Collected 2-5 gal and sample, 1-5 gal to Chen & Assoc & 1-5 gal to Vera Rogers

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

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TAC BORING LOGS:

OFF PILE

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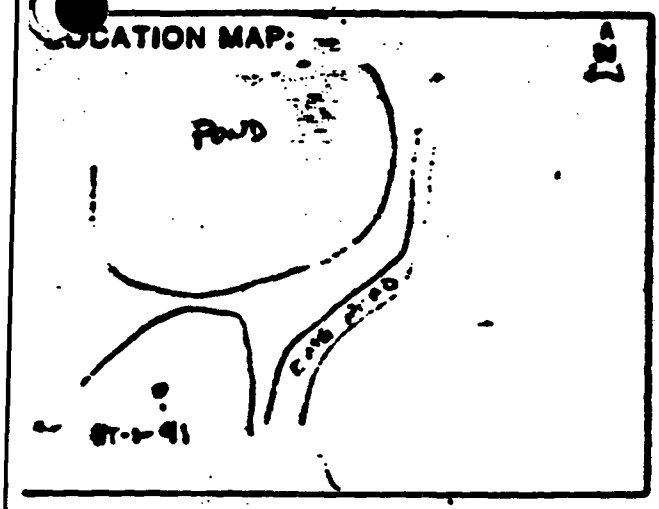
JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HATO1 LOCATION ID: HT-1-41
APPROX. SITE COORDINATES (ft.):
N 8300 E 9150
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA
DRILLER: TCATT
DATE STARTED: 8-12-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION SOUTH OF WEST TAILS AREA
SITE CONDITION ROCKY - RED

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
surface				A	000				
1.5	X	X	X	A	001	AUGER		Ss	SANDSTONE FINE SAND - ANGULAR GRAVEL RED BROWN - DRY
	X	X	X	A	2				
								SM	3-4 SOFT SEAM SM FG. W SILTY TR GRAVEL DRY
4.5	X	X	X	A	3				
					4.5	ROCKS FROM AUGER PLUG			POSSIBLE LIMESTONE
									TD: 5'

COMMENTS: BASED ON AUGER TESTS TO 5' - POLL & BEALE

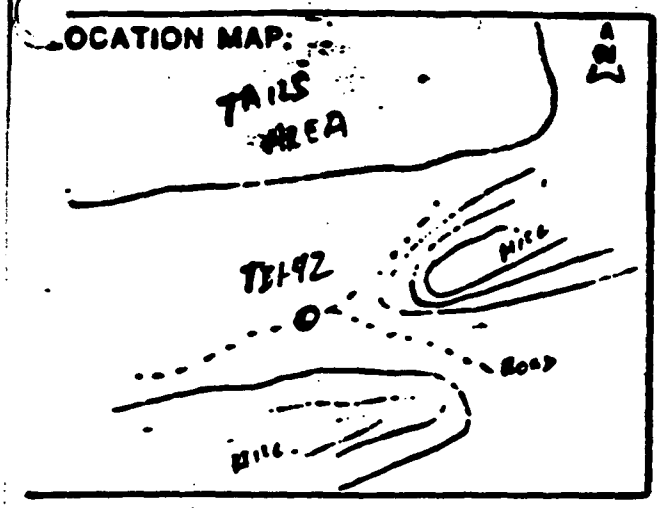
SAMPLE TYPE
A - Auger cuttings
B - 2" O.D. 1.38" I.D. drive barrel
U - 3" O.D. 2.87" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HATBF LOCATION ID: HT-F-42
APPROX. SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HSA
DRILLER: TCATT
DATE STARTED: 10-10-94
DATE COMPLETED: 10-10-94
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/

LOCATION DESCRIPTION: RIDGE ROAD SOUTH OF TAILSAREA ON RIDGE
SITE CONDITION: DRY

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	A	1			SP	SAND f-c PIECES OF SANDSTONE RED BROWN DRY
1	X	X	X	A	2				
2	X	X	X	A	3			SS	SANDSTONE - VERY HARD
33 TD				A	4	ROCKS FROM AUGER CAVE			LIMESTONE - WHITE DRY

COMMENTS: _____

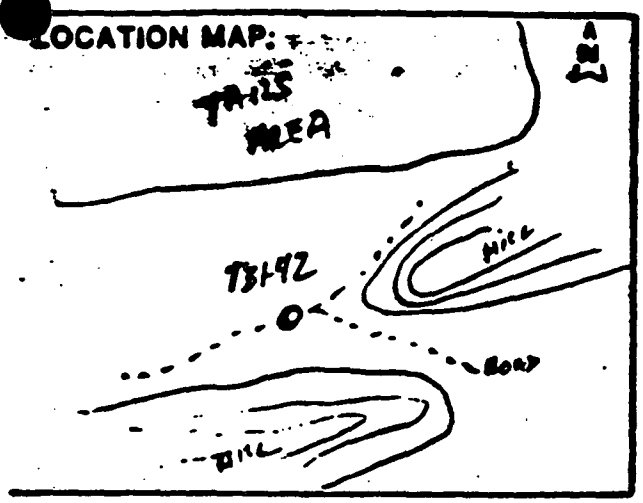
SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. Split barrel
U - 3" O.D. 2.42" I.D. Tube sampler
T - 3" O.D. Thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT BF LOCATION ID: HT-1-#2
APPROX. SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: HSA
DRILLER: TCATT
DATE STARTED: 10-10-84
DATE COMPLETED: 10-10-84
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION: ALONG ROAD SOUTH OF TAILS AREA ON REDROCK
SITE CONDITION: DRY

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	A	1			SP	SAND F-C PIECES OF SANDSTONE RED BROWN DRY
1	X	X	X	A	2			SS	SANDSTONE - VERY HARD
3	X	X	X	A	3				LIMESTONE - WHITE DENSE
33	TD			A	4	ROCKS FROM AUGER CAVE			

COMMENTS: _____

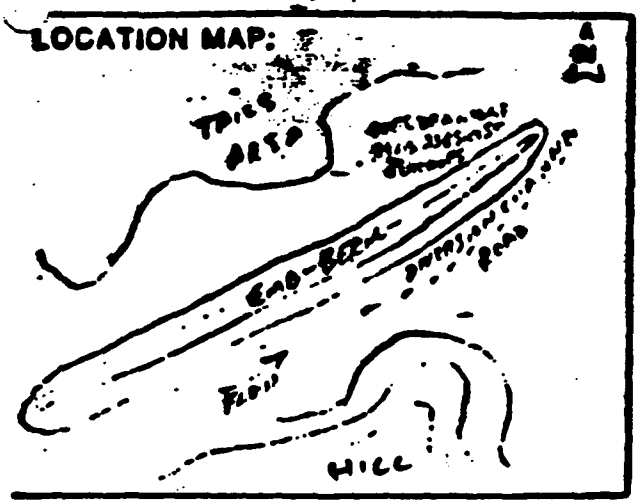
SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT 01 LOCATION ID: HT-43
APPROX. SITE COORDINATES (ft.):
N 8730 E 108[illegible]
GROUND ELEVATION (ft. MSL):
DRILLING METHOD: HSA 6" & CONV 4"
DRILLER: [illegible]
DATE STARTED: 10-10-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION: SOUTH OF SITE ON HILL
SITE CONDITION: HOLE LOCATED IN SOUTH DIRECTION CHANGED MADE BY CAT

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	A	001	AUGER		SP	RED SAND F.G. · GRAVELLY SANDSTONE PIECES
1	X	X	X	A	002	AUGER		SS	ROCK 8 1' VERY DENS · REDDISH BROWN SILTSTONE
									LAYERED SANDSTONE V DENSE
									NO SAMPLES ARE POSSIBLE W/O AUGER CUTTINGS
6	X	X	X	A	003	AUGER			
8									
9	X	X	X	A	004	"			
10									
12	X	X	X	A	005	"			
									12' TD

COMMENTS: DRILLED 6" TO 3' IS
TRIED TO USE 4" TO 12' [illegible]

SAMPLE TYPE
A - Auger cuttings
B - 2" O.D. 1.38" I.D. Split sampler
C - 3" O.D. 2.42" I.D. Tube sampler
T - 3" O.D. Thin-walled Shelby tube

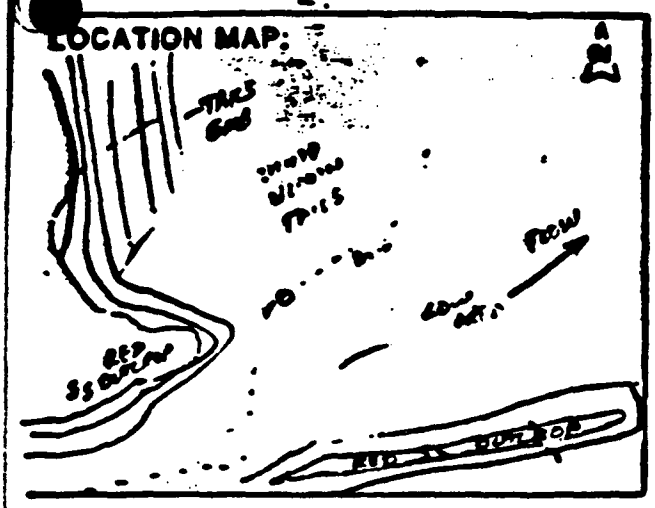
JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: WT-94
APPROX. SITE COORDINATES (ft.):
N 9700 E 11620
GROUND ELEVATION (ft. MSL): 4260
DRILLING METHOD: 6" HSA
DRILLER: T-CATT
DATE STARTED: 10-10-84
DATE COMPLETED: 10-10-84
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION EAST SIDE
SITE CONDITION CUCAT PUSH

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X		A	001	AUGER		SS	SANDSTONE RESIDUUM LAMINATED VFg-MED QZ
									Sorter layers @ 1.5, 3-3.5 STILL HARD
				A		"			
4.5					002				BISTURBED DRILLING 6—10'
	X	X		A	003	"			
6.5									
7.5					DO				
	X	X		T	004	"			
9.5									SS
12	X	X		A	005				
14									REFUSAL TO AUGER @ 14'

COMMENTS: SAMPLES ARE PRIMARY B/A AUGER CUTTINGS

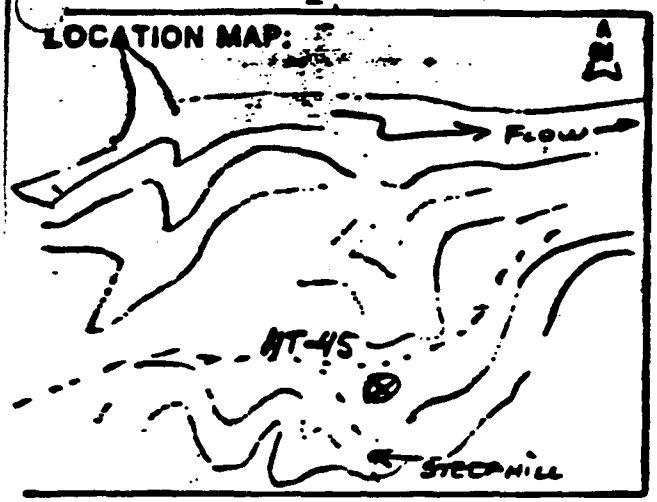
SAMPLE TYPE
A - Auger cuttings
S - 3" O.D. 1.38" I.D. drive sampler
U - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT 95-
APPROX. SITE COORDINATES (ft.):
N 18250 / 1450 E 11250
GROUND ELEVATION (ft. MSL): 421-9
DRILLING METHOD: HSA 6"
DRILLER: TLATT
DATE STARTED: 10-10-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION NORTHUP TAILS @ ROAD FORK
SITE CONDITION WHITE BLOWSAND & ROCKY RED ON PLATEAU ABOVE DRAIN TO HERTL

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									TOP 3" TAILS BLOWSAND - WHITE
1	X	X	X	A	#1			SP-SM	SAND FG SILTY RED BROWN DRY LOOSE
	X	X	X	A	#2			S	SANDSTONE, BLOCK, LT RED BROWN DRY HARD TR SOCHIPS
3	X	X	X	A	#3				
						TD=3' REFUSAL			

COMMENTS: AUGER SAMPLES = GROUND ROCK - SPETNUSED

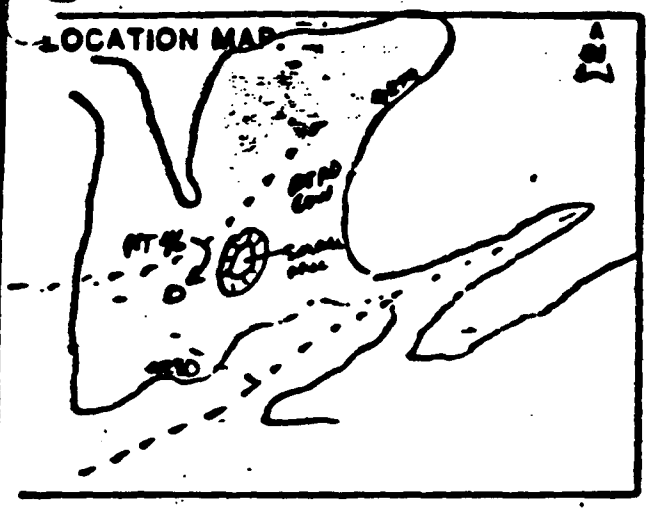
SAMPLE TYPE
A - Auger cuttings
B - 2" O.D. 1.38" I.D. drive sampler
C - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HATOI LOCATION ID: HT46
APPROX. SITE COORDINATES (ft.):
N 10200 E 10500
GROUND ELEVATION (ft. MSL): 9280
DRILLING METHOD:
DRILLER: TEATT
DATE STARTED: 10-10-84
DATE COMPLETED:
FIELD REP.: SKLM

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/

LOCATION DESCRIPTION: NORTH OF PILE ABOVE DRAINAGE ON NORTH
SITE CONDITION: SANDSTONE GENTLY SURFACE

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
	X	X	X	A	001			Sg	SANDSTONE HARD DRY RED BROWN
	X	X	X	A	002	TD=3'	--		
3									TD=3'

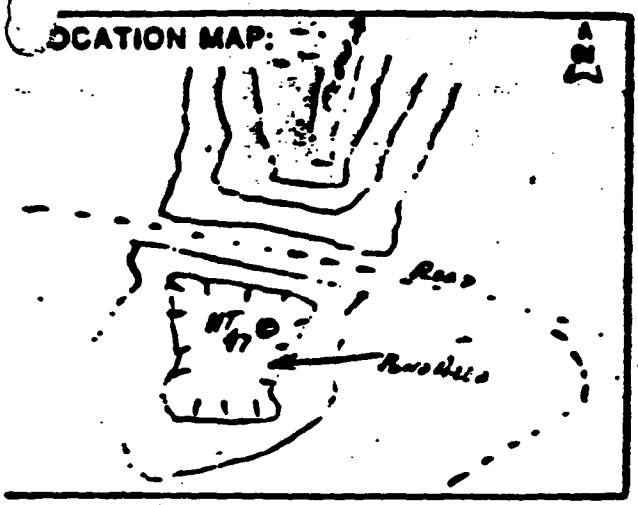
COMMENTS:

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
B - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT-47
APPROX. SITE COORDINATES (ft.):
N 9900 E 9550
GROUND ELEVATION (ft. MSL): 4276
DRILLING METHOD: HSA
DRILLER: TCATT
DATE STARTED: 10-10-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/
/	/	/

LOCATION DESCRIPTION NORTH OF DIKE IN BOUNDARY S. OF ROAD
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X		S	001	2,7,13	20	SM-SC	SAND V SILTY TRACE CLAYEY F.G MOIST
1.5								SM-GM	1.0' PIECES SANDSTONE ANGULAR REDBROWN
				S	002				
4						50/0"		SS	SANDSTONE BEDROCK @ 1.5'
									TRACE SILTSTONE VERY HARD
6	X	X		A					TD=6'

COMMENTS:

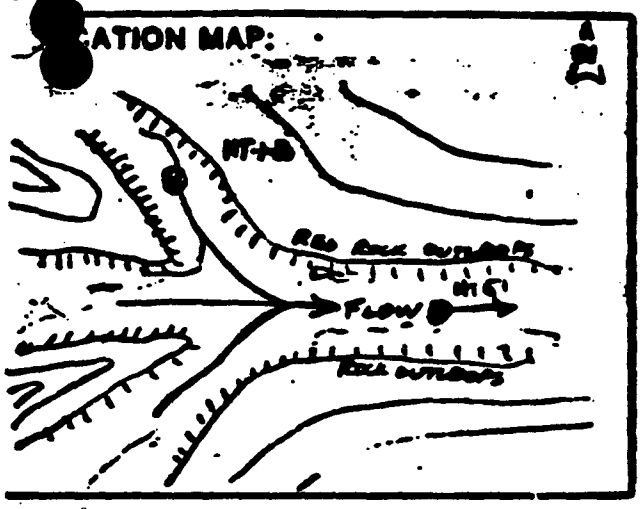
SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. Split spoon
U - 3" O.D. 2.87" I.D. Tube sampler
T - 3" O.D. Thin-walled Shelby tube

G-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT-1-50
APPROX. SITE COORDINATES (ft.):
N 10850 E 10930
GROUND ELEVATION (ft. MSL): 4230'
DRILLING METHOD: HSA 4"
DRILLER: TEATT-SHB
DATE STARTED: 10-23-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
/	/	/
/	/	/

LOCATION DESCRIPTION WEST BRANCH ABOVE CONFLUENCE NORTH OF UPPER PILE
SITE CONDITION DRY - IN DRAINAGE ON ALLUVIUM
NOTE LOW ROCK OUTCROPPING IN NORMAL DRAINAGE FLOW - ALLUVIUM CLEANED OFF

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERED	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
								SM	SAND FG. V.SILTY, MEDIUM DENSE, DRY TO SLIGHT RED BROWN TRACE GRAVEL
									DRY
								SS	SANDSTONE W/S FG. VERY HARD DRY
									DEEP DRILLING WITH UNCONVANCER IN BIGALTO SANDSTONE
									HOLE ABOVE 2 TO 5 - BURNT TEETH

COMMENTS: TEST HOLES SD-56 WERE PILOT HOLES TO CHECK DEPTH TO ROCK AND AMOUNT OF EFFORT REQUIRED TO DRILL ROCK

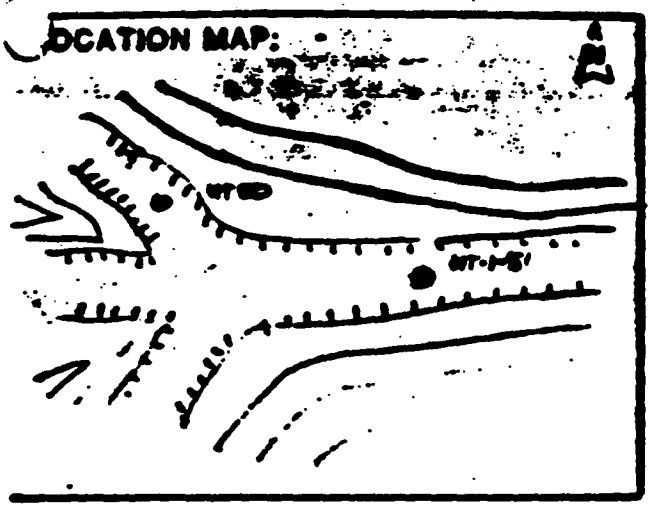
SAMPLE TYPE
A - Auger cuttings
B - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.87" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT-1-51
APPROX. SITE COORDINATES (ft.):
N 10800 E 11090
GROUND ELEVATION (ft. MSL): 4220
DRILLING METHOD: 6" HSA / ROTARY-WATER
DRILLER: T CAFF
DATE STARTED: 10-23-84
DATE COMPLETED: "
FIELD REP.: WILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: BELOW
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
								SM	RESIDUAL SOIL SAND FG VSILTY MEDIUM SL MOIST - RED BROWN N.P.
2								S	SANDSTONE WS WEATHERED [illegible]
									NOTE: SWITCH TO ROTARY @ 3' ROTARY WITH WATER 3'-5' END HOLE @ 5' IN SANDSTONE
									TD=3' SET 5' PIPE 2' S.U. SEAL @1 SAND 3-1 CONTINUOUS
									— HT-1-51 — TD=3' 5' PIPE W/ 2' STICKUP 4' BLANK 1' BOTTOM SLOTTED 1/2 BAG CEMENT GROUT AS FOLLOWS ABOVE SOIL

COMMENTS:

SAMPLE TYPE
A - Auger cuttings
B - 2" O.D. 1.50" I.D. drive sampler
C - 3" O.D. 2.42" I.D. tube sampler
T - 3" O.D. thin-walled Shelby tube

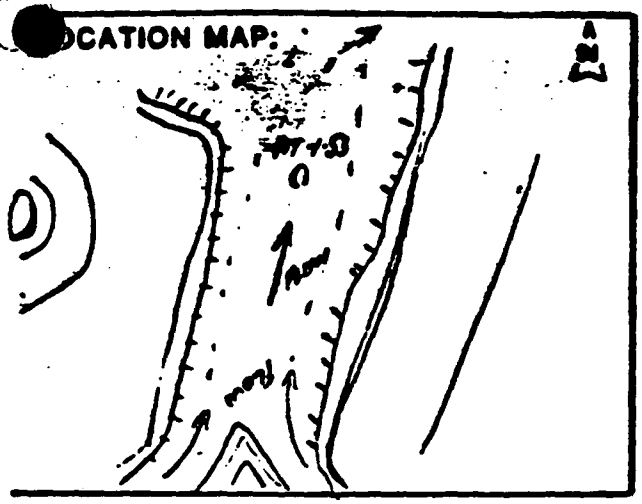
JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT-1-53
APPROX. SITE COORDINATES (ft.):
N 11050 E 12270
GROUND ELEVATION (ft. MSL): ~4185
DRILLING METHOD: 6" HSA
DRILLER: TCAT
DATE STARTED: 10-23-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: IN DRAINAGE NORTH OF SITE
SITE CONDITION: DRY COLD

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
								SM	SAND FG VERY SILTY TRACE GRAVEL SL MOIST
2.5					1			WSS	WEATHERED SANDSTONE
								SS	SANDSTONE RED-BROWN HARD
									TD=2.5' WELL NOT SET
									1" STICKUP 1" SCREEN 2" PVC

COMMENTS:

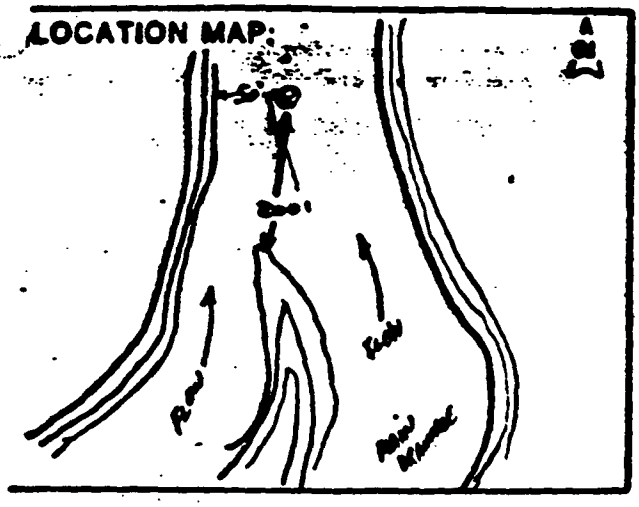
SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HA701 LOCATION ID: HT-53A
APPROX. SITE COORDINATES (ft.):
N 11500 E 12350
GROUND ELEVATION (ft. MSL): ~4180
DRILLING METHOD: 6" HSA
DRILLER:
DATE STARTED: 10-23-84
DATE COMPLETED:
FIELD REP.:

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: DRAINAGE NORTH OF TAILINGS AREA
SITE CONDITION: ALLUVIUM OVER ROCK

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
								SM	SAND & SILTY TRACE GRAVEL
								SS	SANDSTONE HARD RED BROWN
									WELLSET
									WELL SET @ 2.5'
									Bentonite @ 1'
									1' SCREEN
									16" S.M.
									TD = 2.5
									TL. 3.7

COMMENTS: ENCOUNTERED ROCK @ 3.4'/2.5

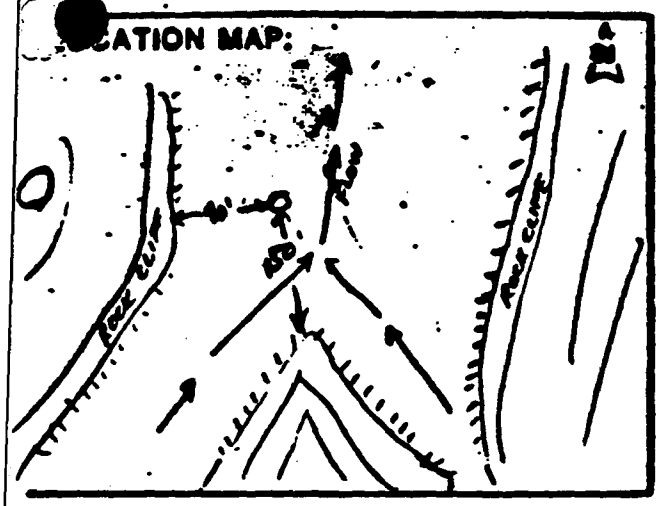
SAMPLE TYPE
A - Auger cuttings
B - 3" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: MATOI LOCATION ID: MT-1-84
APPROX. SITE COORDINATES (ft.):
N 10900 E 12150
GROUND ELEVATION (ft. MSL): 9195
DRILLING METHOD: 6" HSA
DRILLER: TCATT
DATE STARTED: 10-23-84
DATE COMPLETED: "
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: BELOW CONFLUENCE OF DRAINAGES NORTH OF TAILINGS
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
								SM	SAND F.G. V SILTY, SL MOIST RED BROWN MEDIUM DENSE
1.5								SS	TD=1.5
10								SS	SANDSTONE HARD RED BROWN
									WELL SET.
									1-0 SCREENED 0.010
									BENTONITE @ 0
									CEMENT GROUT
									@ SURFACE
									4.5" STICKUP
									ROCK PROTECTORS

COMMENTS:

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sampler
M - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

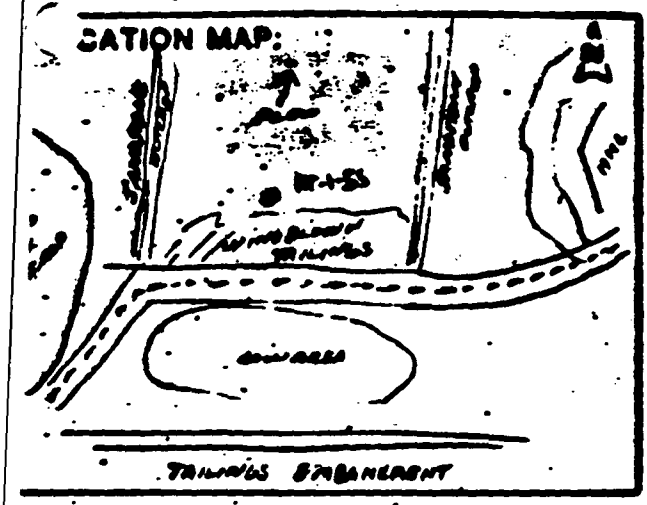
JEG-AL-ENG-28 (9/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: HATOI LOCATION ID: HT-P-56
APPROX. SITE COORDINATES (ft.):
N 10150 E 11700
GROUND ELEVATION (ft. MSL): 4225'
DRILLING METHOD: 6" HSA
DRILLER: TOMM
DATE STARTED: 10-23-87
DATE COMPLETED: -
FIELD REP.: SLM

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: NORTH OF LOWER PILE IN DRAINAGE
SITE CONDITION:

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	PID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
15								SM	6' WINDBLOWN TAILINGS WHITE-LTBN
								SM	SAND V. SILTY RED BROWN TO GRAVEL
5								Sb	SANDSTONE HARD DRIVE DRILLING
									3' TLP
									2" HOLE
									1' STREUP 1' SAND PACK
									YELLOW PELL @ 6'
									NO LOCK CAP
									ROCK PROTECTOR

COMMENTS:

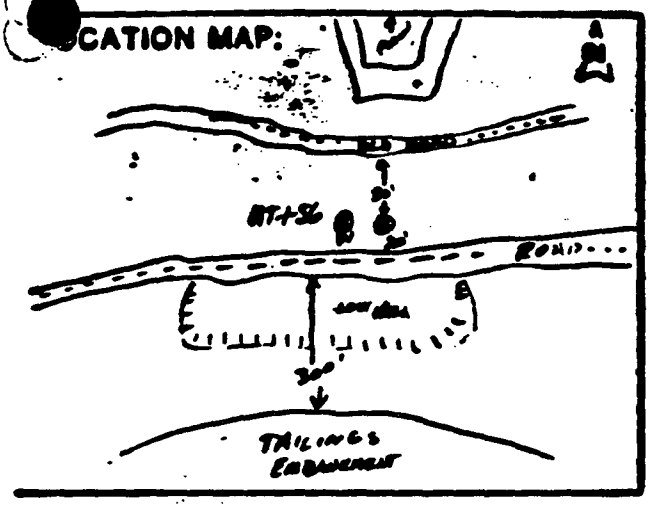
SAMPLE TYPE
B - Bagger cuttings
S - 2" O.D. 1.38" I.D. drive sample
M - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-28 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: HAT01 LOCATION ID: HT-1-SL
APPROX. SITE COORDINATES (ft.):
N 10,040 E 8550
GROUND ELEVATION (ft. MSL): 4294.8
DRILLING METHOD: 6" HSA
DRILLER: TCATT
DATE STARTED: 10-23-84
DATE COMPLETED: 10-23-84
FIELD REP.: SILVA

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: DRAINAGE NORTH OF UPPER PILE WESTERN SIDE OF SITE
SITE CONDITION: BETWEEN ROADS IN LOW AREA

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
								SM	SAND W/SILTY RED BROWN
						AUGER		SP-SM	SILTY RED BROWN BROWN SAND
5								SS	SANDSTONE RED BROWN DENSE
						TD=3'			
									1' SCREENED 3' BLANK 3' STICKUP 8 BENTONITE PELLETS @ 15'
									TD=6'
									STEEL LOCK CAPS

COMMENTS: PROBE HOLE TO ✓ DEPTH TO PAL

SAMPLE TYPE
A - Auger cuttings
B - 2" O.D. 1.38" I.D. drive sample
C - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

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MONITOR WELL BORING LOGS

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PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 905

JOB NO. NAT01 DATE 12/11/84

SURFACE ELEVATION 4294.13

TOP OF FILTER PACK 3.00

WELL CASING TYPE 2.0-in.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

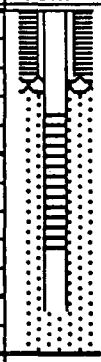
TOTAL DEPTH 12.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH ROTARY/CORE

LOCATION N 10006.30 E 9544.20

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Steel protective casing installed with grout to 2.25 feet. Bentonite pellet seal placed from 2.25 to 3.0 feet. Filter pack placed from 3.0 to 12 feet. Well screen installed from 3.5 to 8.5 feet. Two foot sump at 8.5 to 10.5 ft.		SP	**SOIL:** SAND, fine, variable to lt. reddish brown.
5				SP	**HALGAITO SHALE MEM., CUTLER FM.:** SANDSTONE,fine, closely fractured, dk. grey. Note: Numerous horizontal and vertical fractures.
10					
15					TD AT 12 FEET. Note: Core hole to 9 feet reamed to 12 feet to install well. No log from 9 to 12 feet.
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 906

JOB NO. NAT01 DATE 12/12/84

SURFACE ELEVATION 4220.83

TOP OF FILTER PACK 3.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

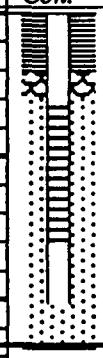
TOTAL DEPTH 11.8 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH ROTARY/CORE

LOCATION N 10137.50 E 11703.10

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Grout seal to 2 feet Bentonite pellet seal from 2 to 3 feet. Filter pack placed from 3 to 11.75 feet. Well screen placed from 3.1 to 8.1 feet.		SP	**SOIL:** SAND, fine to very fine, variable to dk. reddish brown.
5				SP	**HALGAITO SHALE MEM., CUTLER FM.:** SANDSTONE, very fine, reddish brown.
10					
		Two foot sump from 8.1 to 10.1 feet.			TD AT 11.75 FEET.
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 907

JOB NO. NAT01 DATE 12/17/84

SURFACE ELEVATION 4220.51

TOP OF FILTER PACK 107-110

WELL CASING TYPE 3/4-IN.PVC W/PACKER

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 125.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NQ CORE

LOCATION N 10154.10 E 11692.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				SP	**SOIL:** SAND, fine to very fine sand, reddish brown to tan.
		Hole cored drilled to 125 feet, then reamed to 37 feet with 4 3/4-in tricone, then reamed with 3-in to 122 feet. Well designed for packer test of artesian flow from 110 feet. Protective casing placed to 3 feet. Casing is 3/4-in pvc. Bentonite/ grout seal placed to 107 feet.		SP	**HALGAITO SHALE FM., CUTLER FM.:** SANDSTONE, very fine, closely fractured, moderately hard, dk. reddish brown.
5					
10					
15				ML	SILTSTONE, with seams of claystone, soft, dk. reddish brown.
20				SP	SANDSTONE, very fine, with lt. grey nodules, reddish brown.
25				CL SC	MUDSTONE, with seams of silty sandstone, dark reddish brown.
30				SP	SANDSTONE, very fine, with scattered small greyish nodules in upper part, mod. soft, dark reddish brown.
35					
40					
45					Note: Thin limestone seam at 43.3 to 44.3 feet. Note: Moderately hard from 44 feet.
50					Note: Increasing siltstone seams from 48 to 55 feet; with nodules of grey SS and limestone.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 907

JOB NO. NAT01 DATE 12/17/84

SURFACE ELEVATION 4220.51

TOP OF FILTER PACK 107-110

WELL CASING TYPE 3/4-IN.PVC W/PACKER

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 125.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NO CORE

LOCATION N 10154.10 E 11692.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**HALGAITO SHALE MEM.**, Continued.
60					
					Note: Transition to calcareous silt and limestone from 63 to 64.5
65				LS	LIMESTONE, to limy siltstone, mod hard.
70					
75					
				ML	SILTSTONE, to limestone with some coarse sand, hard. reddish brown(10r-3/4).
80					
					Note: with bluish grey nodules.
85					
90					
95				CL SC	MUDSTONE to claystone, mod. soft, dk. reddish brown.
				SP	SANDSTONE, fine, mod. hard, with small green nodules, fractures healed with calcite filling, reddish brown.
100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 907

JOB NO. NAT01 DATE 12/17/84

SURFACE ELEVATION 4220.51

TOP OF FILTER PACK 107-110

WELL CASING TYPE 3/4-IN.PVC W/PACKER

COMPLETION HALGAITO SHALE MEM.

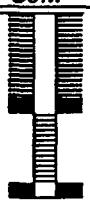
TOTAL DEPTH 125.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NQ CORE

LOCATION N 10154.10 E 11692.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Neoprene packers set at 107 and 110 with 2.5 to 3 foot interval.			HALGAITO SHALE MEM., Continued.
110					Note: Limestone nodule layer at 109.5 to 110; hard bluish grey. Note: Conglomerate layer at 111 to 111.5 feet.
				LS	LIMESTONE, horizontal dip, very hard, blue-grey gradually changing to lt. reddish brown.
115				SP	SANDSTONE, with limestone seams, lt. reddish brown.
120					Note: Limestone nodule layer at 121 to 122 feet.
				LS	Note: Void at 123 feet; water bearing. LIMESTONE, hard, grey.
125		Initially lost circulation at 122 feet; After pulling rods artesian flow measured at 26 gpm. Artesian water was carbonated. Steel tools turned blue (sulfates ?)			TD AT 125 FEET.
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 908

JOB NO. NAT01 DATE 03/28/85

SURFACE ELEVATION 4294.60

TOP OF FILTER PACK UNK

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 197.0 feet

RIG TYPE CME-75

BORING TYPE HSA WITH NQ CORE

LOCATION N 10019.30 E 9538.70

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		2.0-IN PVC well installed to 163 feet. Steel protective casing installed to 3 feet.		SM SC	TAILINGS: SILTY SAND. SOIL: CLAYEY SAND, reddish brown.
5		Grout seal installed to 136 ft. (est.)		ML SM	HALGAITO SHALE MEM., CUTLER FM.: SILTSTONE, with silty sandstone, some grey nodules, hard, brownish red.
10					Note: Limestone seam at 10 to 10.3 feet.
15					Note: Clayey, gravelly seam at 15 to 18 feet.
20				ML	SILTSTONE, with limestone inclusions, grey to reddish brown.
25					
30					
35					Note: Moist at 36 feet. Note: Lenses of lt. grey shale with darker grey breccia (turbidite).
40					Note: Occasional thin seams of grey shale.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 908

JOB NO. NAT01 DATE 03/28/85

SURFACE ELEVATION 4294.60

TOP OF FILTER PACK UNK

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 197.0 feet

RIG TYPE CME-75

BORING TYPE HSA WITH NQ CORE

LOCATION N 10019.30 E 9538.70

DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
						HALGAITO SHALE MEM., Continued.
55						**Continue, SILTSTONE. reddish brown.**
60						
65						
70						
75						
80						**Note: Limestone seam at 79.8 to 79.9 feet.**
85						
						Note: Limestone seam at 87.2 to 87.5 feet.
90						
95						
100						**Note: Occasional thin interbedded shale and limestone seams.**

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 908

JOB NO. NAT01 DATE 03/28/85

SURFACE ELEVATION 4294.60

TOP OF FILTER PACK UNK

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 197.0 feet

RIG TYPE CME-75

BORING TYPE HSA WITH NO CORE

LOCATION N 10019.30 E 9538.70

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**HALGAITO SHALE MEM.**, Continued. (SILTSTONE, reddish brown.)
110				CL	CLAYSTONE, greyish red.
				ML	SILTSTONE, mod. hard, lt. with very small limestone inclusions, reddish brown.
115					
120					
					Note: Hard, greyish red
125					Note: Soft, maroon, with claystone seams. Note: Thin seams of limestone, and limy siltstone from 125.
130					
135		Bentonite pellet seal installed from 136 to 140 ft. (est.)			Note: Limestone seams at 138 and 143 feet; very hard.
140		Filter pack installed from 140 to 163 ft. (est.)			
145		Well screen placed from 146 to 161 feet.			
150					
155					Note: Interbedded limestone seams from 153 feet.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 908

JOB NO. NAT01 **DATE** 03/28/85

SURFACE ELEVATION 4294.60
TOP OF FILTER PACK UNK
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 197.0 feet
RIG TYPE CME-75
BORING TYPE HSA WITH NO CORE
LOCATION N 10019.30 E 9538.70
DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160		Two ft. sump placed at 161 to 163 ft.			**HALGAITO SHALE MEM.**, Continued. (SILTSTONE, reddish brown to greyish red. Note: Thin coarse grained sandstone with varved banding at 162 feet.
165		Initial hole was core drilled to 197 ft. then off-set hole was drilled to 163 for installation of well. Core hole decommissioned by grouting.			
170					Note: Predominantly massive siltstone with interbedded thin limestone seams.
175					
180				LS	LIMESTONE, hard.
				SP	SANDSTONE, strong acid odor, yellow deposits in fractures.
185				LS	LIMESTONE, grey, strong chemical odor, hard, grey.
190					
195					
200					TD AT 197 FEET.
205					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. NAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NO CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-in PVC well to 150 feet.		SM	SOIL: SILTY SAND, lt. reddish brown.
		Protective steel casing placed to 3 feet (?).		SP	HALGAITO SHALE MEM.
				SM	SANDSTONE, with interbedded siltstone, greyish red.
5				ML	SILTSTONE, with limestone nodules, locally closely spaced fractures, grey.
		Installed Bentonite/ grout seal to 117 feet.		CH	CLAYSTONE, highly weathered, greyish red.
10				ML	Note: Limestone seam at 10 to 10.5 feet.
					SILTSTONE, greyish red.
15					Note: Massive bedded, no apparent bedding planes.
20				CL	CLAYSTONE, with grey nodules, mod. weathered, greyish red. Note: Limestone inclusions.
				LS	LIMESTONE, grey.
25				ML	SILTSTONE, very hard, with blue-grey limestone nodules, greyish red.
30					
35					
40					
45					
50					Note: Reddish brown color.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. NAT01 **DATE** 03/29/85

SURFACE ELEVATION 4349.77
TOP OF FILTER PACK 120.00
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet
RIG TYPE MOBILE B-80
BORING TYPE HSA WITH NQ CORE
LOCATION N 7925.50 E 7134.40
DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	55					**HALGAITO SHALE MEM.**, Continued. (SILTSTONE, greyish red.)
	60					
	65					
	70					
	75					Note: Thin bands of limestone, and seams with clay clasts.
	80					
	85					
	90					Note: Clayey, mudstone seams from 90 to 94 feet.
	95					Note: With rock salt sized limestone nodules.
	100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. NAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NQ CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105				~~LS~~	**HALGAITO SHALE MEM., Continued. LIMESTONE, hard, grey.**
				ML	**SILTSTONE, with limestone partical clasts, greyish red.**
110				SC	**MUDSTONE, with siltstone seams, greyish red.**
115				ML	**SILTSTONE, laminar, well cemented, occ. limestone nodules, greyish red.** **Note: Thin limestone seam at 117.1 to 117.3 feet.**
120		**Bentonite pellet seal placed from 117 to 120 feet.**			**Note: Thin limestone seam at 123 feet.**
125		**Filter pack sand installed from 120 to 155 feet.**			**Note: Sandstone layer at 125 to 126 ft.**
130		**Well screen installed from 130 to 150 feet.**			**Note: Color change from greyish red to dark red.**
135					**Note: Alternating interbeds of limestone from 135 to 145 ft.**
140					
145					**Note: Occasional thin seams of claystone and limestone from 145ft.**
150		**Five foot blank sump installed from 150 to 155 ft.**			
155					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. NAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NO CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
		Bentonite pellet seal placed from 155 to 157 ft.			**HALGAITO SHALE MEM.** Continued.
160		Not confirmed if initial core hole was reamed or if off-set hole was drilled for installation of well to 156 feet.		LS	**LIMESTONE**, mod. soft, masssive, grey.
165					
170					Note: sulphur traces in limestone, strong acid odor.
175					Note: traces of petroleum imbedded in core at 177 to 179 ft.
180					
185					Note: Increasing siltstone interbeds from 184 ft. Note: More oil imbedded in core from 185 to 187 ft.
190					
195				ML	**SILTSTONE**, massive, with occasional beds of limestone, red.
200					
205					Note: Interbedded thin limestone seams and nodules.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. NAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NQ CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210						**HALGAITO SHALE MEM., Continued.**
215						**TD AT 215 FEET.**
220						
225						
230						
235						
240						
245						
250						
255						
260						

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 910

JOB NO. NAT01 DATE 02/15/85

SURFACE ELEVATION 4353.22

TOP OF FILTER PACK 139.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 236.0 feet

RIG TYPE CME-75

BORING TYPE HSA WITH NQ CORE

LOCATION N 8336.50 E 10067.70

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Redrilled borehole for well 910A to 182 feet, next to hole 910. Placed steel protective casing to 3.8 feet. Installed bentonite/ grout seal to 137 feet.		SP	**SOIL:** SAND, fine, lt. reddish brown.
5				ML	**HALGAITO SHALE MEM., CUTLER FM.:** SILTSTONE, mod. hard, mineralization in fractures, greyish red.
10					Note: Limestone seam from 12.6 to 12.8 ft.
15					Note: Fractures filled with fine white sand.
20					
25					Note: Scattered very small limestone inclusions.
30					
35					Note: shear zone at 35.1 to 35.4, with crushed angular frag. in clay gouge.
40					
45					Note: Some clay fracture fillings.
50					Note: Occasional thin lenses of very fine sandstone.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 910

JOB NO. NAT01 **DATE** 02/15/85

SURFACE ELEVATION 4353.22
TOP OF FILTER PACK 139.00
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 236.0 feet
RIG TYPE CME-75
BORING TYPE HSA WITH NQ CORE
LOCATION N 8336.50 E 10067.70
DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
						HALGAITO SHALE MEM., Continued.
55						**Continued; SILTSTONE, GREYISH RED.** **Note: Thin interbedded limestone seams from 57 feet.**
60						**Note: limestone clasts in siltstone like conglomerate.**
65						
70						
75						
80						**Note; Grey limestone nodules in siltstone from 74 to 78 feet; well cemented.**
85						
90						**Note: limestone particles, like conglomerate, from 91 to 96.5 ft., well cemented, very few fractures.**
95						**Note; Color change from greyish red to brownish red.**
100						

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 910

JOB NO. NAT01 DATE 02/15/85

SURFACE ELEVATION 4353.22

TOP OF FILTER PACK 139.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 236.0 feet

RIG TYPE CME-75

BORING TYPE HSA WITH NO CORE

LOCATION N 8336.50 E 10067.70

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**HALGAITO SHALE MEM.**, Continued. (SILTSTONE, brownish red.)
110					Note; limestone inclusions, like conglomerate, 110 to 115 ft.; well cemented. Color change to dark red.
115					
120					Note: Limstone inclusions like conglomerate, from 120 to 125 ft.
125					
130					Note: Limestone nodules, olive to grey, from 131 to 135 ft.
135					
		Placed bentonite pellet seal from 137 to 139 feet.			
140		Installed well screen from 140.8 to 180.8 ft.			
145		Placed filter pack from 139 to 182 feet.			
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 910

JOB NO. NAT01 DATE 02/15/85

SURFACE ELEVATION 4353.22

TOP OF FILTER PACK 139.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 236.0 feet

RIG TYPE CME-75

BORING TYPE HSA WITH NQ CORE

LOCATION N 8336.50 E 10067.70

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					**HALGAITO SHALE MEM., Continued. (SILTSTONE, dark red to reddish brown.)**
165					
170					
175					
180		**Installed blank sump from 180.8 to 182.8 ft.**			
185					
190					
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 910

JOB NO. NAT01 DATE 02/15/85

SURFACE ELEVATION 4353.22

TOP OF FILTER PACK 139.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 236.0 feet

RIG TYPE CME-75

BORING TYPE HSA WITH NQ CORE

LOCATION N 8336.50 E 10067.70

DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210						
						HALGAITO SHALE MEM., Continued. (SILTSTONE, brownish red.)
215						Note: petroleum odor and oily fluid.
220						
225						
230						
						Note: Possible gas bearing zone fron 225 ft. Well bubbling with rotten egg odor. Possible sulfide gas hazard.
235						
						TD AT 236 FEET.
240						
245						
250						
255						
260						

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 911

JOB NO. NAT01 DATE 01/06/85

SURFACE ELEVATION 4294.35

TOP OF FILTER PACK 93.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 105.0 feet

RIG TYPE CME-75

BORING TYPE NQ CORE & REAM

LOCATION N 9508.40 E 11114.00

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Corehole through pile, NE corner. Steel protective casing placed to 3 feet (?).		SM	TAILINGS: UNDIFFERENTIATED
5					
10					
15					
20					
25					
30					
35					
40				ML	HALGAITO SHALE MEM. CUTLER FM.: SILTSTONE, calcareous, very hard to mod. hard, reddish brown with lt. grey motteling.
45					Note: with angular to subrounded limestone clasts from 45 to 48 ft.
50					Note: Lost circulation at 51 ft.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 911

JOB NO. NAT01 DATE 01/06/85

SURFACE ELEVATION 4294.35

TOP OF FILTER PACK 93.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 105.0 feet

RIG TYPE CME-75

BORING TYPE NQ CORE & REAM

LOCATION N 9508.40 E 11114.00

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					HALGAITO SHALE MEM., Continued.
60					NOTE: MISSING LOG PORTION FROM 53 TO 98 FEET.
65					
70					
75					
80					
85		Grout installed to 85 feet.			
90		Bentonite pellet seal placed from 85 to 89 feet. Filter pack sand placed from 89 to 104 ft.			
95		Well screen placed from 92 to 102 ft.			
100		Blank sump placed at 102 to 104 ft.			(RESUME LOG AT 98 FEET.) Continue; SILTSTONE, reddish brown. Note: argillaceous from 102.9 to TD.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 911

JOB NO. NAT01 DATE 01/06/85

SURFACE ELEVATION 4294.35

TOP OF FILTER PACK 93.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 105.0 feet

RIG TYPE CME-75

BORING TYPE NO CORE & REAM

LOCATION N 9508.40 E 11114.00

DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105						TD AT 104.5 FEET.
110						
115						
120						
125						
130						
135						
140						
145						
150						
155						

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 912

JOB NO. NAT01 DATE 03/28/85

SURFACE ELEVATION 4294.43

TOP OF FILTER PACK 55.50

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 84.0 feet

RIG TYPE CME-75

BORING TYPE ROTARY

LOCATION N 9527.00 E 11133.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 80 feet. Steel protective casing placed to 3 feet. (?)		SM	TAILINGS: UNDIFFERENTIATED
5					
		Installed grout seal to 52.5 feet.			
10					
15		LITHOLOGY LOG OF WELL 912 TAKEN FROM ADJACENT WELL 911.			
20					
25					
30					
35					
40				ML	HALGAITO SHALE MEM., CUTLER FM.: SILTSTONE, calcareous, very hard to mod. hard, reddish brown with lt. grey motteling.
45					Note: with angular to subrounded limestone clasts from 45 to 48 ft.
50					Note: Lost circulation at 51

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 912

JOB NO. NAT01 DATE 03/28/85

SURFACE ELEVATION 4294.43

TOP OF FILTER PACK 55.50

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 84.0 feet

RIG TYPE CME-75

BORING TYPE ROTARY

LOCATION N 9527.00 E 11133.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
		Installed bentonite pellet seal from 52.5 to 55.5 feet.			ft.(REPORTED IN LOG OF WELL 911)
55		Placed filter pack sand from 55.5 to 80 feet.			
		Installed well screen from 58 to 78 feet.			
60					NOTE; MISSING LOG PORTION FROM 53 FEET TO TD BASED ON LOG OF ADJACENT WELL 911.
65					
70					
75					
		Placed blank sump from 78 to 80 feet.			
80		Cave-in fill from 80 to 84 feet.			
85					TD AT 84 FEET.
90					
95					
100					Note: argillaceous from 102.9 to TD.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF WELL BORING NO. 930

JOB NO. *NAT01* DATE *10/10/85*

SURFACE ELEVATION *4311.65*

TOP OF FILTER PACK *94.00*

WELL CASING TYPE *4.0-IN.SCHED.40 PVC*

COMPLETION *HONAKER TRAIL FM.*

TOTAL DEPTH *116.0 feet*

RIG TYPE

BORING TYPE *ROTARY-AIR*

LOCATION *N 10550.30 E 7733.00*

DATUM *MSL, @ GROUND SURFACE*

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in. PVC well to 112 feet. Steel protective casing placed to 3 feet. (?)		ML	**HALGAITO SHALE FM.:** SANDY SILTSTONE, calcareous, thin bedded, highly to mod. weathered, moist, medium reddish brown.
5		Installed grout seal to 85 feet.			
10				SM	SILTY SANDSTONE, slightly calcareous, thin bedded, medium reddish brown.
15					
20					Note: Strongly calcareous (cementation) from 20 feet.
25					
30					Note: some interbedded reddish orange mudstone from 28 to 31 feet.
35					
40					
45					Note: Some thin interbedded grey limestone from 46 to 80 feet; and some reddish orange mudstone from 46 to 58 feet.
50					

GROUNDWATER

DEPTH	HOUR	DATE
52.3		10-12-85

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 930

JOB NO. NAT01 DATE 10/10/85

SURFACE ELEVATION 4311.65

TOP OF FILTER PACK 94.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HONAKER TRAIL FM.

TOTAL DEPTH 116.0 feet

RIG TYPE

BORING TYPE ROTARY-AIR

LOCATION N 10550.30 E 7733.00

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**HALGAITO SHALE FM. OF CUTLER GROUP, Continued.**
60					
65					
70					
75					
80				ML	**SANDY SILTSTONE, thin bedded, with interbedded grey limestone, medium reddish brown.**
				SM	**SILTY SANDSTONE, thin bedded, occ. interbedded limestone seams, med. reddish brown.**
85		**Installed bentonite pellet seal from 85 to 90 feet.**			
90		**Placed filter pack sand from 90 to 112 feet.**			
95				LS	**HONAKER TRAIL FORMATION: LIMESTONE, mod. hard, light to medium grey.**
100		**Installed well screen from 100 to 110 feet.**			

GROUNDWATER

DEPTH	HOUR	DATE
52.3		10-12-85

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 930

JOB NO. NAT01 DATE 10/10/85

SURFACE ELEVATION 4311.65

TOP OF FILTER PACK 94.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HONAKER TRAIL FM.

TOTAL DEPTH 116.0 feet

RIG TYPE

BORING TYPE ROTARY-AIR

LOCATION N 10550.30 E 7733.00

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**HONAKER TRAIL FM., Continued.**
110		**Placed blank sump from 110 to 112 feet.**			**Note: Interbedded sandstone seams from 110 to 113 feet.**
115		**Cave-in fill from 112 to 116 feet.**		SM	**SANDSTONE, silty, calcareous, thin bedded, with limstone seams and nodules, medium reddish brown.**
					TD AT 116 FEET.
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
52.3		10-12-85

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 931

JOB NO. *NAT01* **DATE** *10/12/85*

LOCATION *N12083.0 E9971.0*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY -AIR* *7 7/8-IN*
SURFACE ELEV *4316.27*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								LS	Hole grouted to surface after encountering strong petroliferous odor at 177 feet with oily cuttings. No water encountered.	**HALGAITO SHALE MEM., CUTLER FM.:** LIMESTONE, silty, fine grained, thin bedded, brown. higly weathered to 4 feet, occasional orange siltstone interbedded.
5										
								ML		SILTSTONE, sandy, calcareous, very thin beds, medium orange-brown. Occasional thin limestone beds from 13 to 16 feet.
10										
15										
								CL SC		MUDSTONE, friable, limonitic, med. orange.
20										
25								ML		SILTSTONE, very thin bedded, calcareous, med. orange.
30								CL SC		MUDSTONE, calcareous, soft, med. to dark orange-brown. Becomes more silty and harder with depth.
35										
								ML		SILTSTONE, calcareous, thin bedded, med. orange-brown. Occasional thin limestone seam from 46 to 48 ft.
40										
45										
								SM		SANDSTONE, silty, fine, calcareous, med. orange-brown.
50										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 931

JOB NO. *NAT01* DATE *10/12/85*

LOCATION *N12083.0 E9971.0*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY -AIR* *7 7/8-IN*
SURFACE ELEV. *4316.27*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
55										**HALGAITO SHALE MEM., CUTLER FM., Continued.**
60										
65										
70										
								ML		**SILTSTONE, calcareous, thin bedded, light to med. brown.**
75										
80										
85										
90										
95										**Note: Occasional interbeds of lt. orange-brown mudstone from 100 ft.**
100										

GROUNDWATER

DEPTH	*HOUR*	*DATE*

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 931

JOB NO. *NAT01* DATE *10/12/85*

LOCATION *N12083.0 E9971.0*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY -AIR* *7 7/8-IN*
SURFACE ELEV *4316.27*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
105										**HALGAITO SHALE MEM., CUTLER FM., Continued.**
110										**Note: Increasing to equal amounts of mudstone interbeds from 110 ft.**
115								LS		**LIMESTONE, some siltstone interbeds, fine grained, mostly orangeish brown with some lt. grey.**
120								ML		**SILTSTONE, calcareous, med. reddish brown.**
125								LS		**LIMESTONE, fine grained, light grey.**
130										**Note; Change to sandy limestone from 129 feet.**
135										
140								SM		**SILTY SANDSTONE, fine, calcareous, thin bedded, med. reddish brown.**
145										**Note: Anomolous radioactivity at 147.5 on geophysical well log.**
150								ML		**SILTSTONE, with limestone seams interbeds, lt. and med. greenish to brownish grey.**
155								SM		**SANDSTONE, with interbeds of limestone, med. brown.**

GROUNDWATER

	DEPTH	HOUR	DATE
▽			
▼			

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 931

JOB NO. NAT01 DATE 10/12/85

LOCATION N12083.0 E9971.0
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY -AIR 7 7/8-IN
SURFACE ELEV 4316.27
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
160										
165										
170								LS		LIMESTONE, silty, fine grained, calcareous, sulfur odor, lt. medium blue to greenish grey. Note: Becomes thin bedded, fissle, dark grey from 172 ft.
175								SP		SANDSTONE, fine grained, weakly calcareous, friable, lt. yellow grey to olive. Has petroliferous odor, Possible "baby member" of Honaker Trail Formation.
										TD AT 177 FEET. HOLE DECOMMISSIONED BY GROUTING FULL.

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 932

JOB NO. *NAT01* **DATE** *10/13/85*

LOCATION *N13167.7 E12636.3*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV *4225.13*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								LS		**HALGAITO SHALE MEM., CUTLER FM.:** LIMESTONE, sandy, fine grained, med. orange- brown.
5										
								CL SC		MUDSTONE, calcareous, friable, with siltstone interbeds, "brick" orange.
10									Hole decommissioned by grouting to surface.	
								ML		SILTSTONE, sandy, fine grained, med. orange brown.
15									Encountered possible hydrogen sulfide gas followed by water with petroliferous odor. Water level line coated with two feet of brown oil. Water quality shows salinity 2%; EC 3100 uMhos; pH 8.08.	
20								SM		SILTY SANDSTONE, calcareous, fine grained, med. orange- brown.
25										Note: Some interbedded orange mudstone from 26 to 28 ft.
30										
35										
40										
45										Note: Considerable mudstone interbeds from 48 to 50 ft.
50								ML		SILTSTONE, sandy, fine grained, calcareous, med. brown to reddish

GROUNDWATER

DEPTH	HOUR	DATE
151.0	07:35	10-14-85

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 932

JOB NO. NAT01 DATE 10/13/85

LOCATION N13167.7 E12636.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV. 4225.13
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
										brown. Note: Some interbedded limestone seams to 54 feet. **HALGAITO SHALE MEM., CUTLER FM., Continued.**
55										
60										
65										
70										Note: Color change to greenish grey from 72 to 76 feet.
75										
80										
85										
90										
95										Note: Color change to greyish green from 96 to 98 feet. Note: Some orange mudstone interbeds from 98 to 102 feet.
100										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	151.0	07:35	10-14-85
▼			

SAMPLE TYPE
RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 932

JOB NO. NAT01 DATE 10/13/85

LOCATION N13167.7 E12636.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV. 4225.13
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
105										**HALGAITO SHALE MEM., CUTLER FM., Continued.**
110										**Note: Color change to lt. greenish grey from 110 to 114 ft.**
115										**Note: Considerable interbedded orange mudstone with trace limestone from 116 to 118 feet.**
120										
125										**Note: Some interbeds of lt. grey limestone from 132 to 138 ft.**
130										
135										
140										
145										**Note: Some interbeds of lt. to med. grey limestone from 146 to 187 ft.**
150										
155										

GROUNDWATER

DEPTH	HOUR	DATE
151.0	07:35	10-14-85

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 932

JOB NO. NAT01 DATE 10/13/85

LOCATION N13167.7 E12636.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV 4225.13
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
160									Top of Honaker Trail Formation may be at 162 or 187 feet. The geopysical logs do not show any break between 50 to 187 ft.	
165										
170										
175										
180										
185										
190								LS		LIMESTONE, fine grained, lt. to medium grey.
										TD AT 193 FEET.

GROUNDWATER

DEPTH	HOUR	DATE
151.0	07:35	10-14-85

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 933

JOB NO. *NAT01* DATE *10/15/85*

LOCATION *N7782.3 E8444.7*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV *4365.03*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	Trace water found in borehole, unable to determine source from geophysical log. Hole decommissioned by grouting to surface.	**HALGAITO SHALE MEM., CUTLER FM.:** SILTSTONE, calcareous, medium brown to orangish brown. Note: Color variable includes seams with lt. grey.
5										
10										
15								CL SC		MUDSTONE, calcareous, with interbeds of siltstone, soft, orangish brown.
20										
25										
30										
								ML		SILTSTONE, with mudstone interbeds, occasional thin limestone seams, med. reddish brown.
35										Note: Mudstone decreasing from 38 feet. Note: Trace chert from 40 to 45 feet.
40										
45										Note: Color slightly greenish from 45 ft.
50										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 933

JOB NO. NAT01 DATE 10/15/85

LOCATION N7782.3 E8444.7
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV. 4365.03
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
55										Note: No mudstone from 52 feet; occasional chert and limestone inclusions. to 55 feet. **HALGAITO SHALE MEM, CUTLER FM., Continued.**
60										Note: Some orange mudstone seams from 62 to 65 feet.
65								CL SC		MUDSTONE, calcareous, soft, brick" orange.
70										
								ML		SILTSTONE, calcareous, thin bedded, med. orange- brown. Some interbeds of orange mudstone.
75										
80										Note: Considerable chert material from 80 to 86 ft.
85										
90										Note: Trace lt. grey limestone interbeds from 90 to 96 ft.
95										
100										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 933

JOB NO. *NAT01* **DATE** *10/15/85*

LOCATION *N7782.3 E8444.7*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV *4365.03*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
105										**HALGAITO SHALE MEM., CUTLER FM., Continued.**
110										
115										
120										
125										
130										
135										
140										
145										
150										
155										

GROUNDWATER

	DEPTH	HOUR	DATE
▽			
▼			

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 933

JOB NO. *NAT01* **DATE** *10/15/85*

LOCATION *N7782.3 E8444.7*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV. *4365.03*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
160										**HALGAITO SHALE MEM., Continued.**
165										
170								LS		**HONAKER TRAIL FORMATION:** LIMESTONE, shaley at contact, lt. grey to greyish brown.
175										**TD AT 175 FEET.**

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. NAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				ML	**HALGAITO SHALE MEM., CUTLER FM.:** SILTSTONE, cherty, calcareous, some interbedded mudstone, medium orange- brown. Note: Surface strewn with rock slabs of weathered limestone, and traces of gypsum.
		Reamed 5 1/8-in hole to 8-in hole. Installed 4-in PVC cased well to 197 feet.			
5					
		Placed steel protective casing to 8 feet.			
10					
15		Installed bentonite-cement grout to 172 feet.			Note: Color change to med. brown.
20					Note: Becomes thin bedded, little or no chert present from 22 ft.
25					
30					Note: Considerable mudstone interbeds from 29 to 36 feet.
35					
40					Note: Occasional mudstone seams from 36 to 44 feet.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. NAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	55					**HALGAITO SHALE MEM.**, Continued. Note: Some mudstone interbeds from 55 to 57 feet.
	60					
	65					Note: Occasional thin limestone and mudstone interbeds from 66 to 82 ft.
	70					
	75					
	80					
	85					
	90					
	95					
	100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. NAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105						**HALGAITO SHALE MEM., Continued.**
110						**Note: Occasional interbeds of thin grey limestone and orange mudstone seams from 100 to 117 feet.**
115						
120						**Note: cherty siltstone from 120 to TD; Occasional thin limestone and mudstone seams.**
125						
130						
135						
140						
145						
150						**Note: Wet below 150 feet.**
155						**Note: Stopped drilling 5 1/8-in**

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. NAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
					borehole at 155 feet. Reamed with 8.0-in and deepened to 200 feet after water encountered at 150 ft.
160					**HALGAITO SHALE MEM.**, Continued.
165					
170					
		Placed bentonite- slurry seal from 172 to 177 feet.			
175					Note; Some interbeds of sandstone, slightly micaceous. Color change to dark red to red.
		Placed filter pack sand from 177 to 197 feet.			
180					
185					
		Placed .051 slot well screen from 188 to 198 feet.			
190					Note: Color change to orange red, slightly clayey, trace mica, calcareous,
195					
		Cave-in fill from 197 to 200 feet. Two foot sump installed at 198 ft.			
200					TD AT 200 FEET.
205					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 935

JOB NO. *NAT01* DATE *10/19/85*

LOCATION *N10023.8 E12468.3*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV *4230.62*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SP		**HALGAITO SHALE MEM., CUTLER FM.:** **SANDSTONE, very fine grained, calcareous, fissle, hard, occasional siltstone seams, reddish brown.**
								ML		**SILTSTONE, highly calcareous, hard, dark red to lt. orange red.**
5										
10										
15										
20										
25								ML SM		**SANDSTONE AND SILTSTONE, alternating with variable sand content, reddish brown.**
30										
35										
40										
45										
50										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 935

JOB NO. NAT01 DATE 10/19/85

LOCATION N10023.8 E12468.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV. 4230.62
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
										HALGAITO SHALE MEM., Continued.
55										**Note: Some orange clayey siltstone interbeds with sandstone and siltstone layers.**
60										
65										
70										
75										
80								SM		**SANDSTONE, silty, very fine grained, calcareous, lt. grey.**
85								ML SM		**SANDSTONE AND SILTSTONE, interbedded, highly calcareous, hard, dark red to reddish brown.**
90										
95										
100										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 935

JOB NO. *NAT01* DATE *10/19/85*

LOCATION *N10023.8 E12468.3*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV *4230.62*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
105										**HALGAITO SHALE MEM., Continued.**
110										
115										
120										
125										
130										
135										**Note; Continued alternating sandstone and siltstone with change of color of siltstone to maroon, highly calcareous.**
140										
145										
150										
155										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 935

JOB NO. NAT01 DATE 10/19/85

LOCATION N10023.8 E12468.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV 4230.62
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
										HALGAITO SHALE MEM., Continued.
160								ML		**SILTSTONE, reddish brown, with 50 % interbedded lt. grey limestone,some thin sandstone seams.**
165								ML		**SILTSTONE, maroon, with 5 % limestone seams,**
170										
								ML SM		**SANDSTONE AND SILTSTONE, interbedded, limestone absent, moist, maroon to reddish brown.**
175										**Note: Color change to dark red or reddish brown to chocolate brown siltstone/sandstone; fissle, very hard.**
180										
185								ML		**SILTSTONE , with 50 % lt. grey limestone.**
										TD AT 187 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 936

JOB NO. *NAT01* **DATE** *10/20/85*

LOCATION *N11391.7 E10912.3*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV. *4182.90*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML		**HALGAITO SHALE MEM., CUTLER FM.:** **SILTSTONE, with clay seams, dark reddish brown.**
5										
10										**Note: Becomes calcareous, very hard, no clay, dark reddish brown to chocolate brown.**
15										
20										
25										
30										
35										
40										
45										
50										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 936

JOB NO. *NAT01* **DATE** *10/20/85*

LOCATION *N11391.7 E10912.3*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV. *4182.90*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
55										**HALGAITO SHALE MEM., Continued.**
60										
65										
70										
75										
80										
85										
90										
95										**Note: Becoming sandy with sandstone seams, maroon to lt. green to dk. red.** **Occasional limestone seams.**
100										**Note: Sandstone comprises 50 % of cuttings.**

GROUNDWATER

	DEPTH	*HOUR*	*DATE*
▽			
▼			

SAMPLE TYPE
RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 936

JOB NO. NAT01 DATE 10/20/85

LOCATION N11391.7 E10912.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV. 4182.90
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
105										Note: Sandstone comprises 30 % of cuttings. Color change to chocolate brown, fissle. HALGAITO SHALE MEM., Continued.
110										
115										Note: Becoming very moist at 115 feet. Considerable Sandstone seams, calcareous to highly calcareous, fissle.
120										
125										
130										
135										
140										Note: Hydrogen sulfide odor at 142. Stopped drilling. Also odor of petroleum, confirmed by oil smear on probe tool.
										TD AT 142 FEET. DECOMMISSIONED HOLE BY GROUTING TO SURFACE.

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE
RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 190

JOB NO. NAT01 DATE 10/23/84

SURFACE ELEVATION 4220.00

TOP OF FILTER PACK 1.00

WELL CASING TYPE 4-IN PVC

COMPLETION DRAINAGE BOTTOM

TOTAL DEPTH 5.0 feet

RIG TYPE CME-55

BORING TYPE HSA / ROTARY

LOCATION N 10781.30 : E 11109.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Shallow well installed to 3.0 ft. in drainage to check for seep/ spring flow. Grout and bentonite seals installed to 1.0 foot. Filter pack sand placed from 1 to 3 feet. Slotted section placed at 2 to 3 feet.		SM SP	**ALLUVIUM:** SILTY SAND, fine, sl. moist, reddish brown.
					HALGAITO SHALE MEM.: SANDSTONE, hard, reddish brown.
5					**TD AT 3.0**
10					
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 192

JOB NO. NAT01 DATE 10/23/84

SURFACE ELEVATION 4185.00

TOP OF FILTER PACK 1.00

WELL CASING TYPE 4-IN PVC

COMPLETION DRAINAGE BOTTOM

TOTAL DEPTH 2.5 feet

RIG TYPE CME-55

BORING TYPE HSA

LOCATION N 11683.10 E 12321.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Shallow well installed to 2.5 ft. in drainage to check for seep/ spring flow. Grout and bentonite seals installed to 1.0 foot. Filter pack sand placed from 1 to 2.5 feet. Slotted section placed at 1.5 to 2.5 feet.		SM	**ALLUVIUM:** SILTY SAND, fine, tr. gravel, sl. moist, reddish brown.
				SP	**HALGAITO SHALE MEM.:** SANDSTONE, hard, reddish brown.
5					TD AT 2.5 FT.
10					
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF WELL BORING NO. 193

JOB NO. *NAT01* DATE *10/23/84*

SURFACE ELEVATION *4195.00*
TOP OF FILTER PACK *0.50*
WELL CASING TYPE *4-IN PVC*
COMPLETION *DRAINAGE BOTTOM*

TOTAL DEPTH *1.5 feet*
RIG TYPE *CME-55*
BORING TYPE *HSA*
LOCATION *N 10935.20 E 12126.80*
DATUM *MSL, @ GROUND SURFACE*

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				SM	**ALLUVIUM:** SILTY SAND, fine, tr. gravel, sl. moist, reddish brown.
				SP	**HALGAITO SHALE MEM.:** SANDSTONE, hard, reddish brown.
5		**Shallow well installed to 1.5 ft. in drainage to check for seep/ spring flow. Grout and bentonite seals installed to 0.5 foot. Filter pack sand placed from .5 to 1.5 feet. Slotted section placed at 0.5 to 1.5 feet.**			**TD AT 1.5 FT.**
10					
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 194

JOB NO. NAT01 DATE 10/23/84

SURFACE ELEVATION 4225.00

TOP OF FILTER PACK 1.00

WELL CASING TYPE 4-IN PVC

COMPLETION DRAINAGE BOTTOM

TOTAL DEPTH 2.0 feet

RIG TYPE CME-55

BORING TYPE HSA

LOCATION N 10152.60 E 11711.00

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				SM	ALLUVIUM: SILTY SAND, fine, tr. gravel, sl. moist, reddish brown.
				SP	HALGAITO SHALE MEM.: SANDSTONE, hard, reddish brown.
		Shallow well installed to 2.0 ft. in drainage to check for seep/ spring flow. Grout and bentonite seals installed to 0.5 foot. Filter pack sand placed from .5 to 2.0 feet. Slotted section placed at 1.0 to 2.0 feet.			TD AT 2.0 FT.
5					
10					
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 195

JOB NO. NAT01 **DATE** 10/23/84

SURFACE ELEVATION 4294.80
TOP OF FILTER PACK 1.50
WELL CASING TYPE 4-IN PVC
COMPLETION DRAINAGE BOTTOM

TOTAL DEPTH 3.0 feet
RIG TYPE CME-55
BORING TYPE HSA
LOCATION N 10019.30 E 9538.70
DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Shallow well installed to 3.0 ft. in drainage to check for seep/ spring flow. Grout and bentonite seals installed to 1.5 foot. Filter pack sand placed from 1.5 to 3.0 feet. Slotted section placed at 2.0 to 3.0 feet.		SM SP SP	**ALLUVIUM:** SILTY SAND, fine, tr. gravel, sl. moist, reddish brown. SAND,fine, lt. brn. **HALGAITO SHALE MEM.:** SANDSTONE, hard, reddish brown. TD AT 3.0 FT.
5					
10					
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 601

JOB NO. MON01 DATE 10/24/84

SURFACE ELEVATION 4881.51

TOP OF FILTER PACK 9.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION ALLUVIUM/SANDSTONE

TOTAL DEPTH 24.0 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 54980.40 E 88017.70

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 24 feet		SP	**EOLIAN:** SAND, fine, tr. silt, lt. brown to reddish tan.
5		Protective steel casing placed to 5 feet.			
		Bentonite/ cement grout seal placed to 7 feet.		SP	**ALLUVIUM:** SAND, medium too fine, with fine gravel, dry, rounded, lt. brown. Note: Moist. Layer of reddish brown eolian sand at 8 ft.
10		Bentonite pellet seal installed from 7 to 9 feet.			Note: Very moist at 11 ft.
		Filter pack placed from 9 to 24 feet.		SP SP	SAND, fine, with frag. sandstone, lt. brown.
15		.010-in. slot well screen installed from 12 to 22 feet.			**SHINARUMP MEM., CHINLE FM.** SANDSTONE, yellowish brown to white.
20		Blank sump placed from 22 to 24 feet.			
25					TD AT 24 FEET.
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
18.5	12:00	2-15-85
13.8	15:10	4-7-86

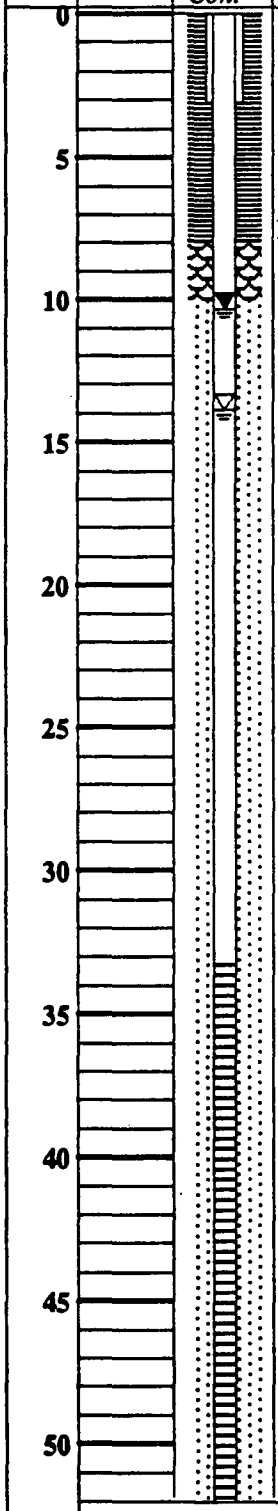
JEG TAC TEAM

LOG OF WELL BORING NO. 603

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 **DATE** 10/24/84

SURFACE ELEVATION	4846.64	TOTAL DEPTH	55.0 feet
TOP OF FILTER PACK	10.00	RIG TYPE	CME-75
WELL CASING TYPE	2.0-IN.SCHED.40 PVC	BORING TYPE	HS AUGER
COMPLETION	ALLUVIUM	LOCATION	N 57812.70 E 89036.90
		DATUM	MSL; GROUND SURFACE



Depth	Remarks	USCS	Visual Classification
0	Installed 2-in PVC well to 55 feet	SM	EOLIAN: SILTY SAND, fine, lt. reddish brown.
		SP	SAND, medium to fine lt reddish brown.
5	Protective steel casing placed to 3 feet.		
	Bentonite/ cement grout seal placed to 8 feet.		
10	Bentonite pellet seal installed from 8 to 10 feet.	CL	ALLUVIUM: CLAY, high plasticity, stiff, brown.
		SP	EOLIAN: SAND, fine. Note: Wet at 10.5 feet. Note: Water table at 11.5 feet.
15	Filter pack of caved eolian sand from 10 to 55 feet.		
20			
25			Note: trace of fine gravel at 27 feet.
30			
35	.010-in. slot well screen installed from 33 to 53 feet.		
40			
45			
50			

GROUNDWATER

	DEPTH	HOUR	DATE
▽	13.9	12:00	2-15-85
▼	10.3	11:46	4-6-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 603

JOB NO. MON01 DATE 10/24/84

SURFACE ELEVATION 4846.64

TOP OF FILTER PACK 10.00

WELL CASING TYPE 2.0-IN. SCHED. 40 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 55.0 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 57812.70 E 89036.90

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
			Blank sump placed from 53 to 55 feet.			
55						TD AT 55 FEET.
60						
65						
70						
75						
80						
85						
90						
95						
100						

GROUNDWATER

	DEPTH	HOUR	DATE
▽	13.9	12:00	2-15-85
▼	10.3	11:46	4-6-86

JEG TAC TEAM

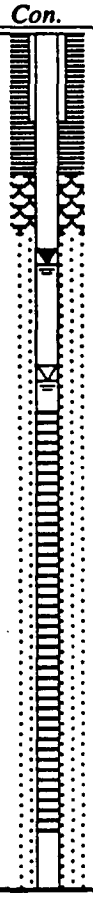
LOG OF WELL BORING NO. 604

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 **DATE** 10/25/84

SURFACE ELEVATION 4837.30
TOP OF FILTER PACK 7.00
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 30.0 feet
RIG TYPE CME-75
BORING TYPE HS AUGER
LOCATION N 58397.00 E 89424.60
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 30 feet		SP	**EOLIAN:** SAND, fine, little silt, lt. dry, reddish brown.
5		Protective steel casing placed to 3 feet.			
		Bentonite/ cement grout seal placed to 5 feet.			
10		Bentonite pellet seal installed from 5 to 7 feet.			Note: water table encountered at 11.5 feet.
15		Filter pack of caved eolian sand from 7 to 30 feet.			
20		.010-in. slot well screen installed from 13 to 28 feet.			Note: change to lt. brown, no silt.
25					
		Blank sump placed from 28 to 30 feet.		SP	**ALLUVIUM:** SANDY CLAY, medium plasticity, soft, wet, grey.
30					TD AT 30 FEET.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
12.2	12:00	2-15-85
8.1	10:44	4-6-86

JEG TAC TEAM

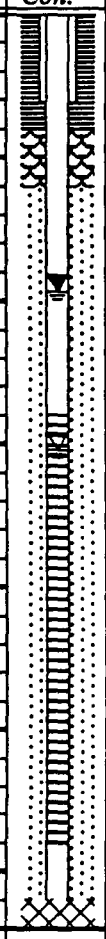
LOG OF WELL BORING NO. 605

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 **DATE** 10/25/84

SURFACE ELEVATION 4831.42
TOP OF FILTER PACK 6.00
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 32.0 feet
RIG TYPE CME-75
BORING TYPE HS AUGER
LOCATION N 58707.60 E 90066.70
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 31 feet		SP	**EOLIAN:** SAND, fine, dry, loose, non-plastic, lt. reddish brown. Note: medium to fine grained from 3 feet.
5		Protective steel casing placed to 3 feet.			
		Bentonite/ cement grout seal placed to 4 feet.			
10		Bentonite pellet seal installed from 4 to 6 feet.			Note: Water table encountered at 13 feet.
15		Filter pack of caved eolian sand from 6 to 32 feet.			
20		.010-in. slot well screen installed from 14 to 29 feet.			
25		Blank sump placed from 29 to 31 feet.			
30					Note: Color change to grey, some clay at 31 feet.
					TD AT 32 FEET.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
15.2	12:00	2-15-85
9.7	12:55	4-5-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 606

JOB NO. MON01 **DATE** 10/26/84

SURFACE ELEVATION 4860.44
TOP OF FILTER PACK 31.00
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 47.0 feet
RIG TYPE CME-75
BORING TYPE HS AUGER
LOCATION N 59034.20 E 88634.00
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 47 feet		SM	EOLIAN: SILTY SAND, fine, slightly moist to dry, lt. reddish brown.
		Protective steel casing placed to 3 feet.		SP	SAND, fine, medium dense, lt. reddish brown.
5		Bentonite/ cement grout seal placed to 4 feet.			
10		Bentonite/ cuttings mix fill from 4 to 27.			
15					
20				SM	SILTY SAND, med. dense, lt. reddish brown.
25		Cave-in fill from 27 to 29 ft.			
30		Bentonite pellet seal installed from 29 to 31 feet.			Note: Moist at 30 feet.
35		Filter pack of caved eolian sand from 31 to 47 feet. .010-in. slot well screen installed from 32 to 42 feet.			Note: Water table encountered at 36 feet.
40		Blank sump placed from 42 to 47 feet.			
45				SP	SHINARUMP MEM., CHINLE FM.: SANDSTONE, soft, weathered.
					TD AT 47 FEET.
50					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	35.2	12:00	3-7-85
▼	35.0	15:15	4-5-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 607

JOB NO. MON01 DATE 10/26/84

SURFACE ELEVATION 4869.41

TOP OF FILTER PACK 11.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 30.0 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 59657.20 E 87519.20

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 27.5 feet		SM	EOLIAN: SILTY SAND, fine, moist, lt. reddish brown.
		Protective steel casing placed to 3 feet.			
5		Bentonite/ cement grout seal placed to 4 feet.			
		Bentonite/ cuttings mix fill from 4 to 8.		SP	SHINARUMP MEM., CHINLE FM.: SANDSTONE, lt. brown to yellow.
10		Bentonite pellet seal installed from 8 to 11 feet.			Note: Color change to lt. yellow to grey.
15		Filter pack of crusher chips from 11 to 27.5 feet.			Note; Color change to yellow brown.
20		.010-in. slot well screen installed from 15.5 to 25.5 feet.			
25		Blank sump placed from 25.5 to 27.5 feet.			
30		Cave-in fill from 27.5 to 30 feet.			TD AT 30 FEET.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	DRY	2-15-85
	DRY	4-6-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 608

JOB NO. MON01 **DATE** 03/15/85

SURFACE ELEVATION 4901.08
TOP OF FILTER PACK 88.00
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 120.0 feet
RIG TYPE CME-75
BORING TYPE HS AUGER
LOCATION N 58685.70 E 87189.40
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 120 feet		SP	SHINARUMP MEM.; CHINLE FM.: SANDSTONE, med. to coarse, yellowish grey.
5		Protective steel casing placed to 3 feet.			
		Bentonite/ cement grout seal placed to 86 feet.			
10				CL SP	SHALE, with fine sand, thnly laminated.
					SANDSTONE, medium to coarse, mod. well cemented,noncalcareous, occasional clayey matrix, mostly cross bedded, yellowish grey (5YR,5/4).
15		SEE LOG 608C FOR RESULTS OF CORING.			
20					
25					
				GP	CONGLOMERATE, coarse sand to med. gravel, subrrounded, some clay matrix, sufficient porosity to lose circulation, medium yellowish brown (10YR,5/4).
30					
				CL ML	MOENKOPI FORMATION: SHALE, with coarse sand, to silty, poorly indurated, very thinnly laminated, greyish orange (10YR,7/4).
35					SILTSTONE, with very fine sand, occasional thin calcite stringers as fracture fillings, noncalcareous, thinly laminated, very hard, yellowish grey (5Y,7/2). Note: with inter bedded greyish orange from 34 feet. Some pyrite in the matrix.
40					
				ML	Note: color change to reddish brown (10R,4/6) from 39 feet.
45					SILTSTONE, dark reddish brown.
50					

GROUNDWATER

DEPTH	HOUR	DATE
58.4	16:31	4-23-85
57.6	15:00	4-7-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 608

JOB NO. MON01 DATE 03/15/85

SURFACE ELEVATION 4901.08

TOP OF FILTER PACK 88.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 120.0 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 58685.70 E 87189.40

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
					MOENKOPI FM., Continued. Note: Becomes soft, more moist, from 54 feet.
55				ML SM	SILTSTONE AND SANDSTONE, interbedded, yellowish grey.
60					
65					Note: Increase in sand, sandstone is lt. grey.
70					Note: less siltstone interbeds from 72 ft.
75				SW	SANDSTONE, coarse to fine, dark reddish brown.
80					Note: Color change to very lt. grey, massive, from 78 ft. Note: Alternating color bands from very lt. grey to pale red from 80 ft.
85		Bentonite pellet seal installed from 86 to 88 feet.			
90		Filter pack sand from 88 to 120 feet.		SP	**DeCHELLY SANDSTONE MEM., CUTLER FORMATION:** SANDSTONE, coarse to med., dune deposit, cross bedded, lt. brown to med. reddish brown (10R,4/6). Note: Lost circulation at 91 ft. due to porosity of this formation.
95					
100		.010-in. slot well screen installed from 98 to 118 feet.			

GROUNDWATER

DEPTH	HOUR	DATE
58.4	16:31	4-23-85
57.6	15:00	4-7-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 608

JOB NO. MON01 DATE 03/15/85

SURFACE ELEVATION 4901.08

TOP OF FILTER PACK 88.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 120.0 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 58685.70 E 87189.40

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					Note: color change to variable lt. brown and greyish orange.
		Blank sump placed from 118 to 120 feet.			
120		Core hole reamed with rotary/Revert mud to 120 ft.			TD AT 120 FEET.
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	58.4	16:31	4-23-85
▼	57.6	15:00	4-7-86

JEG TAC TEAM

LOG OF WELL BORING NO. 609

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 **DATE** 01/03/85

SURFACE ELEVATION 4878.30

TOP OF FILTER PACK 6.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION ALLUVIUM/SHINARUMP MEM.

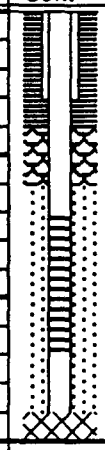
TOTAL DEPTH 15.0 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 59052.10 E 87652.90

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 14 feet Protective steel casing placed to 3 feet. Bentonite/ cement grout seal placed to 4 feet. Bentonite pellet seal installed from 4 to 6 feet. Filter pack sand from 6 to 14 feet.		SP	**EOLIAN:** SAND, fine, slightly moist, med. dense, lt. reddish brown.
5					
10				SW	**SHINARUMP MEM. CHINLE FM.:** SANDSTONE, coarse to fine, dry, yellowish olive green.
15		.010-in. slot well screen installed from 7 to 12 feet. Blank sump placed from 12 to 14 feet. Cave-in fill from 14 to 15 ft.			TD AT 15 FEET.
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	DRY	2-15-85
	DRY	4-6-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 610

JOB NO. MON01 DATE 12/03/84

SURFACE ELEVATION 4860.83

TOP OF FILTER PACK 63.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION SHINARUMP MEM.

TOTAL DEPTH 130.5 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 56338.80 E 88611.60

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 85.5 feet		SP	**EOLIAN:** SAND, fine, dry, med. dense, lt. reddish brown (5YR,5/3,5/4).
5		Protective steel casing placed to 5 feet.			Note: Very Moist at 6 feet.
					Note: Water table encoountered at 8 feet.
10		Bentonite/ cement grout seal placed to 58 feet.			
15					
20		SEE LOG 610C FOR RESULTS OF CORING.			
25					
30					
				SP	**SHINARUMP MEM., CHINLE FM.:** SANDSTONE, med. grain. mod. hard, mod. weathered. thick bedding, brownish red.
35					
40					Note: Med. grey lens at 39 .5 to 40 feet.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
5.4	08:30	4-23-85
5.4	11:59	4-6-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 610

JOB NO. MON01 DATE 12/03/84

SURFACE ELEVATION 4860.83

TOP OF FILTER PACK 63.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION SHINARUMP MEM.

TOTAL DEPTH 130.5 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 56338.80 E 88611.60

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Note: Color change to dk. brown (10YR,8/4).
					SHINARUMP MEM., Continued.
60		Bentonite pellet seal installed from 58 to 63 feet.			Note: Occasional clast of siltstone.
65		Filter pack sand from 63 to 85.5 feet.			
		.010-in. slot well screen installed from 63 to 83 feet.			
70					
				CL	SHALE, yellowish brown to grey.
75				SP CL	SANDSTONE, very fine grained, grey; With thin interbedded lenses of grey shale.
				SP	SANDSTONE, very fine, greyish white.
80					
		Blank sump placed from 83 to 85 feet.			
85		Cave-in fill from 85 to 130.5 ft when reamed.		SW CL	CONGLOMERATE, with fine to coarse gravel, well cemented.
					SHALE, lt. grey.
90				CL	MOENKOPI FORMATION: SHALE, reddish brown.
95		Hole cored to 130.5 feet, then reamed for well installation to 87 feet.(No record of seal for sandstone unit at 115 feet so that water levels / quality could show Moenkopi influence)			
100					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	5.4	08:30	4-23-85
▼	5.4	11:59	4-6-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 610

JOB NO. MON01 DATE 12/03/84

SURFACE ELEVATION 4860.83

TOP OF FILTER PACK 63.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION SHINARUMP MEM.

TOTAL DEPTH 130.5 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 56338.80 E 88611.60

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	105					
	110					
	115				SP	SANDSTONE, very fine, well cemented, reddish brown.
	120					Note: Becomes moderately cemented at 120.5 feet. Note: thin shale bed, reddish brown at 122 feet.
	125					
	130					TD AT 130.5 FEET.
	135					
	140					
	145					
	150					
	155					

GROUNDWATER

DEPTH	HOUR	DATE
5.4	08:30	4-23-85
5.4	11:59	4-6-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 611

JOB NO. MON01 DATE 03/05/85

SURFACE ELEVATION 4846.35

TOP OF FILTER PACK:

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 185.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 57811.00 E 89017.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 185 feet		SP	EOLIAN:
5		Protective steel casing placed to 63 feet.			
10		SEE LOG 611C FOR RESULTS OF CORING			
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
10.7	12:45	6-7-89

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 611

JOB NO. MON01 DATE 03/05/85

SURFACE ELEVATION 4846.35

TOP OF FILTER PACK

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 185.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 57811.00 E 89017.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55, 60					
65		Est.)Bentonite/ cement grout seal placed to 156 feet.		SP	SHINARUMP MEM., CHINLE FM. SANDSTONE, fine to med, with conglomeritic layers, soft, with hematite and limonite stain, lt. grey to yellow to orange.
70, 75					
80					Note: Less altered in fractures, less weathered, becomes mod. soft.
85					Note: Uniform grain size fine to medium, no conglomeritic layers. Sericite mica on fracture planes. Becomes mod. hard from 85 feet.
90					
95					Note: Occasional carbonaceous material, from 90 feet.
100					
				SP SC	SANDSTONE, coarse to fine, with pyrite, some coal, soft, greenish grey.

GROUNDWATER

DEPTH	HOUR	DATE
10.7	12:45	6-7-89

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 611

JOB NO. MON01 DATE 03/05/85

SURFACE ELEVATION 4846.35

TOP OF FILTER PACK

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 185.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 57811.00 E 89017.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105				SP	SANDSTONE, shaley (indicated by geophy. log). Note: core not recovered from this zone.
110				ML	SANDSTONE, with conglomeritic zones, pyrite common, slightly calcareous, lt. green to grey. Note: Basal portion of Shinarump Member at 108 ft. as evidenced by pebbly chert conglomerate, rounded.
115				CL	MOENKOPI FM.: SILTSTONE, greenish grey, very clayey, slightly calcareous, soft, greenish grey to 112, variable yellow grey to dark reddish brown.
120					CLAYSTONE, silty, with interbeds of siltstone, cross laminated, calcareous, mod. soft to mod. hard, dark reddish brown. Note: artesian flow encountered as claystone aquitard penetrated.
125				ML	
				CL	SILTSTONE, clayey, with minor nonclayey lenses, reddish brown.
130				SP	SANDSTONE, very fine, lt. grey, with interbeds of reddish brown claystone; calcareous, mod. soft to mod hard.
				ML	SILTSTONE, clayey, hard, mottled red-brown to lt. grey.
135				SP	SANDSTONE, fine to med. clayey, calcareous, pinkish brown to greenish grey. Occasional variable seams of reddish brown to bleached.
140					Note: Mottled at 143, hard.
145					Note: Becoming coarser from 145 ft., calcareous.
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
10.7	12:45	6-7-89

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 611

JOB NO. MON01 DATE 03/05/85

SURFACE ELEVATION 4846.35

TOP OF FILTER PACK

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 185.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 57811.00 E 89017.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
		Est.)Bentonite pellet seal installed from 156 to 160 feet.		SP	DeCHELLY MEM.,CUTLER FM: SANDSTONE, fine, cross bedded, mod. soft, reddish brown.
160		Est.)Filter pack sand from 160 to 185 feet.			
165		Est.).010-in. slot well screen installed from 163 to 183 feet.			
170					
175					
180		Est.)Blank sump placed from 183 to 185 feet.			
185					TD AT 185 FEET.
190					
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE
10.7	12:45	6-7-89

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 612

JOB NO. MON01 DATE 02/21/85

SURFACE ELEVATION 5000.09

TOP OF FILTER PACK 43.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 58437.20 E 85614.80

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 215 feet		SP	**SHINARUMP MEM., CHINLE FM.:** SANDSTONE, little clay fraction, medium to coarse, friable, thinnly bedded, mod. spaced fractures, lt. yellowish brown, to yellowish grey(10YR-6/2;5Y-7/2). Note: Occasional lenses to 5-in. of dk. grey shale,
5		Protective steel casing placed to 5 feet.			
10		Bentonite/ cement grout seal placed to 41 feet.			Note: pinkish, with limonite stains on fractures, well cemented, calcareous, cross bedded; from 11 feet.
15				GP	CONGLOMERATE: coarse sand to 1-in. pebbles. subangular to subrounded, cemented, slightly calcareous, massive bedded, light grey (N7).
20		(SEE LOG 612C FOR ROCK CORE RESULTS) Cored to 208 ft., then reamed hole to 215 for well inst.		SP	Note: Possible fault/shear plane at 16.5 ft. SANDSTONE, very fine, very well cemented, slightly calcareous, 2-6-in. beds. ripple laminations, alternating layers of yellowish grey to lt. grey.
25				ML	**MOENKOPI FORMATION:** SANDY SILTSTONE, with thin clayey lenses, clay binder, bioturbated layers, pale red to greyish red (10R-6/2; 10R-4/2).
30					
35				SP	SANDSTONE, very fine, well cemented, very calcareous, thin stratum cross bedded, slump structures, light grey (N7).
40		Bentonite pellet seal installed from 40.7 to 43 feet.		ML	SANDY SILTSTONE, little clay, cross bedded, thin contorted bedding, bioturbation, pale red to greyish red. Note: Medium to fine grained, limonite stained, from 41 ft.
45		No. 20 filter pack sand placed from 43 to 215 feet.		ML SM	SILTSTONE TO SILTY SANDSTONE, laminated to very thin laminated, rippled and cross bedded, bioturbation, minor sandstone lenses, greyish red.
50				ML	

GROUNDWATER

DEPTH	HOUR	DATE
	12:00	2-19-85
60.9	14:37	4-7-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 612

JOB NO. MON01 DATE 02/21/85

SURFACE ELEVATION 5000.09

TOP OF FILTER PACK 43.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 58437.20 E 85614.80

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55				ML SM	SANDY SILTSTONE, 50 % silt, 50% sand, cross bedded, very fine to fine sand, calcareous, greyish red. SILTSTONE, greyish red.
60					SILTY SANDSTONE, medium to fine, abundant black mineral grains, very limonite stained, well cemented, calcareous, intensly cross bedded, with clay clasts, greyish red. Note: becomes massive bedded at 63 ft, with bleached spots.
65					
70				SW	SANDSTONE, fine to coarse, arkosic with 50 % feldspar, very well cemented, very calcareous to noncalcareous, mostly massive with ripple and cross bedding, greyish orange-pink (5YR,7/2).
75					
80				SP	DeCHELLY SANDSTONE MEM.;CUTLER FORMATION: SANDSTONE, medium to fine, well cemented, slightly calcareous and ferric cement, cross bedded, isotropic porosity, pale red (10R,6/2).
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
	12:00	2-19-85
60.9	14:37	4-7-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 612

JOB NO. MON01 DATE 02/21/85

SURFACE ELEVATION 5000.09

TOP OF FILTER PACK 43.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 58437.20 E 85614.80

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105						**DeCHELLY SANDSTONE MEM.;CUTLER FM., Continued.**
110						
115						
120						
125						
130						
135						
140						
145						
150						
155						

GROUNDWATER

	DEPTH	HOUR	DATE
▽		12:00	2-19-85
▼	60.9	14:37	4-7-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 612

JOB NO. MON01 DATE 02/21/85

TOTAL DEPTH 215.0 feet

SURFACE ELEVATION 5000.09

RIG TYPE CME-75

TOP OF FILTER PACK 43.00

BORING TYPE CORE/ ROTARY

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

LOCATION N 58437.20 E 85614.80

COMPLETION DeCHELLY MEM.

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
					DeCHELLY SANDSTONE MEM., continued.
160					
165					Note: Color changes to dark red, fine grained, better cementation, from 166 ft.
170					
175					
180					
185					
190					
195		.010-in. slot well screen installed from 195 to 205 feet.			
200					
205		Blank sump placed from 205 to 215 feet.			DeCHELLY SANDSTONE MEM.,

GROUNDWATER

DEPTH	HOUR	DATE
	12:00	2-19-85
60.9	14:37	4-7-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 612

JOB NO. MON01 DATE 02/21/85

SURFACE ELEVATION 5000.09

TOP OF FILTER PACK 43.00

WELL CASING TYPE 2.0-IN. SCHED. 40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 58437.20 E 85614.80

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210						Continued.
215			Core hole reamed to 215 feet for well installation.			TD AT 215 FEET.
220						
225						
230						
235						
240						
245						
250						
255						
260						

GROUNDWATER

DEPTH	HOUR	DATE
	12:00	2-19-85
60.9	14:37	4-7-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 613

JOB NO. MON01 DATE 03/05/85

SURFACE ELEVATION 4860.81

TOP OF FILTER PACK 136.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 160.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 56377.80 E 88643.70

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 160 feet		SP	**EOLIAN:** SAND, fine. lt. reddish brown to tan.
5		Protective steel casing placed to 5 feet.			
10		Bentonite/ cement grout seal placed to 134 feet.			
15		Cored to 144.7 feet. then reamed to 160 feet for well inst.			
20		(See log 613C for results of coring).			
25		SEE LOG 613C FOR RESULTS OF CORING.			
30					
35				SP	**SHINARUMP MEM., CHINLE FM.:** SANDSTONE, medium to coarse grained. See log of nearby well 610 for description of materials to 78 feet. Not recorded for this hole.
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
0.0	FLOWING	2-19-85
5.2	12:00	2-26-92

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 613

JOB NO. MON01 DATE 03/05/85

SURFACE ELEVATION 4860.81

TOP OF FILTER PACK 136.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 160.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 56377.80 E 88643.70

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**SHINARUMP MEM.,Continued.**
60					
65					
70					
75					
				SP	Note: No log until coring commenced at 77.8 feet. SANDSTONE, fine to medium grained, cross bedded with hematite and limonite common, noncalcareous, lt. grey to yellowish brown.
80					
85					Note: Thin seam of black chert pebble cong. at base of Shinarump mem.
				CL	**MOENKOPI FORMATION:** CLAYSTONE, with finely disseminated pyrite, reduction environment, mod. spaced fractures, slightly calcareous, greenish grey. Note: Color change to reddish brown, closely spaced fractures.
90					
95				ML	Note: Color change to dark brown, becomes micaceous, closely spaced fractures, with minor seams of lt. orange micaceous sandstone.
				CL	
				CL	
100					SILTSTONE AND CLAY STONE, interbedded, calcareous, lt. grey to dk. brown.
					CLAYSTONE, with minor interbeds of siltstone, dk. brown.

GROUNDWATER

DEPTH	HOUR	DATE
0.0	FLOWING	2-19-85
5.2	12:00	2-26-92

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ.

LOG OF WELL BORING NO. 613

JOB NO. MON01, DATE 03/05/85

SURFACE ELEVATION 4860.81

TOP OF FILTER PACK 136.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 160.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 56377.80 E 88643.70

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					Note: One foot layer of sandstone at 100 feet. Note: Closely space fractures at 103 feet.
				SP	Note: Thin seam of sandstone at 103 feet and at 104.5 ft..
110				CL	MOENKOPI,Continued. CLAYSTONE/SANDSTONE, interbedded, mottled dark brown and lt grey respectively.
115				SP	Note: Intensly fractured at 110 to 111 feet. Artesian flow from borehole, 1.6 gpm, during drilling.
120					SANDSTONE, fine to coarse, trace to little clay, calcareous, dk. brown to pinkish white. Note: Color change to pale yellow at 120 ft.
125					Note: Color change to dark brown with varying amounts of clay/shale seams from 122 feet. Note: Color change to reddish brown, clean, friable, calcareous from 125 feet.
130				SP	DeCHELLY SANDSTONE MEM.,CUTLER FM. (Probable contact) SANDSTONE, fine to very fine, cross bedded, with limonite cementation, yellowish brown. Note: Color change to tan.
135		Bentonite pellet seal installed from 134 to 136 feet.			
140		No. 20 filter pack sand placed from 136 to 160 feet.			
145		.010-in. slot well screen installed from 138 to 158 feet.			TD AT 144.7 FEET. Artesian flow at 2.0 gpm at completion of drilling. Packer set at 130.3 feet had 5 gpm flowing through pipe.
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
0.0	FLOWING	2-19-85
5.2	12:00	2-26-92

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 613

JOB NO. MON01 DATE 03/05/85

SURFACE ELEVATION 4860.81

TOP OF FILTER PACK 136.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION DeCHELLY MEM.

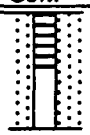
TOTAL DEPTH 160.0 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 56377.80 E 88643.70

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
			Blank sump placed from 158 to 160 feet.			
160						
165						
170						
175						
180						
185						
190						
195						
200						
205						

GROUNDWATER

DEPTH	HOUR	DATE
0.0	FLOWING	2-19-85
5.2	12:00	2-26-92

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 614

JOB NO. MON01 DATE 03/04/85

SURFACE ELEVATION 4854.28

TOP OF FILTER PACK 43.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION MOENKOPI FM.

TOTAL DEPTH 84.5 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 60940.50 E 87832.60

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in PVC well to 70 feet		SP SM	EOLIAN: SAND, fine, brown.
5		Protective steel casing placed to 5 feet.			
10		Bentonite/ cement grout seal placed to 40.9 feet.			
15					
20					
25					
30					
35					
40		Bentonite pellet seal installed from 40.9 to 43.1 feet.			
45		No. 20 filter pack sand placed from 43.1 to 70 feet.			
50		.010-in. slot well screen installed from 48 to 68 feet.		SP	SHINARUMP MEM., CHINLE FM: SANDSTONE, fine to medium grained, well cemented, noncalcareous, massive with occ.

GROUNDWATER

DEPTH	HOUR	DATE
48.3	12:00	3-7-85
49.7	10:15	4-5-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 614

JOB NO. MON01 DATE 03/04/85

SURFACE ELEVATION 4854.28

TOP OF FILTER PACK 43.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION MOENKOPI FM.

TOTAL DEPTH 84.5 feet

RIG TYPE CME-75

BORING TYPE CORE/ ROTARY

LOCATION N 60940.50 E 87832.60

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55, 60, 65					traces of cross bedding, limonite stains, good porosity, lt. grey to dark greyish orange. Note: Cross bedding becoming more prominent. Note: large clast of grey claystone.
70		Blank sump placed from 68 to 70 feet. Cave-in fill from 70 to 84.5 feet.		SW GP	CONGLOMERATE, fine sand to pebbles, subangular to subrounded, well cemented, noncalcareous, cross bedded, porous, pale yellowish brown 910YR,6/2).
75				CL	MOENKOPI FORMATION: CLAYSTONE, with siltstone interbeds, altered, bleached, micaceous with diseminated pyrite, brownish yellow.
80				ML	SILTSTONE, with interbedded sandstone seams (15%), firmly cemented to friable, ripple laminations, occasional clay lenses, yellowish brown.
85, 90, 95, 100					TD AT 84.5 FEET.

GROUNDWATER

DEPTH	HOUR	DATE
48.3	12:00	3-7-85
49.7	10:15	4-5-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 650

JOB NO. MON01 **DATE** 09/30/85

SURFACE ELEVATION 4790.15
TOP OF FILTER PACK 73.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 104.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 64970.00 E 89923.80
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 100 feet		SP SM	**EOLIAN:** SAND, silty, fine to medium, nonplastic, lt. reddish brown.
5		Steel surface casing placed to 20 feet.			
10		Bentonite/ cement grout seal placed to 68 feet.			
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
19.3	12:00	10-19-85
19.2	09:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 650

JOB NO. MON01 DATE 09/30/85

SURFACE ELEVATION 4790.15

TOP OF FILTER PACK 73.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 104.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 64970.00 E 89923.80

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					EOLIAN DEPOSIT, Continued.
60					
65					
70		Bentonite pellet seal installed from 68 to 73 feet.			
75		No.8-12 filter pack sand placed from 73 to 99.5 feet.			
80		.051-in. slot well screen installed from 78 to 98 feet.			
85					
90					
95		Blank sump placed from 98 to 100 feet.			
100		Cave-in fill from 100 to 104 feet.		SP	SHINARUMP MEM., CHINLE FM.: SANDSTONE, soft, red.

GROUNDWATER

	DEPTH	HOUR	DATE
▽	19.3	12:00	10-19-85
▼	19.2	09:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 650

JOB NO. MON01 DATE 09/30/85

SURFACE ELEVATION 4790.15

TOP OF FILTER PACK 73.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 104.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 64970.00 E 89923.80

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105						TD AT 104 FEET.
110						
115						
120						
125						
130						
135						
140						
145						
150						
155						

GROUNDWATER

	DEPTH	HOUR	DATE
▽	19.3	12:00	10-19-85
▼	19.2	09:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 651

JOB NO. MON01 **DATE** 09/29/85

SURFACE ELEVATION 4781.46
TOP OF FILTER PACK 17.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 82.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 63788.90 E 92734.30
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 82 feet		SP SM	**EOLIAN:** SAND, some silt, fine to medium, nonplastic, lt. reddish brown.
5		Steel surface casing placed to 13 feet.			
10					
15		Bentonite/ cement grout seal placed to 13 feet.			
20		Bentonite pellet seal installed from 13 to 17 feet.			
25		No.8-12 filter pack sand placed from 17 to 82 feet.			
30		.051-in. slot well screen installed from 20 to 80 feet.			
35					
40					
				CL	**ALLUVIUM:** SANDY CLAY, low plasticity, tan.
45				SP SM	**EOLIAN:** SAND, some silt, fine to medium, nonplastic, lt. reddish brown.
50					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	5.8	12:00	10-19-85
▼	8.1	13:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 651

JOB NO. MON01 DATE 09/29/85

SURFACE ELEVATION 4781.46

TOP OF FILTER PACK 17.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 82.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 63788.90 E 92734.30

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70				CL	ALLUVIUM: SANDY CLAY, low plasticity, tan to lt. brown.
75					
80		Blank sump placed from 80 to 82 feet.			
					TD AT 82 FEET.
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
5.8	12:00	10-19-85
8.1	13:00	4-29-86

JEG TAC TEAM

LOG OF WELL BORING NO. 652

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 **DATE** 09/29/85

SURFACE ELEVATION 4800.69
TOP OF FILTER PACK 29.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 58.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 62581.50 E 93759.30
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 56 feet		SP SM	EOLIAN: SAND, some silt, fine to medium, nonplastic, lt. reddish brown.
5					
10					
15					
20		Steel surface casing placed to 20 feet.			
25		Bentonite/ cement grout seal placed to 25 feet.			
30		Bentonite pellet seal installed from 25 to 29 feet.			
35		No.8-12 filter pack sand placed from 29 to 56 feet.			
40		.051-in. slot well screen installed from 34 to 54 feet.			
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
19.0	12:00	10-19-85
18.6	12:30	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 652

JOB NO. MON01 DATE 09/29/85

SURFACE ELEVATION 4800.69

TOP OF FILTER PACK 29.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 58.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 62581.50 E 93759.30

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	55		Blank sump placed from 54 to 56 feet.			EOLIAN,Continued.
			Cave-in from 56 to 58 feet when hole reamed.		SP	SHINARUMP MEM., CHINLE FM.: SANDSTONE, soft, lt. red.
	60					TD AT 58 FEET.
	65					
	70					
	75					
	80					
	85					
	90					
	95					
	100					

GROUNDWATER

DEPTH	HOUR	DATE
19.0	12:00	10-19-85
18.6	12:30	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 653

JOB NO. MON01 DATE 09/25/85

SURFACE ELEVATION 4832.14

TOP OF FILTER PACK 50.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 78.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61249.30 E 89596.30

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 78 feet		SP SM	EOLIAN: SAND, some silt, lt. reddish brown. Note: undifferentiated to total depth.
5					
10					
15					
20		Steel surface casing placed to 22 feet.			
25					
30					
35					
40					
45		Bentonite/ cement grout seal placed to 45 feet.			
50		Bentonite pellet seal installed from 45 to 50 feet.			

GROUNDWATER

DEPTH	HOUR	DATE
35.6		10-19-85

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 653

JOB NO. MON01 DATE 09/25/85

SURFACE ELEVATION 4832.14

TOP OF FILTER PACK 50.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 78.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61249.30 E 89596.30

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		No.8-12 filter pack sand placed from 50 to 78 feet.			**EOLIAN DEPOSITS, continued.**
60		.051-in. slot well screen installed from 56 to 76 feet.			
65					
70					
75		Blank sump placed from 76 to 78 feet.			
80					**TD AT 78 FEET.** Note: Caving badly to TD.
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
35.6		10-19-85

JEG TAC TEAM

LOG OF WELL BORING NO. 654

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 DATE 09/27/85

SURFACE ELEVATION 4824.41

TOP OF FILTER PACK 47.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 79.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59351.40 E 91063.40

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 79 feet		SP SM	EOLIAN: SAND, some silt, lt. reddish brown. Note: undifferentiated to total depth.
5					
10					
15					
20		Steel surface casing placed to 20 feet.			
25					
30					
35					
40					
45		Bentonite/ cement grout seal placed to 47 feet.			
50		Bentonite pellet seal installed from 47 to 51 feet.			

GROUNDWATER

DEPTH	HOUR	DATE
1.7		10-19-85
1.2	10:28	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 654

JOB NO. MON01 DATE 09/27/85

SURFACE ELEVATION 4824.41

TOP OF FILTER PACK 47.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 79.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59351.40 E 91063.40

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		No.8-12 filter pack sand placed from 51 to 79 feet.			**EOLIAN DEPOSITS, continued.**
60		.051-in. slot well screen installed from 57 to 77 feet.			
65					
70					
75		Blank sump placed from 77 to 79 feet.			
80					**TD AT 79 FEET.** Note: Caving badly to TD.
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
1.7		10-19-85
1.2	10:28	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 655

JOB NO. MON01 DATE 09/12/85

SURFACE ELEVATION 4857.73

TOP OF FILTER PACK 33.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 60.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59754.60 E 88624.10

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 60 feet		SP SM	EOLIAN: SAND, some silt, lt. reddish brown. Note: undifferentiated to total depth.
5					
10					
15					
20		Steel surface casing placed to 21 feet.			
25					
30		Bentonite/ cement grout seal placed to 30 feet.			
35		Bentonite pellet seal installed from 30 to 33 feet.			
40		No.8-12 filter pack sand placed from 33 to 60 feet.			
45		.051-in. slot well screen installed from 38 to 58 feet.			
50					

GROUNDWATER

DEPTH	HOUR	DATE
39.2		10-;9-85
38.8	09:45	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 655

JOB NO. MON01 DATE 09/12/85

SURFACE ELEVATION 4857.73

TOP OF FILTER PACK 33.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

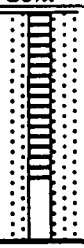
TOTAL DEPTH 60.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59754.60 E 88624.10

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Blank sump placed from 58 to 60 feet.			**EOLIAN DEPOSITS, continued.**
60					**TD AT 60 FEET.** **Note: Caving badly to TD.**
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
39.2		10-19-85
38.8	09:45	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 656

JOB NO. MON01 DATE 09/12/85

SURFACE ELEVATION 4852.07

TOP OF FILTER PACK 33.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 60.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59545.20 E 89175.10

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 60 feet		SP SM	EOLIAN: SAND, some silt, lt. reddish brown. Note: undifferentiated to total depth.
5					
10					
15					
20		Steel surface casing placed to 21 feet.			
25					
30		Bentonite/ cement grout seal placed to 30 feet.			
35		Bentonite pellet seal installed from 30 to 33 feet.			
40		No.8-12 filter pack sand placed from 33 to 60 feet.			
45		.051-in. slot well screen installed from 38 to 58 feet.			
50					

GROUNDWATER

DEPTH	HOUR	DATE
36.0		10-19-85
35.5	12:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 656

JOB NO. MON01 DATE 09/12/85

SURFACE ELEVATION 4852.07

TOP OF FILTER PACK 33.00

WELL CASING TYPE 4.0-IN. SCHED. 80 PVC

COMPLETION ALLUVIUM

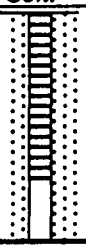
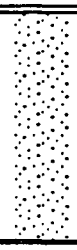
TOTAL DEPTH 60.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59545.20 E 89175.10

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Blank sump placed from 58 to 60 feet.			**EOLIAN DEPOSITS, continued.**
60					**TD AT 60 FEET.** **Note: Caving badly to TD.**
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
36.0		10-19-85
35.5	12:00	4-29-86

JEG TAC TEAM

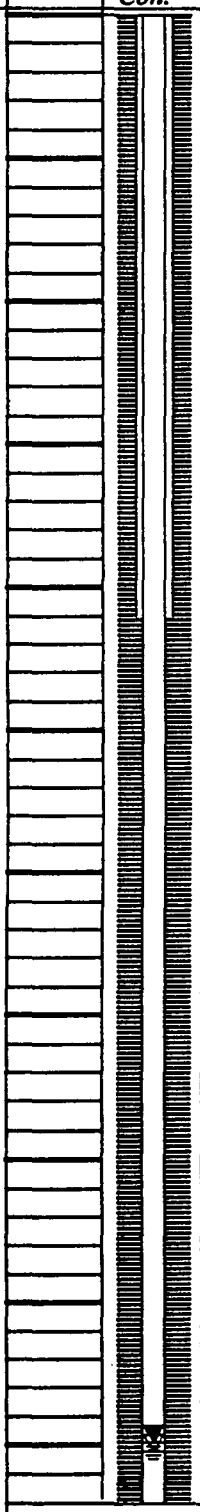
LOG OF WELL BORING NO. 657

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 **DATE** 09/04/85

SURFACE ELEVATION 4881.18
TOP OF FILTER PACK 118.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 140.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 59266.00 E 87596.50
DATUM MSL; GROUND SURFACE



Depth	Remarks	USCS	Visual Classification
0	Installed 4-in PVC well to 138 feet	SP SM	**EOLIAN:** SAND, some silt, lt. reddish brown. Note: undifferentiated to total depth.
5		SW	**ALLUVIUM:** GRAVELLY SAND, medium to coarse sand, with fine gravel, lt. reddish brown.
10			**EOLIAN:** SAND, some silt, lt. reddish brown.
15			
20	Steel surface casing placed to 21 feet.	SP SM	Note: Occasional pebbles indicating some lenses of reworked alluvial deposits from 20 to 35 feet
25			
30	Bentonite/ cement grout seal placed to 113 feet.		
35			
40		SW	**ALLUVIUM:** GRAVELLY SAND, with interbeds of eolian sand, tan.
45			
50			

GROUNDWATER

DEPTH	HOUR	DATE
50.2		10-19-85
49.9	11:35	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 657

JOB NO. MON01 DATE 09/04/85

SURFACE ELEVATION 4881.18

TOP OF FILTER PACK 118.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 140.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59266.00 E 87596.50

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	55					**EOLIAN DEPOSITS, continued.**
	60					
	65					
	70					
	75					
	80					
	85					
	90					
	95					
	100				GP	**SANDY GRAVEL, coarse sand.**
						ALLUVIUM, continued.

GROUNDWATER

	DEPTH	HOUR	DATE
▽	50.2		10-19-85
▼	49.9	11:35	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 657

JOB NO. MON01 DATE 09/04/85

SURFACE ELEVATION 4881.18

TOP OF FILTER PACK 118.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 140.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59266.00 E 87596.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105				SP SM	**EOLIAN:** **SAND, fine to medium, lt. reddish brown.**
110				GP	**ALLUVIUM:** **SANDY GRAVEL, with fragments of Moenkopi Formation.**
115		**Bentonite pellet seal installed from 113 to 118 feet.**			
120		**No.8-12 filter pack sand placed from 118 to 138 feet.** **.051-in. slot well screen installed from 121 to 136 feet.**		SP	**DeCHELLY SANDSTONE MEM., CUTLER FM.** **SANDSTONE, lt. brn to med. reddish brown.**
125					
130					
135		**Blank sump placed from 136 to 138 feet.** **Cave-in fill from 138 to 140 feet.**			
140					**TD AT 140 FEET.**
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
50.2		10-19-85
49.9	11:35	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 658

JOB NO. MON01 **DATE** 09/26/85

SURFACE ELEVATION 4876.19
TOP OF FILTER PACK 114.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION ALLUVIUM

TOTAL DEPTH 165.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 54763.40 E 88857.00
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 157 feet		SP SM	**EOLIAN DEPOSITS:** SAND, medium to fine, little silt, reddish brown.
5					Note: Undifferentiated dune deposits to 90 feet.
10					
15					
20		Steel surface casing placed to 95 feet.			
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
9.6		10-19-85
9.3	11:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 658

JOB NO. MON01 DATE 09/26/85

SURFACE ELEVATION 4876.19

TOP OF FILTER PACK 114.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 165.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 54763.40 E 88857.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**EOLIAN DEPOSITS, Continued.**
60					
65					
70					
75					
80					
85					
90				SP	**SHINARUMP MEM., CHINLE FM.:**
95		**Bentonite/ cement grout seal placed to 109 feet.**			
100					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	9.6		10-19-85
▼	9.3	11:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 658

JOB NO. MON01 DATE 09/26/85

SURFACE ELEVATION 4876.19

TOP OF FILTER PACK 114.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 165.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 54763.40 E 88857.00

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105						**SHINARUMP MEM., Continued.**
110			**Bentonite pellet seal installed from 109 to 114 feet.**			
115			**No.8-12 filter pack sand placed from 114 to 157 feet.**			
120						
125						
130						
135			**.051-in. slot well screen installed from 135 to 155 feet.**			
140						
145						
150						
155			**Blank sump placed from**			

GROUNDWATER

DEPTH	HOUR	DATE
9.6		10-19-85
9.3	11:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 658

JOB NO. MON01 DATE 09/26/85

SURFACE ELEVATION 4876.19

TOP OF FILTER PACK 114.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM

TOTAL DEPTH 165.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 54763.40 E 88857.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
		155 to 157 feet.			
		Cave-in fill from 157 to 165 feet.		ML	MOENKOPI FM. SILTSTONE, altered, bluish grey. Note: Color change to reddish brown.
160					
165					TD AT 165 FEET.
170					
175					
180					
185					
190					
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE
9.6		10-19-85
9.3	11:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 659

JOB NO. MON01 **DATE** 09/11/85

SURFACE ELEVATION	4860.84	TOTAL DEPTH	110.0 feet
TOP OF FILTER PACK	82.00	RIG TYPE	GARDNER-DENVER
WELL CASING TYPE	4.0-IN.SCHED.80 PVC	BORING TYPE	ROTARY MUD
COMPLETION	ALLUVIUM/EOLIAN	LOCATION	N 59069.80 E 88670.30
		DATUM	MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 109 feet		SP SM	**EOLIAN DEPOSITS:** SAND, medium to fine, little silt, reddish brown.
5					Note: Undifferentiated dune deposits to 90 feet.
10					
15					
20		Steel surface casing placed to 51 feet.			
25					
30					
35					
40					
45					
50				SW	**SHINARUMP MEM., CHINLE FM.:** SANDSTONE, medium to coarse, occasional conglomeritic stratum, white with limonite stains.

GROUNDWATER

DEPTH	HOUR	DATE
36.5		10-19-85
35.3	15:35	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 659

JOB NO. MON01 DATE 09/11/85

TOTAL DEPTH 110.0 feet

SURFACE ELEVATION 4860.84

RIG TYPE GARDNER-DENVER

TOP OF FILTER PACK 82.00

BORING TYPE ROTARY MUD

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

LOCATION N 59069.80 E 88670.30

COMPLETION ALLUVIUM/EOLIAN

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	55					
	60					
	65					
	70					
	75					
	80		Bentonite/ cement grout seal placed to 79 feet.			
	85		Bentonite pellet seal installed from 79 to 82 feet.			
	90		No.8-12 filter pack sand placed from 82 to 109 feet.			
	95					
	100					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	36.5		10-19-85
▼	35.3	15:35	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 659

JOB NO. MON01 DATE 09/11/85

SURFACE ELEVATION 4860.84

TOP OF FILTER PACK 82.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM/EOLIAN

TOTAL DEPTH 110.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59069.80 E 88670.30

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105			.051-in. slot well screen installed from 87 to 107 feet.			**SHINARUMP MEM., Continued.**
110			**Blank sump placed from 107 to 109 feet.** **Cave-in fill from 109 to 110 feet.**			**TD AT 110 FEET.**
115						
120						
125						
130						
135						
140						
145						
150						
155						

GROUNDWATER

	DEPTH	HOUR	DATE
▽	36.5		10-19-85
▼	35.3	15:35	4-27-86

JEG TAC TEAM

LOG OF WELL BORING NO. 660

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

JOB NO. MON01 **DATE** 09/24/85

SURFACE ELEVATION 4831.38
TOP OF FILTER PACK 124.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION SHINARUMP MEM.

TOTAL DEPTH 155.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 61303.40 E 89584.30
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 155 feet		SP	EOLIAN: UNDIFFERENTIATED, dune sand, medium to fine, lt. reddish brown.
5					
10					
15					
20		Steel surface casing placed to 96 feet.			
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
33.3		10-19-85
31.4	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 660

JOB NO. MON01 **DATE** 09/24/85

SURFACE ELEVATION 4831.38
TOP OF FILTER PACK 124.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION SHINARUMP MEM.

TOTAL DEPTH 155.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 61303.40 E 89584.30
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**EOLIAN DEPOSITS, Continued.**
60					
65					
70					
75					
80					
85					
90				SW	**SHINARUMP MEM., CHINLE FORMATION:** SANDSTONE, medium to coarse, tan to white. Occasional coaly fragments indicate channel fill deposit.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
33.3		10-19-85
31.4	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 660

JOB NO. MON01 DATE 09/24/85

SURFACE ELEVATION 4831.38

TOP OF FILTER PACK 124.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION SHINARUMP MEM.

TOTAL DEPTH 155.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61303.40 E 89584.30

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**SHINARUMP MEM., Continued.**
110					
115		**Bentonite/ cement grout seal placed to 119 feet.**			
120		**Bentonite pellet seal installed from 119 to 124 feet.**			
125					
130		**No.8-12 filter pack sand placed from 124 to 155 feet.**			
135		**.051-in. slot well screen installed from 133 to 153 feet.**			
140					
145					
150		**Blank sump placed from 153 to 155 feet.**			
155					**TD AT 155 FEET.**

GROUNDWATER

DEPTH	HOUR	DATE
33.3		10-19-85
31.4	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 661R

JOB NO. MON01 DATE 10/06/85

SURFACE ELEVATION 5057.34

TOP OF FILTER PACK 179.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 56366.10 E 85447.70

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 212 feet		SP	**SHINARUMP MEM., CHINLE FM.:** SANDSTONE, fine to medium, well cemented, beige to pale tan.
5		Protective steel casing placed to 5 feet.			
10		Bentonite/ cement grout seal placed to 174 feet.			
15					
20		Note: Original hole 661 was grouted full with casing in-place.			Note: Becomes coarse grained with lt. limonite staining, medium yellowish brown.
25				SM	**MOENKOPI FM.:** MUDSTONE, friable, thin bedded, medium yellowish brown.
30					Note: Color change to medium to dark reddish brown.
35					
40				ML	SILTSTONE, very thin bedded, medium reddish brown to chocolate brown.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
164.2		10-19-85
162.8	14:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 661R

JOB NO. MON01 DATE 10/06/85

TOTAL DEPTH 218.0 feet

SURFACE ELEVATION 5057.34

RIG TYPE GARDNER-DENVER

TOP OF FILTER PACK 179.00

BORING TYPE ROTARY MUD

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

LOCATION N 56366.10 E 85447.70

COMPLETION DeCHELLY MEM.

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60				ML SP	**DeCHELLY MEM., CUTLER FM.:** SANDY SILTSTONE, chocolate brown, with interbedded lt. carmel siltstone.
65					
70					
				SP	SANDSTONE, fine, lt. to med. orangish brown.
75					
80					
					Note: Color change to lt. brown.
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
164.2		10-19-85
162.8	14:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 661R

JOB NO. MON01 DATE 10/06/85

SURFACE ELEVATION 5057.34

TOP OF FILTER PACK 179.00

WELL CASING TYPE 4.0-IN. SCHED. 80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 56366.10 E 85447.70

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**DeCHELLY SANDSTONE MEM., CUTLER FM., Continued.**
110					
115					
120					**Note: Color change to lt. orange brown.**
125					
130					
135					
140					
145					
150					**Note: Becoming weakly to mod. cemented.**
155					

GROUNDWATER

DEPTH	HOUR	DATE
164.2		10-19-85
162.8	14:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 661R

JOB NO. MON01 **DATE** 10/06/85

SURFACE ELEVATION 5057.34
TOP OF FILTER PACK 179.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 56366.10 E 85447.70
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					Note: Becoming moist to very moist from 158 feet. **DeCHELLY SANDSTONE MEM., CUTLER FM.**, Continued.
165					
170					
175		Bentonite pellet seal installed from 174 to 179 feet.			
180		No.8-12 filter pack sand placed from 179 to 212 feet.			
185					
190		.051-in. slot well screen installed from 190 to 210 feet.			
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE
164.2		10-19-85
162.8	14:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 661R

JOB NO. MON01 **DATE** 10/06/85

SURFACE ELEVATION 5057.34
TOP OF FILTER PACK 179.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 56366.10 E 85447.70
DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210			Blank sump placed from 210 to 212 feet.			DeCHELLY SANDSTONE MEM., CUTLER FM., Continued.
215						
						TD AT 218 FEET.
220						
225						
230						
235						
240						
245						
250						
255						
260						

GROUNDWATER

DEPTH	HOUR	DATE
164.2		10-19-85
162.8	14:00	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 662

JOB NO. MON01 DATE 10/05/85

SURFACE ELEVATION 4877.07

TOP OF FILTER PACK 35.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALJ.UVIUM/EOLIAN

TOTAL DEPTH 70.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59236.50 E 87577.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 69.5 feet		SP SM	EOLIAN: SAND, some silt, lt. reddish brown. Note: undifferentiated to total depth.
5					
10					
15					
20		Steel surface casing placed to 21 feet.			
25		Bentonite/ cement grout seal placed to 32 feet.			
30					
35		Bentonite pellet seal installed from 32 to 35 feet.			
40		No.8-12 filter pack sand placed from 35 to 69.5 feet.			
45		.051-in. slot well screen installed from 35.5 to 67.5 feet.			
50					

GROUNDWATER

DEPTH	HOUR	DATE
51.5		10-19-85
51.0	11:35	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 662

JOB NO. MON01 DATE 10/05/85

SURFACE ELEVATION 4877.07

TOP OF FILTER PACK 35.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION ALLUVIUM/EOLIAN

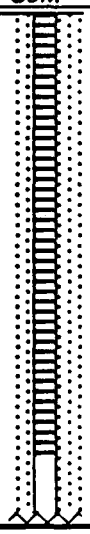
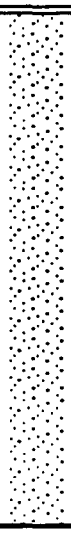
TOTAL DEPTH 70.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59236.50 E 87577.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**EOLIAN DEPOSITS, continued.**
60					
65		**Blank sump placed from 67.5 to 69.5 feet.**			
70		**Cave-in fill from 69.5 to 70 ft.**			**TD AT 70 FEET. Note: Caving badly to TD.**
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
51.5		10-19-85
51.0	11:35	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 663

JOB NO. MON01 DATE 09/10/85

SURFACE ELEVATION 4861.56

TOP OF FILTER PACK 155.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 217.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59069.60 E 88593.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 217 feet		SP	EOLIAN: UNDIFFERENTIATED, DUNE SAND, with minor alluvium in lower section consisting of minor fine gravel derived from Shinarump formation, and minor Moenkopi rock fragments.
5		Flowing well at 5 gpm initially.			
10		Steel surface casing placed to 51 feet.			
15					
20					
25					
30					
35					
40					
45					
50				SM	SHINARUMP MEM., CHINLE FORMATION:

GROUNDWATER

DEPTH	HOUR	DATE
33.2		10-19-85
32.6	11:49	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 663

JOB NO. MON01 DATE 09/10/85

TOTAL DEPTH 217.0 feet

SURFACE ELEVATION 4861.56

RIG TYPE GARDNER-DENVER

TOP OF FILTER PACK 155.00

BORING TYPE ROTARY MUD

WELL CASING TYPE 4.0-IN. SCHED. 80 PVC

LOCATION N 59069.60 E 88593.50

COMPLETION DeCHELLY MEM.

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite/ cement grout seal placed to 150 feet.			SANDSTONE, fine to coarse, occ. pebbles, whitish tan to reddish tan. Note: Water began flowing at 5 gpm at 52 feet during drilling, continuing until hole deepened to 55 feet. SHINARUMP MEM., Continued.
60					
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
33.2		10-19-85
32.6	11:49	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 663

JOB NO. MON01 DATE 09/10/85

SURFACE ELEVATION 4861.56

TOP OF FILTER PACK 155.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 217.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59069.60 E 88593.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**SHINARUMP MEM.**, Continued. Note: Conglomeritic from 107 to 110 feet. Occasional coaly fragment indicates channel fill deposit.
110					
115					
120				ML	**MOENKOPI FORMATION:** SILTSTONE, with minor thin interbeds of sandstone, upper few feet altered to bleached, grey; changing to reddish brown.
125					
130					
135					
140					
145					
150		Bentonite pellet seal installed from 150 to 155 feet.			
155		No.8-12 filter pack sand			

GROUNDWATER

DEPTH	HOUR	DATE
33.2		10-19-85
32.6	11:49	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 663

JOB NO. MON01 DATE 09/10/85

SURFACE ELEVATION 4861.56

TOP OF FILTER PACK 155.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 217.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59069.60 E 88593.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
		placed from 155 to 217 feet.			
160					MOENKOPI FM.,Continued.
165					
				SP	DeCHELLY SANDSTONE MEM., CUTLER FM.: SANDSTONE, medium to fine, reddish tan to orange.
170					
175		.051-in. slot well screen installed from 175 to 215 feet.			
180					
185					
190					
195					
200					
205					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	33.2		10-19-85
▼	32.6	11:49	4-27-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 663

JOB NO. MON01 DATE 09/10/85

SURFACE ELEVATION 4861.56

TOP OF FILTER PACK 155.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 217.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 59069.60 E 88593.50

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210					DeCHELLY SANDSTONE MEM., Continued.
215		Blank sump placed from 215 to 217 feet.			
					TD AT 217 FEET.
220					
225					
230					
235					
240					
245					
250					
255					
260					

GROUNDWATER

DEPTH	HOUR	DATE
33.2		10-19-85
32.6	11:49	4-27-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ.

LOG OF WELL BORING NO. 664

JOB NO. MON01. DATE 09/19/85

SURFACE ELEVATION 4832.84

TOP OF FILTER PACK 202.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 233.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61255.90 E 89537.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 233 feet		SP	EOLIAN DEPOSITS: SAND, medium to fine, reddish brown.
5					
10		Steel surface casing placed to 90 feet.			
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
30.8		10-19-85
30.2	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ.

LOG OF WELL BORING NO. 664

JOB NO. MON01, DATE 09/19/85

SURFACE ELEVATION 4832.84

TOP OF FILTER PACK 202.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 233.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61255.90 E 89537.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**EOLIAN DEPOSITS, Continued.**
60					
65					
70					
75					
80					
85				SW	**SHINARUMP MEM., CHINLE FM.:** SANDSTONE, medium to coarse, occasional conglomeritic seams, well cemented, limonite stained, tan to white.
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
30.8		10-19-85
30.2	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ.

LOG OF WELL BORING NO. 664

JOB NO. MON01. DATE 09/19/85

SURFACE ELEVATION 4832.84

TOP OF FILTER PACK 202.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 233.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61255.90 E 89537.00

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105						**SHINARUMP MEM.,Continued.**
110						
115						
120						
125						
130						
135						
140						
145					SW GP	**SANDSTONE, coarse to medium, with gravelly conglomeritic lenses, abundant coaly material,(channel fill deposit), tan to white.**
150						
155						

GROUNDWATER

DEPTH	HOUR	DATE
30.8		10-19-85
30.2	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ.

LOG OF WELL BORING NO. 664

JOB NO. MON01, DATE 09/19/85

SURFACE ELEVATION 4832.84

TOP OF FILTER PACK 202.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 233.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61255.90 E 89537.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					SHINARUMP MEM., Continued.
165					
170					
175				ML	MOENKOPI FORMATION: SILTSTONE, reddish brown with blue-grey bleached zone at top.
180					
185					
190					
195		Bentonite/ cement grout seal placed to 197 feet.		SP	DeCHELLY SANDSTONE MEM., CUTLER FM,: SANDSTONE, medium to fine, reddish to orange.
200		Bentonite pellet seal installed from 197 to 202 feet.			
205					

GROUNDWATER

DEPTH	HOUR	DATE
30.8		10-19-85
30.2	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ.

LOG OF WELL BORING NO. 664

JOB NO. MON01, DATE 09/19/85

SURFACE ELEVATION 4832.84

TOP OF FILTER PACK 202.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 233.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 61255.90 E 89537.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210		No.8-12 filter pack sand placed from 202 to 233 feet.			DeCHELLY SANDSTONE MEM., Continued.
215					
220		.051-in. slot well screen installed from 211 to 231 feet.			
225					
230		Blank sump placed from 231 to 233 feet.			
					TD AT 233 FEET.
235					
240					
245					
250					
255					
260					

GROUNDWATER

DEPTH	HOUR	DATE
30.8		10-19-85
30.2	14:25	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 668

JOB NO. MON01 **DATE** 10/04/85

SURFACE ELEVATION 4864.27
TOP OF FILTER PACK 167.00
WELL CASING TYPE 4.0-:N.SCHED.80 PVC
COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 60171.40 E 88287.00
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 215 feet		SP SM	**EOLIAN:** SAND, some silt, lt. reddish brown. Note: undifferentiated to total depth.
5					
10		Steel surface casing placed to 60 feet.			
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
41.3		10-19-85
40.0	09:30	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 668

JOB NO. MON01 DATE 10/04/85

SURFACE ELEVATION 4864.27

TOP OF FILTER PACK 167.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 60171.40 E 88287.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**EOLIAN DEPOSITS, continued.**
				SP	**SHINARUMP MEM., CHINLE FM.: SANDSTONE, fine, well cemented, variable, lt. grey to lt. pinkish brown.**
60		**Bentonite/ cement grout seal placed to 162 feet.**			
65					
70					
75				CH SC	**CLAYSTONE, with mudstone interbeds, occ. thin sandstone seam, high plasticity, lt. olive grey grading to blueish grey.**
80					
85				SP	**SANDSTONE, fine, well cemented, with occ, grey shale interbeds, variable lt. olive grey to lt. orange brown.**
90		**Gamma log shows rad. zone from 92 to 100 ft.**			
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
41.3		10-19-85
40.0	09:30	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 668

JOB NO. MON01 DATE 10/04/85

SURFACE ELEVATION 4864.27

TOP OF FILTER PACK 167.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 60171.40 E 88287.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105				CL	**SHINARUMP MEM., CHINLE FM.,** Continued. SHALE, thin bedded, with lenses of sandstone, occasional coal fragment.
110					
115				CL ML	**MOENKOPI FM.:** MUDSTONE AND SILTSTONE, interbedded, reddish brown to chocolate brown.
120					
125					Note: Increasing sand from 126 feet.
130					
135					Note: Gas bubbles in mud tub from 136 feet.
140					
145					
150				SP CL	**DeCHELLY SANDSTONE MEM., CUTLER FM.** SANDSTONE, with interbedded shale, fine, medium orange brown.
155					

GROUNDWATER

DEPTH	HOUR	DATE
41.3		10-19-85
40.0	09:30	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 668

JOB NO. MON01 DATE 10/04/85

SURFACE ELEVATION 4864.27

TOP OF FILTER PACK 167.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 60171.40 E 88287.00

DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160		Bentonite pellet seal installed from 162 to 167 feet.			
165		No.8-12 filter pack sand placed from 167 to 215 feet.			
170					
175					
180		.051-in. slot well screen installed from 180 to 200 feet.		SP	SANDSTONE,fine, medium orange brown.
185					
190					
195					
200		Blank sump placed from 200 to 215 feet.			
205					

GROUNDWATER

DEPTH	HOUR	DATE
41.3		10-19-85
40.0	09:30	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 668

JOB NO. MON01 DATE 10/04/85

SURFACE ELEVATION 4864.27

TOP OF FILTER PACK 167.00

WELL CASING TYPE 4.0-IN.SCHED.80 PVC

COMPLETION DeCHELLY MEM.

TOTAL DEPTH 218.0 feet

RIG TYPE GARDNER-DENVER

BORING TYPE ROTARY MUD

LOCATION N 60171.4C E 88287.00

DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210						DeCHELLY SANDSTONE MEM.,Continued.
215			Cave-in fill from 215 to 218 feet.			
220						TD AT 218 FEET.
225						
230						
235						
240						
245						
250						
255						
260						

GROUNDWATER

DEPTH	HOUR	DATE
41.3		10-19-85
40.0	09:30	4-29-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 669

JOB NO. MON01 **DATE** 10/05/85

SURFACE ELEVATION 4863.19
TOP OF FILTER PACK 29.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION ALLUVIUM.

TOTAL DEPTH 56.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 60146.30 E 88247.80
DATUM MSL; GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in PVC well to 56 feet		SP SM	**EOLIAN:** SAND, fine, nonplastic, moist, orange.
5					
10		Steel surface casing placed to 18 feet.			
15					
20		Bentonite/ cement grout seal placed to 24.5 feet.		SP	**ALLUVIUM/EOLIAN:** SAND, fine, little reworked shale frag. nonplastic, orange.
25		Bentonite pellet seal installed from 24.5 to 29 feet.			
30		No.8-12 filter pack sand placed from 29 to 56 feet.			
35		.051-in. slot well screen installed from 34 to 54 feet.			
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
49.3		10-19-85
49.0	13:00	4-28-86

JEG TAC TEAM

PROJECT MONUMENT VALLEY SITE, ARIZ.; UMTRA TAILINGS AREA

LOG OF WELL BORING NO. 669

JOB NO. MON01 **DATE** 10/05/85

SURFACE ELEVATION 4863.19
TOP OF FILTER PACK 29.00
WELL CASING TYPE 4.0-IN.SCHED.80 PVC
COMPLETION ALLUVIUM.

TOTAL DEPTH 56.0 feet
RIG TYPE GARDNER-DENVER
BORING TYPE ROTARY MUD
LOCATION N 60146.30 E 88247.80
DATUM MSL; GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
			Blank sump placed from 54 to 56 feet.			
55						TD AT 56 FEET.
60						
65						
70						
75						
80						
85						
90						
95						
100						

GROUNDWATER

DEPTH	HOUR	DATE
49.3		10-19-85
49.0	13:00	4-28-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 608C

DATE COMPL.	03/15/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	HS AUGER
CORE SIZE,IN.	6 5/8-IN
GRID COORD. N / E	N58685.7 E87189.4
SURFACE ELEV. FT.	4901.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0											SP	Core hole reamed to 5 5/8-in. to install 2-in PVC well.	SHINARUMP MEM.; CHINLE FM.: SANDSTONE, med. to coarse, yellowish grey.
5												See log 608 for well installation	
10	NO	100	70			30	X				CL		SHALE, with fine sand, thnly laminated.
											SP		SANDSTONE, medium to coarse, mod. well cemented,noncalcareous, occasional clayey matrix, mostly cross bedded, yellowish grey (5YR,5/4).
						30		X					
15	NO	100	100										
20							X						
25	NO	100	100			3	X						
											GP		CONGLOMERATE, coarse sand to med. gravel, subrrounded, some clay matrix, sufficient porosity to lose circulation, medium yellowish brown (10YR,5/4).
	NO	0	0										
30						3		X					
	NO	100	50								CL		MOENKOPI FORMATION: SHALE, with coarse sand, to silty, poorly indurated, very thinnly laminated, greyish orange (10YR,7/4).
											ML		
35	NO	100	45			3	X						
						3			X				SILTSTONE, with very fine sand, occasional thin calcite stringers as fracture fillings, noncalcareous, thinly laminated, very hard, yellowish grey (5Y,7/2). Note: with inter bedded greyish orange from 34 feet. Some pyrite in the matrix. Note: color change to reddish brown (10R,4/6) from 39 feet.
40						3	X						
											ML		
45	NO	100	76			3	X						SILTSTONE, dark reddish brown.
50						3	X						

GROUNDWATER

	DEPTH	HOUR	DATE
▽	58.4	16:31	15:00
▼	57.6	4-23-85	4-7-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 608C

DATE COMPL.	03/15/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	HS AUGER
CORE SIZE,IN.	6 5/8-IN
GRID COORD. N / E	N58685.7 E87189.4
SURFACE ELEV. FT.	4901.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
													MOENKOPI FM., Continued. Note: Becomes soft, more moist, from 54 feet.
55	NC	100	52			3		X			ML SM		SILTSTONE AND SANDSTONE, interbedded, yellowish grey.
60						3		X					
65	NC	100	95										Note: Increase in sand, sandstone is lt. grey.
70						3		X					Note: less siltstone interbeds from 72 ft.
75	NC	100	95								SW		SANDSTONE, coarse to fine, dark reddish brown. Note: Color change to very lt. grey, massive, from 78 ft.
80						3	X						Note: Alternating color bands from very lt. grey to pale red from 80 ft.
85	NC	100	97										
90						45	X				SP		**DeCHELLY SANDSTONE MEM., CUTLER FORMATION:** SANDSTONE, coarse to med., dune deposit, cross bedded, lt. brown to med. reddish brown (10R,4/6). Note: Lost circulation at 91 ft. due to porosity of this formation.
95	NC	100	100										
100						45	X						

GROUNDWATER

	DEPTH	HOUR	DATE
▽	58.4	16:31	15:00
▼	57.6	4-23-85	4-7-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01.

LOG OF CORE HOLE NO. 608C

DATE COMPL.	03/15/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	HS AUGER
CORE SIZE,IN.	6 5/8-IN
GRID COORD. N / E	N58685.7 E87189.4
SURFACE ELEV. FT.	4901.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105													
110						45	X						
115													Note: color change to variable lt. brown and greyish orange.
120													TD AT 120 FEET.

GROUNDWATER

	DEPTH	HOUR	DATE
▽	58.4	16:31	15:00
▼	57.6	4-23-85	4-7-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 610C

DATE COMPL.	12/03/84
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	HS AUGER
CORE SIZE,IN.	6 5/8-IN
GRID COORD. N / E	N56338.8 E88611.6
SURFACE ELEV. FT.	4860.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0											SP	Core hole reamed to 4.5-in to install 2-in. PVC casing.	**EOLIAN:** SAND, fine, dry, med. dense, lt. reddish brown (5YR,5/3,5/4).
5												See log 610 for well construction log.	Note: Very Moist at 6 feet. Note: Water table encoountered at 8 feet.
10													
15													
20													
25													
30	NO	0	0										
	NO	0	0										
											SP		**SHINARUMP MEM., CHINLE FM.:** SANDSTONE, med. grain. mod. hard, mod. weathered. thick bedding, brownish red.
35	NO	98	86			20			X				
40	NO	100	95										Note: Med. grey lens at 39 .5 to 40 feet.
45													
50	NO	100	93			3		X					

GROUNDWATER

	DEPTH	HOUR	DATE
▽	5.4	08:30	11:59
▼	5.4	4-23-85	4-6-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 610C

DATE COMPL. 12/03/84

RIG TYPE 2.0-IN.SCHED.40 PVC

METHOD HS AUGER

CORE SIZE,IN. 6 5/8-IN

GRID COORD. N / E N56338.8 E88611.6

SURFACE ELEV. FT. 4860.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
													Note: Color change to dk. brown (10YR,8/4).
55													
													SHINARUMP MEM., Continued.
													Note: Occasional clast of siltstone.
60	NO	100	95			20	X						
65													
70	NO	100	50			20			X				
	NO	60	50						X		CL		SHALE, yellowish brown to grey.
	NO	100	0								SP		SANDSTONE, very fine grained, grey; With thin interbedded lenses of grey shale.
75	NO	100	95			15		X			CL		
	NO	100	40										
	NO	100	50										
	NO	100	100			7		X			SP		SANDSTONE, very fine, greyish white.
						90			X				
80	NO	100	95										
						3	X						
85													
	NO	100	95								SW CL		CONGLOMERATE, with fine to coarse gravel, well cemented. SHALE, lt. grey.
90	NO	100	97								CL		MOENKOPI FORMATION: SHALE, reddish brown.
	NO	100	95										
95													
100													

GROUNDWATER

	DEPTH	HOUR	DATE
▽	5.4	08:30	11:59
▼	5.4	4-23-85	4-6-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 610C

DATE COMPL.	12/03/84
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	HS AUGER
CORE SIZE,IN.	6 5/8-IN
GRID COORD. N / E	N56338.8 E88611.6
SURFACE ELEV. FT.	4860.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE: NONE	FRACTURE: ANGLE, DEG.	FRACTURE: WIDE,>20 IN	FRACTURE: MOD.5-20 IN	FRACTURE: CLOSE <5in.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105													
110													
115											SP		SANDSTONE, very fine, well cemented, reddish brown.
120													Note: Becomes moderately cemented at 120.5 feet. Note: thin shale bed, reddish brown at 122 feet.
125													
130													TD AT 130.5 FEET.

GROUNDWATER

	DEPTH	HOUR	DATE
▽	5.4	08:30	11:59
▽	5.4	4-23-85	4-6-86

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01.

LOG OF CORE HOLE NO. 611C

DATE COMPL. 03/05/85

RIG TYPE 2.0-IN.SCHED.40 PVC

METHOD CORE/ ROTARY

CORE SIZE,IN. 6 -IN

GRID COORD. N / E N57811.0 E89017.5

SURFACE ELEV. FT. 4846.4

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0											SP	Core hole reamed to 6-in to install 2-in PVC casing.	EOLIAN:
5												See log 611 for well construction log.	
10													
15													
20													
25													
30													
35													
40													
45													
50													

GROUNDWATER

DEPTH	HOUR	DATE
10.7	12:45	
	6-7-89	

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 611C

DATE COMPL.	03/05/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	CORE/ ROTARY
CORE SIZE,IN.	6 -IN
GRID COORD. N / E	N57811.0 E89017.5
SURFACE ELEV. FT.	4846.4

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE, >20 IN	FRACTURE MOD. 5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55													
60													
											SP		SHINARUMP MEM., CHINLE FM. SANDSTONE, fine to med, with conglomeritic layers, soft, with hematite and limonite stain, lt. grey to yellow to orange.
65	NO	100	71			3			X				
						3		X					
70						3			X				
						3		X					
75	NO	100	71			3			X				
						25			X				Note: Less altered in fractures, less weathered, becomes mod. soft.
80						20			X				
						10		X					
85	NO	100	79										Note: Uniform grain size fine to medium, no conglomeritic layers. Sericite mica on fracture planes. Becomes mod. hard from 85 feet.
						20		X					
						3		X					
90													
						3			X				Note: Occasional carbonaceous material, from 90 feet.
95	NO	83	66			3			X				
						X	X						
100													
											SP		SANDSTONE, coarse to fine, with
						3			X		SC		pyrite, some coal, soft, greenish

GROUNDWATER

DEPTH	HOUR	DATE
10.7	12:45	
	6-7-89	

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 611C

DATE COMPL.	03/05/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	CORE/ ROTARY
CORE SIZE,IN.	6 -IN
GRID COORD. N / E	N57811.0 E89017.5
SURFACE ELEV. FT.	4846.4

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	NO	92	75			0		X			SP		grey. SANDSTONE, shaley (indicated by geophy. log). Note: core not recovered from this zone.
110	NO	30	30			0			X		ML		SANDSTONE, with conglomeritic zones, pyrite common, slightly calcareous, lt. green to grey. Note: Basal portion of Shinarump Member at 108 ft. as evidenced by pebbly chert conglomerate, rounded.
115	NO	50	41			3			X		CL		MOENKOPI FM.: SILTSTONE, greenish grey, very clayey, slightly calcareous, soft, greenish grey to 112, variable yellow grey to dark reddish brown.
120						3			X				CLAYSTONE, silty, with interbeds of siltstone, cross laminated, calcareous, mod. soft to mod. hard, dark reddish brown.
125	NO	100	77								ML CL		Note: artesian flow encountered as claystone aquitard penetrated.
											SP		SILTSTONE, clayey, with minor nonclayey lenses, reddish brown.
130						2	X				ML		SANDSTONE, very fine, lt. grey, with interbeds of reddish brown claystone; calcareous, mod. soft to mod hard.
													SILTSTONE, clayey, hard, mottled red-brown to lt. grey.
135	NO	100	73								SP		SANDSTONE, fine to med. clayey, calcareous, pinkish brown to greenish grey. Occasional variable seams of reddish brown to bleached.
140	NO	100	100			2	X						Note: Mottled at 143, hard.
145	NO	100	91			30		X					Note: Becoming coarser from 145 ft., calcareous.
150								X					
155	NO	100	100				X						

GROUNDWATER

	DEPTH	HOUR	DATE
▽	10.7	12:45	
▼		6-7-89	

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 611C

DATE COMPL.	03/05/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	CORE/ ROTARY
CORE SIZE,IN.	6 -IN
GRID COORD. N / E	N57811.0 E89017.5
SURFACE ELEV. FT.	4846.4

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE ANGLE, DEG. NONE	WIDE,>20 IN	MOD.5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
										SP		DeCHELLY MEM.,CUTLER FM: SANDSTONE, fine, cross bedded, mod. soft, reddish brown.
160												
165	NO	100	100									
170						X						
175	NO	100	100									
180						X						
185						X						TD AT 185 FEET.

GROUNDWATER

DEPTH	HOUR	DATE
10.7	12:45	
	6-7-89	

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 613C

DATE COMPL.	03/05/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	CORE/ ROTARY
CORE SIZE,IN.	6 -IN
GRID COORD. N / E	N56377.8 E88643.7
SURFACE ELEV. FT.	4860.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	NO	100	69			10		X					CLAYSTONE, with minor interbeds of siltstone, dk. brown. Note: One foot layer of sandstone at 100 feet.
											SP CL		Note: Closely space fractures at 103 feet.
110						10			X				Note: Thin seam of sandstone at 103 feet and at 104.5 ft.. MOENKOPI,Continued.
115	NO	99	84			10		X			SP		CLAYSTONE/SANDSTONE, interbedded, mottled dark brown and lt grey respectively. Note: Intensly fractured at 110 to 111 feet. Artesian flow from borehole, 1.6 gpm, during drilling.
120						10	X						SANDSTONE, fine to coarse, trace to little clay, calcareous, dk. brown to pinkish white. Note: Color change to pale yellow at 120 ft.
125	NO	100	90			10		X					Note: Color change to dark brown with varying amounts of clay/shale seams from 122 feet.
130						20			X				Note: Color change to reddish brown, clean, friable, calcareous from 125 feet. DeCHELLY SANDSTONE MEM.,CUTLER FM. (Probable contact)
						65			X				SANDSTONE, fine to very fine, cross bedded, with limonite cementation, yellowish brown.
135	NO	40	0										Note: Color change to tan.
140													

TD AT 144.7 FEET.
Artesian flow at 2.0 gpm at completion of drilling.
Packer set at 130.3 feet had 5 gpm flowing through pipe.

GROUNDWATER

	DEPTH	HOUR	DATE
▽	0.0	FLOWING	12:00
▼	5.2	2-19-85	2-26-92

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 613C

DATE COMPL. 03/05/85
RIG TYPE 2.0-IN.SCHED.40 PVC
METHOD CORE/ ROTARY
CORE SIZE,IN. 6 -IN
GRID COORD. N / E N56377.8 E88643.7
SURFACE ELEV. FT. 4860.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE NONE	FRACTURE ANGLE, DEG.	FRACTURE WIDE,>20 IN	FRACTURE MOD.5-20 IN	FRACTURE CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55													SHINARUMP MEM.,Continued.
60													
65													
70													
75													
	NO	100	100								SP		Note: No log until coring commenced at 77.8 feet. SANDSTONE, fine to medium grained, cross bedded with hematite and limonite common, noncalcareous, lt. grey to yellowish brown.
80						10	X						
85	NO	100	85										
						20			X		CL		Note: Thin seam of black chert pebble cong. at base of Shinarump mem.
90													MOENKOPI FORMATION: CLAYSTONE, with finely disseminated pyrite, reduction environment, mod. spaced fractures, slightly calcareous, greenish grey.
	NO	98	0										
95						10			X				
	NO	100	14								ML		Note: Color change to reddish brown, closely spaced fractures.
											~~CL~~ CL		Note: Color change to dark brown, becomes micaceous, closely spaced fractures, with minor seams of lt. orange micaceous sandstone.
100						10			X				SILTSTONE AND CLAY STONE, interbedded, calcareous, lt. grey to dk. brown.

GROUNDWATER

DEPTH	HOUR	DATE
0.0	FLOWING	12:00
5.2	2-19-85	2-26-92

JEG TAC TEAM

PROJECT MONUMENT SITE, AZ. UMTRA

JOB NO. MON01,

LOG OF CORE HOLE NO. 613C

DATE COMPL.	03/05/85
RIG TYPE	2.0-IN.SCHED.40 PVC
METHOD	CORE/ ROTARY
CORE SIZE,IN.	6 -IN
GRID COORD. N / E	N56377.8 E88643.7
SURFACE ELEV. FT.	4860.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURE: NONE	FRACTURE: ANGLE, DEG.	FRACTURE: WIDE,>20 IN	FRACTURE: MOD.5-20 IN	FRACTURE: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0											SP	Core hole reamed to 5 5/8-in to install 2-in PVC well.	EOLIAN: SAND, fine. lt. reddish brown to tan.
▽5												See log 613 for well construction log.	
10													
15													
20													
25													
30													
											SP		SHINARUMP MEM., CHINLE FM.: SANDSTONE, medium to coarse grained. See log of nearby well 610 for description of materials to 78 feet. Not recorded for this hole.
35													
40													
45													
50													

GROUNDWATER

	DEPTH	HOUR	DATE
▽	0.0	FLOWING	12:00
▼	5.2	2-19-85	2-26-92

JEG TAC TEAM

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MSRD BORING LOGS

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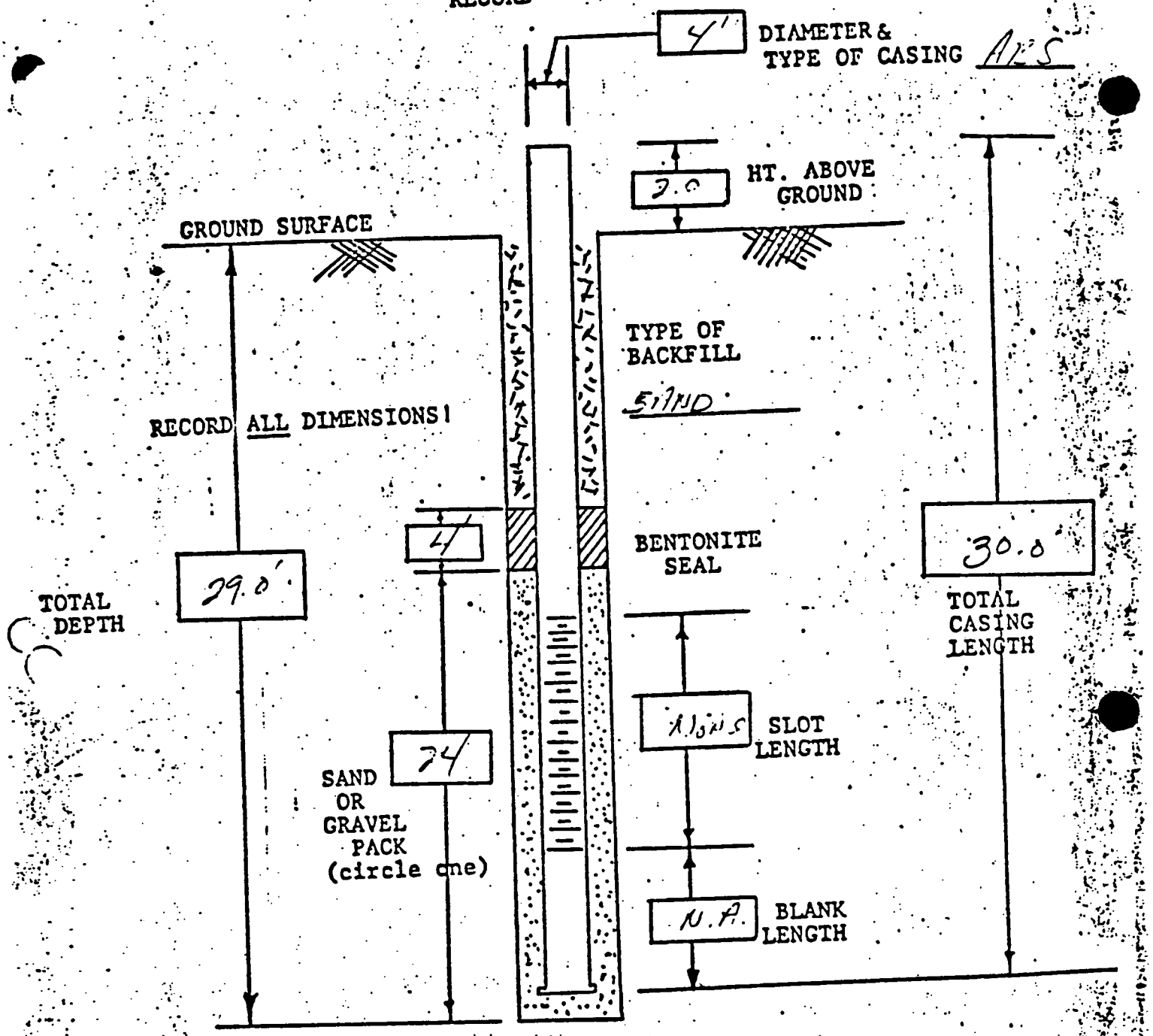
Mexican Hat Piezometer Data

Piezometer	Location	Hole Depth	Interface	Pipe Depth	Slot Length	Fill around Pipe
H2	Survey 55	28'6"	~24'	27'6"	—	Sand to 3', then bentonite
H3	Survey 12	60'	~54'	58'9"	10'	Sand to 3', then bentonite

The surface and subsurface materials around and under the pile were shale and hard sandstone which were difficult or impossible for the drilling equipment to penetrate. Attempts to drill and to install piezometers off pile were unsuccessful and, upon evaluation of the site conditions, deemed unnecessary.

PIEZOMETER OR WELL COMPLETION RECORD



WELL OR PIEZOMETER NUMBER HGCC 2

SITE LOCATION MERIDIAN HWY

GROUNDWATER LOCATION None

COMMENTS:

DATE 1/23/92

JOB NO. EE-63K

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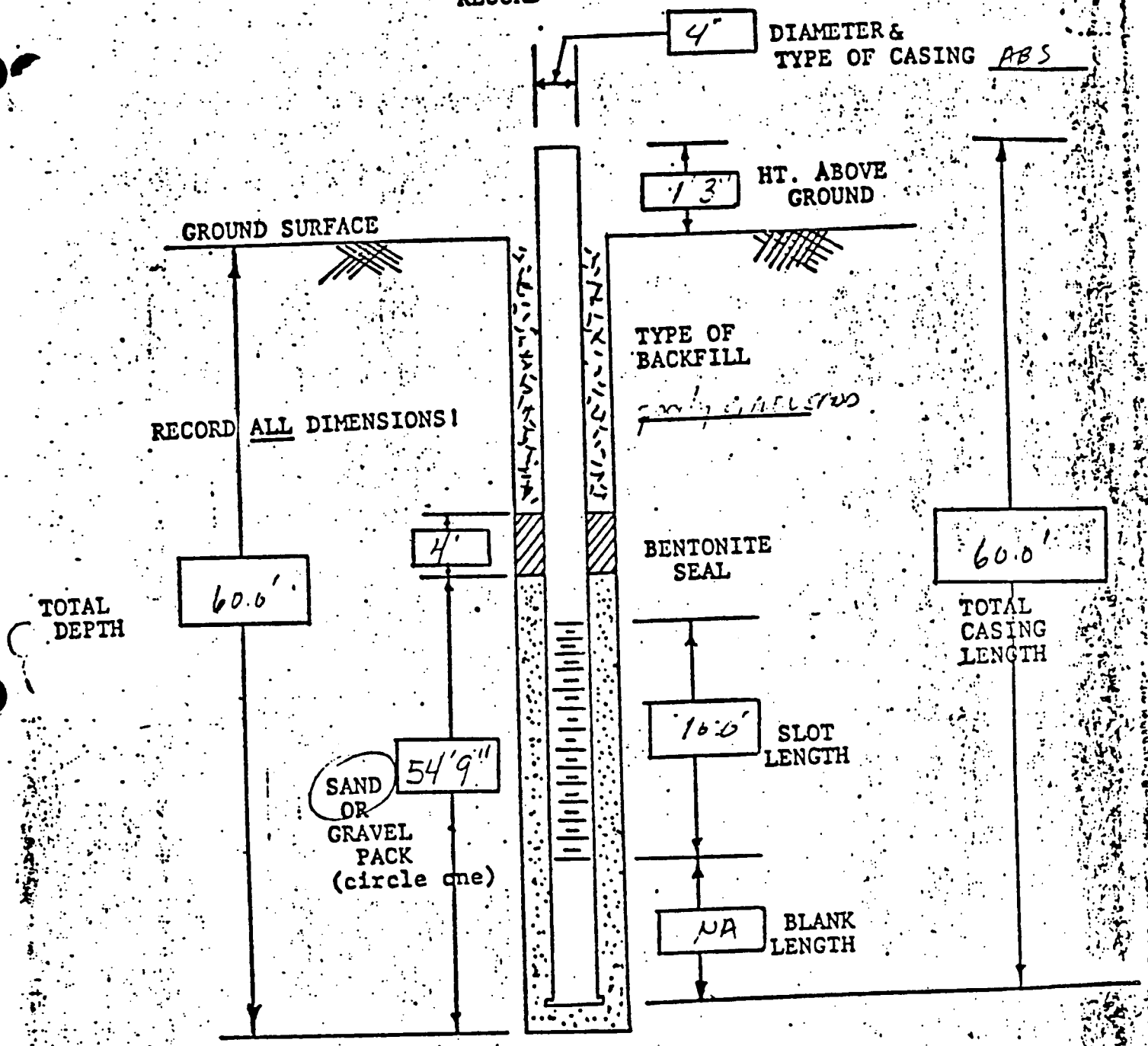
PIEZOMETER OR WELL COMPLETION RECORD



WELL OR PIEZOMETER NUMBER Well 3

SITE LOCATION [illegible]

GROUNDWATER LOCATION None

COMMENTS:

DATE 1/23/82

JOB NO. EB1631C

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PROJECT

JOB NO. DATE

LOG OF TEST BORING NO. #4

RIG TYPE Ome 55 #203

BORING TYPE 8" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									dry	[illegible] SANDS [illegible]
5										Auger stopped @ 8 [illegible] penetrometer not set
10										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. [illegible] DATE [illegible]

LOG OF TEST BORING NO. 117

RIG TYPE Ore 55 #203

BORING TYPE [illegible]

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									dry hard	bedrock subbase road
5										
10										
										auger refusal @ 11.0' piezometer hole - No piez. set.)

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/8/82U

LOG OF TEST BORING NO. A-1

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		26"	X					ML	dry	Silt
			X	U	6-9-8-9-14				firm	Weakly cemented
										NP
			X	U	12-44-50/1½"				hard	brown to red
5				S	50/1"					
										Auger stopped @ 5'
										Sampler refused @ 5'1"
10										
15										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/81

LOG OF TEST BORING NO. A-2

RIG TYPE CME 75(206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
		16"	X	U1	3-15-46-54/3"			ML	dry	Silt (Native) some gravel some cobbles Lo PI red
				U					dry	
5										
										Sandstone
10										
										Sampler refused @ 1'9"
15										Auger refused @ 3'
20										
25										
30										
35										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. A-3

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	U	5-7-9-9-50/5"			ML	moist hard	Silt weakly cemented NP brown to red [Note: sampler refused on sandstone]
5										
10										Auger stopped @ 2 1/2' Sampler refused @ 2'5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

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JOB NO. E81-13K DATE 11/8/82

LOG OF TEST BORING NO. A-4

RIG TYPE CME 75(206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	sl. moist	Sandy Silt (Native) trace clay LoPI red
		25"	X	U	9-7-12-21-21					
		10"	X	U	17-50/5"					
5										
10										Sandstone
15										Sampler refused @ 3'5" Auger refused @ 4'6"
20										
25										
30										
35										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. A-5

RIG TYPE CME 55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	U	4-2-2-2-4			ML	moist soft	Silt
			X	U	~~18-22-50/4"~~				hard	weakly cemented
										NP
5										tan to red
										refusal on bedrock
										Auger stopped @ 2½'
										Sampler refused @ 3'10"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

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JOB NO. E81-63K DATE 1/8/81

LOG OF TEST BORING NO. A-6

RIG TYPE CME-75 (206)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	sl. moist	Silty Sand
		22"		U	1-2-3-3-4					Lo PI
		20"		U	3-4-4-6-8					grey
5										(tailings)
		20"		U	3-3-4-6-50/4"					(subbase)
										Sandstone
10										
										Auger stopped @ 5'
										Sampler refused @ 7'4"
15										
20										
25										
30										

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. A-7

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		26"		U	5-7-8-7-5			SM	moist soft	Silty Sand
		19"		U	5-3-3-2-4					Lo PI
5		18"		U	3-2-1-1-1					weakly cemented
		18"		U	18-22-32-36-40					tan to red
10		4"		U	44-50/4"					[Note: refusal on sandstone
										Auger stopped @ 10'
15										Sampler refused @ 10'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. A-8

RIG TYPE CME 75 (200) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM	moist	Silty Sand trace clay NP gray [Note: some slime lenses @ 12'] (tailings)
		23"	X	U	6-4-4-5-4					
		21"	X	U	1-3-4-6-6					
5			X							
		19"	X	U	3-4-4-5-6					
		19"	X	U	6-5-7-7-6					
10			X							
		20"	X	U	3-9-7-16-24					
		17"	X	U	17-37-50/2"					(subbase) Sandstone some silt
15										Auger stopped @ 5' Sampler refusal @ 13'8"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. A-9

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	moist soft	Silty Sand
		2½'	X	T						some layered slimes
										Lo PI
		2½'	X	T						moderately cemented
5										
		2½'	X	T						
									hard	brown to tan to red
		18"	X	T						[Note: cementation
10										increases with depth]
										Auger stopped @ 5'
										Sampler refused @ 9'

GROUND WATER

DEPTH	HOUR	DATE
	-	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-631K DATE 1/8/82

LOG OF TEST BORING NO. A-10

RIG TYPE CME 75/206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM	moist	Silty Sand
		23"	X	U	2-3-3-4-7					NP
										grey
		19"	X	U	4-4-4-5-6-7					(tailings)
5			X							(subbase)
		20"	X	U	10-9-9-29-50/5"					Sandstone
10										

Auger stopped @ 5'
Sampler refused @ 7'5"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample
U – 3" O.D. 2.42" I.D. tube sample
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. A-11

RIG TYPE CME 55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									dry hard	Siltstone red
5										Auger refused @ 5' no sampling

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-163K DATE 1/9/81

LOG OF TEST BORING NO. B-12

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		23"	X	U	1-1-4-3-4				moist	NP
		19"	X	U	4-3-4-4-5					gray
5										
		20"	X	U	3-3-5-5-10					
		19"	X	U	8-9-9-11-13					
10										
		19"	X	U	3-3-4-5-10					
		19"	X	U	5-4-6-7-45					
15		4"	X	U	50/4"					(tailings)
										(subsoil)
										Sandstone
20										Auger stopped @ 5'
										Sampler refused @ 15'4"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample
U – 3" O.D. 2.42" I.D. tube sample
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-631K DATE 1/8/82

LOG OF TEST BORING NO. A-13

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
		23"	X	U	1-1-3-2-1			SM	moist soft	Silty Sand Lo PI weakly cemented tan to red (tailings)
		26"	X	U	2-4-3-6-7					
5		6"	X	U	50/6"					
									hard	bedrock (subbase) red
10										
										Auger stopped @ 5' Sampler refused @ 5'6"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-62L DATE 1/18/82

LOG OF TEST BORING NO. B-14

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		25"	X	U	3-4-4-5-6			SM		Silty Sand
									moist	NP
		20"	X	U	4-4-3-4-6					grey
5										
		19"	X	U	3-2-3-4-8					[Note: occasional thin silty sand lenses below 3']
		19"	X	U	4-5-4-7-10					
10										
		19"	X	U	7-6-7-9-10					
		19"	X	U	6-5-7-9-10					
15										
		19"	X	U	6-7-6-9-10					
		18"	X	U	7-12-16-15-15					
20										(tailings) (subbase)
		18"	X	U	11-9-11-15-11					
		19"	X	U	8-8-7-7-6					Weathered Sandstone
25		16"	X	U	7-9-50/5"					
30										Auger stopped @ 5' Sampler refused @ 26'5"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. B-15

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		26"	X	U	3-3-4-4-5			SM	moist soft	Silty Sand Lo PI weakly cemented tan to white to red [Note: slimes below 14']
		22"	X	U	5-7-9-7-7					
5		21"	X	U	19-24-30-10-9					
		18"	X	U	3-3-4-5-3					
10		18"	X	U	3-2-1-1-1					
		23"	X	U	2-1-1-1-1					
15		27"	X	U	1-1-1-3-5					(tailings) (subbase)
		21"	X	U	15-24-35-24-50/5 3/4"				dry hard	bedrock red
20										Auger stopped @ 17 1/2' Sampler refused @ 19' 11 3/4"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-163K DATE 1/8/82

LOG OF TEST BORING NO. B-16

RIG TYPE CME 75 (200) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		25"	X	U	2-3-11-11-13			SM	moist	Silty Sand NP grey
		19"	X	U	13-12-13-15-14					
5		19"	X	U	4-6-8-10-11					
		18"	X	U	3-4-5-6-8					
10		19"	X	U	6-5-6-8-9					
		19"	X	U	6-8-9-11-11					
15		19"	X	U	6-7-8-9-11					
		19"	X	U	7-7-9-11-11					
20		18"	X	U	6-8-9-10-11					
		19"	X	U	10-11-15-19-25					
25		15"	X	U	14-9-10-14-17					
		20"	X	U	11-11-11-15-13					
30		20"	X	U	7-7-7-9-10					(tailings)
		19"	X	U	7-22-22-22-50/5"				v. moist	(subbase) Weathered Sandstone
35		10"	X	S	13-50/5"					
40										Auger stopped @ 5' Sampler refused @ 35'11"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings · B – Block sample
S – 2" O.D. 1.38" I.D. tube sample
U – 3" O.D. 2.42" I.D. tube sample
T – 3" O.D. thin-walled Shelby tube

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. B-17

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23"	X	U	1-1-1-2-3			SM	moist soft	Silty Sand weakly cemented Lo PI tan to brown to yellow
		21"	X	U	5-4-2-3-2					
5		21"	X	U	1-5-3-3-6					
		18"	X	U	3-2-2-4-5					
10		18"	X	U	3-3-2-2-2					
		15"	X	U	1-1-1-2-4					
15		18"	X	U	4-4-2-2-1					
		21"	X	U	1-1-1-2-1					
20.		26"	X	U	1-1-2-10-22					(tailings)
		16"	X	U	~~21-26-50/5"~~				dry hard	(subbase)
25										Bedrock red

Auger stopped @ 5'

Sampler refused @ 23'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. B-18

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand NP grey
		26"	X	U	5-5-6-11-17					
		21"	X	U	9-8-9-8-10					
5										
		19"	X	U	2-3-4-6-7					
		20"	X	U	5-6-6-6-9					
10										
		19"	X	U	5-6-6-7-7					
		19"	X	U	4-5-6-7-10					
15										
		19"	X	U	5-6-6-7-9					
		19"	X	U	7-7-7-9-10					
20										
		18"	X	U	4-9-22-50/4 1/2"					(tailings) (subbase)
		NR		S	50/1"					Weathered Sandstone
25										
30										Auger stopped @ 5' Sampler refused @ 22'7"
35										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat tailings

JOB NO. E31-63-K DATE 1/8/82 U

LOG OF TEST BORING NO. B-19

RIG TYPE CME 55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		19"	X	U	7-2-3-4-6			SM		Silty Sand Lo PI weakly cemented brown to yellow
		20"	X	U	6-2-2-4-5					
5		21"	X	U	6-8-10-11-13					
		18"	X	U	4-5-5-5-5					
10		21"	X	U	3-5-6-6-9					
		20"	X	U	7-8-9-10-8					
15		18"	X	U	6-7-7-6-6					
		24"	X	U	5-4-4-4-5				v. moist	
20		21"	X	U	5-6-6-5-6				mod. firm	
		20"	X	U	4-5-4-6-13					(tailing (subbase)
25		NR	X	U	50/2"					Bedrock red

Auger stopped @ 5'
Sampler refused @ 25'2"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample
U – 3" O.D. 2.42" I.D. tube sample
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. 541-63K DATE 1/18/82

LOG OF TEST BORING NO. B-20

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					[50/5"]					Sandstone (Native)
5										Auger refused @ 2' Sampler refused @ 5"
10										
15										
20										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. B-21

RIG TYPE CME 55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb., 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		22"	X	U	1-2-3-4-3			SM	moist soft	Silty Sand Lo PI
		21"	X	U	3-2-1-2-2				mod. firm	weakly cemented
5		18"	X	U	6-14-3-3-2					tan to yellow to white
		18"	X	U	5-4-5-5-4					
10		20"	X	U	4-5-5-5-4					(tailings)
			X	U	29-50/4½"					(subbase)
15									hard	Bedrock red

Auger stopped @ 5'
Sampler refused @ 13'4½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/9/81

LOG OF TEST BORING NO. B-22

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		25"	X	U	1-2-1-2-3			ML	moist	Silt Lo PI grey
		19"	X	U	1-2-2-3-4					
5		18"	X	U	7-9-7-6-7			SM	moist	Silty Sand NP grey
		19"	X	U	3-4-4-6-9					
10		18"	X	U	6-6-6-8-10					
		19"	X	U	8-6-7-9-8					
15		19"	X	U	58-45-50/2"					(tails)
		NR		S	50/1½"					(subface) Weathered Sandstone
20										
25										Auger stopped @ 5' Samples refused @ 17'6½"
30										
35										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. B-23

RIG TYPE CME 55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								Sm	moist soft	Silty Sand
		23"		U	1-1-1-4-5					Lo PI
		20"		U	3-4-4-3-2					weakly cemented
5		18"		U	6-5-4-7-6					tan to yellow to white
		20"		U	4-3-3-3-2					
10		20"		U	3-2-1-1-1					
		18"		U	1-2-2-1-2					
15		20"		U	1-2-2-1-1					(tailings)
		16"		U	15-42-45-50/5"				dry hard	(subbase)
20										Bedrock red
										Auger stopped @ 5'
										Sampler refused @ 19'5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/9/81

LOG OF TEST BORING NO. B-24

RIG TYPE CME 75(206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML		
		20"		U	1-2-1-1-4				moist	Silt
		20"		U	3-2-2-2-3					Lo PI
5										grey
		18"		U	5-7-8-8-8					
		19"		U	5-5-6-7-5					[Note: some sand
10										and clay lenses
		18"		U	5-6-8-7-9					@ 10'-20']
		19"		U	8-10-12-12-11					
15										
		20"		U	10-12-11-8-10					
		19"		U	7-7-8-11-15					
20										
		19"		U	11-11-15-17-16					
		17"		U	8-6-11-9-10					(tailings) (subbase)
25										Sandstone
		18"		U	6-6-6-5-6					
		8"		U	36-50/2"					
30										Auger stopped @ 5' Sampler refused @ 28'2"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/9/82

LOG OF TEST BORING NO. A-25

RIG TYPE CME 55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23"	X	U	1-1-1-3-4			SM	moist soft	Silty Sand weakly cemented Lo PI tan to white to yellow (tailings)
		16"	X	U	5-7-7-9-8					
5		20"	X	U	11-13-9-9-11					
		12"	X	U	13-29-50/4"					
10										(subbase) Bedrock red

Auger stopped @ 5'
Sampler refused @ 8'10"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/9/82

LOG OF TEST BORING NO. B-26

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		22"	X	U	3-3-2-3-4			SM	moist	Silty Sand NP grey
		19"	X	U	2-1-1-2-3					
5		18"	X	U	4-5-6-7-9					
		20"	X	U	5-5-5-7-8					
10		19"	X	U	7-8-7-9-10					
		19"	X	U	8-9-8-7-10					
15		19"	X	U	7-7-7-8-7					
		20"	X	U	7-9-13-12-13					
20		20"	X	U	10-12-13-21-24					
		19"	X	U	14-15-16-19-16					
25		19"	X	U	5-6-9-9-9					
		19"	X	U	5-13-14-16-14					(tailings) (subdike) Sandstone
30		7"	X	U	5-6-6-9-10					
		19"	X	U	5-8-19-[50/3"]					
35										Auger stopped @ 5' Sampler refused @ 34'3"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. ES1-63K DATE 1/9/82

LOG OF TEST BORING NO. A-2

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									dry hard	Bedrock red (from surface)
5										Auger stopped @ 5'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/9/82

LOG OF TEST BORING NO. B-28

RIG TYPE CME 55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	moist soft	Silty Sand weakly cemented Lo PI tan to white to yellow (tailings) (subbase)
		20"	X	U	1-2-2-4-5					
		20"	X	U	6-8-7-8-8					
5		18"	X	U	3-6-2-3-1					
		20"	X	U	1-2-1-1-2					
10		18"	X	U	2-2-1-2-1					
		12"	X	U	4-39-50/3 1/2"					Bedrock red
15										Auger stopped @ 5' Sampler refused @ 13'9 1/2"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mo. Hat

JOB NO. 681-63K DATE 1102

LOG OF TEST BORING NO. A29

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSP

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									Soft moist	Silty, sand
		24		U	1-1-1-2-3			SM		Low p.I.
										wk'ly cemented
		20		U	2-2-3-3-4					tan to white to yellow
5		15								
				U	5-8-7-8-7				mod firm	(TAILINGS)
		19		U	8-10-12-12-10				dry hard	bedrock (SUBBASE)
10										red
				U	50/4"					
										Auger refusal @ 5.0'
										sampler refusal @ 10'4"
15										
20										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. EB-63K DATE [illegible]

LOG OF TEST BORING NO. B30

RIG TYPE CME-55 (203)

BORING TYPE [illegible]

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	Fine sand wkly cemented Low PI tan to yellow to white
		23	X	u	1-2-3-2-4			≤10		
		18	X	u	2-2-2-3-4					
5		19	X	u	4-4-4-3-6					
		20	X	u	6-6-8-8-9					
10		19	X	u	6-8-9-9-9					
		19	X	u	5-10-10-9-8					
15		20	X	u	9-8-8-5-6					
		24	X	u	4-4-4-5-6					Note: Some thin silt lenses encountered throughout depth
20		20	X	u	8-8-9-11-12				firm	
		18	X	u	8-9-10-12-11					
25		19	X	u	5-8-6-9-11					
		20	X	u	8-10-13-13-11					
30		12	X	u	13-44-50/5				dry hard	bedrock red (TAILINGS) (SUBBASE)
35										Auger stopped @ 5.0' sampler 2" refusal @ 31'5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE 1 6 82

LOG OF TEST BORING NO. B31

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth In Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty, sand
		2½'						SM		Low PI.
				T						wkly cemented
		2½		T						tans white to yellow
5										
		2½'								
				T						
		2½'		T						
10										
		2½		T						
		2½		T						
15										
		2½		T						
		2½		T						
20										
		2½		T						
		2½		T						(TAILINGS)
25										(SUBBASE)
		29"		T						bedrock
		(DC)			50/2"				clay hard	rel
30										Auger refusal @ 5.0'
										[illegible] @ 27'6"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-67K DATE 1/9/82

LOG OF TEST BORING NO. B32

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		26"	X	U	1-4-5-6-6					some clay
		17"	X	U	4-4-5-5-6				moist	NP
5										grey
		20"	X	U	3-3-3-5-6					
		17"	X	U	5-5-6-7-13					
10										
		19"	X	U	7-8-10-10-11					
		20"	X	U	7-8-8-13-13					
15										
		19"	X	U	13-11-13-14-16					
		19"	X	U	13-9-12-16-21					
20										
		19"	X	U	12-10-12-16-20					
		18"	X	U	12-13-23-24-26					
25										
		20"	X	U	9-13-13-17-18					
		19"	X	U	9-8-14-16-17					
30										
		19"	X	U	11-8-7-11-13					
		19"	X	U	9-9-10-12-16					tailings
35										subbase
		20"	X	U	12-14-16-20-24					Sandstone
		4"	X	U	50/4"					
40										Auger stopped @ 5'
										Sampler refused @
										37'10"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat
JOB NO. E81-63K DATE 1/9/82

LOG OF TEST BORING NO. B33

RIG TYPE CME-55 #203
BORING TYPE 6½" HSA
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X						moist soft	Silty SAND
		16	X	U	1-2-3-4-3			SM		Low PI.
			X							wkly cemented
		20	X	U	3-3-4-6-4					tan to yellow to white
5			X							
		20"	X	U	3-3-4-5-4-5					
			X							
		20"	X	U	3-3-5-6-6					
10			X							
		20	X	U	6-4-6-6-5					
			X							
		18	X	U	4-5-6-6-7					
15			X							
		21	X	U	4-5-5-6-7					
			X						mod firm	TAILINGS
		22	X	U	1-2-3-5-7					SUBBASE
20		13	X	U	18-33-50/5"				dry hard	bedrock red
										Auger stopped @ 5.0' sampler refusal @ 21'5"
25										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/9/81

LOG OF TEST BORING NO. B34

RIG TYPE CME 75(206)CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		20"	X	U	5-7-12-10-6			MSM	moist	Silty Sand NP grey
		19"	X	U	15-11-11-15-15					
5		19"	X	U	4-5-8-9-15					
		18"	X	U	6-7-6-9-10					
10		19"	X	U	5-4-7-7-6					
		18"	X	U	4-1-6-8-8					
15		19"	X	U	4-5-5-6-6					tailing subbase
		18"	X	U	8-8-8-7-6					
20		NR	X	U	6-7-8-7-8					Sandstone
		17"	X	U	7-5-5-5					
25										Auger stopped @ 5' Sampler refused 23'5"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat
JOB NO. E81-63K DATE 1/9/82

LOG OF TEST BORING NO. B35

RIG TYPE CME-55 #203
BORING TYPE 4½" HSA
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		2½'		T				Sm	moist / soft	silty sand wk'y cemented low pt. tan to white to yellow
		2½'		T						
5		2½		T						
		2½'		T						
10		2½'		T						
		2½		T						
15		2½		T						
		2½		T						
20		2'		T						
		24		U	21-23-26-27-39				hard	
25		26"		U	17-13-7-7-3				mod firm	TAILINGS SUBGRADE
		22"		U	7-5-6-7-8				hard	bedrock red
30		1.0		T					dry	
35										Refusal @ 30.0' Estimated refusal @ 31'0"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE
A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. 81-623 DATE 1/9/82

LOG OF TEST BORING NO. A36

RIG TYPE CME 75 (206) CL

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		25"	X	U	1-9-1-44-17					NP
									moist	gray
		20"	X		7-8-9-9-12					
5										
		19"	X		8-7-9-7-10					
		19"	X		7-6-7-8-10					
10										
		20"	X		4-4-6-7-10					
		19"	X		8-7-8-8-10					
15										
		20"	X	U	4-4-5-7-8					
		20"	X	U	5-5-7-7-8					
20										
		18"	X	U	4-7-9-45-[50/3"]					tailings
										subbase
										Sandstone
25										
										sampler refusal @ 22'3"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mex. HAT

JOB NO. EB1-63K DATE 1/9/82

LOG OF TEST BORING NO. A37

RIG TYPE MME-55 # 203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	moist soft	silty sand Low PI. wk'ly cemented tan to white to yellow
		2½								
		2½		T						
5										
		2½								
		2½		T						
10										HAL 12 miles subbase
		2½		T						bedrock red
		2.0		T						
15										Auger not used sampler refusal @ 14½'
20										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-123 DATE 1/9/81

LOG OF TEST BORING NO. A38

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		20"	X	U	1-5-6-6-9				moist	NP
										grey
		21"	X	U	7-6-7-6-7					
5										
		19"	X		11-7-9-8-9					tailings
										subbase
		20"	X		5-5-4-5-50/3"					Sandstone
10										
										Auger stopped @ 5'
										Sampler refused @
15										14' 9"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE [illegible]

LOG OF TEST BORING NO. C39

RIG TYPE CME-55 #203

BORING TYPE 6"½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		14	X	U	5-13-29-50/5"			SM	moist soft	sil sand low PI wkly cemented tan
5										TAILINGS sabkhaa
										bedrock red
										sampler refusal @ 1'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/10/82

LOG OF TEST BORING NO. C40

RIG TYPE CM2 75(206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										Silty Sand NP grey
		25"	X	a	5-2-3-3-2			SM	sl. moist	
		20"	X	u	3-3-4-4-50/3"					tailings
5										sublase Sandstone
10										Auger stopped @ 5' Sampler refused @ 4'9"
15										
20										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E9[illegible]K DATE [illegible]

LOG OF TEST BORING NO. C41

RIG TYPE CME-55 #203

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		21"	X	U	3-3-2-2-2			SM	moist soft	Silty SAND low PI. Wkly cemented tan to yellow to white
		20	X	U	4-3-4-2-1					
5		21	X	U	8-14-23-9-5					Note: slimes from 1' and deeper
		26	X	U	4-5-5-8-13				firm	TAILINGS
10		8	X	U	18-50(2")				hard	SUBBASE
										Auger stopped @ 5.0' sampler refused @ 10'8"
15										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/10/81

LOG OF TEST BORING NO. C42

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		25"	X	U	3-3-4-5-5				sl. moist	NP
		19"	X	U	4-4-6-6-6					gray
5										
		19"	X	U	4-4-5-7-7					
		20"	X	U	5-5-5-7-8					
10										
		19"	X	U	5-7-10-50/5"					
										tailings subbase
										Sandstone
15										
										Sampler refused @ 11'11"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. EB163K DATE 11/3/81

LOG OF TEST BORING NO. C95

RIG TYPE CME-55 #203

BORING TYPE 6'6" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	Silty SAND
		16"		U	3-2-4-1			SM		Low PI.
										Wk. cemented
		20		U	2-1-1-1-1					tan to yellow to white
5										
		18		U	3-4-3-6-7					
		18		U	6-6-7-8-9					
10										
		13		U	8-8-9-11-17					TAILINGS
		18		U	25-45-50/6				dry HARD	SANDSTONE
15										Auger stopped @ 5.0' sampler refusal @ 14'10"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/10/82

LOG OF TEST BORING NO. C44

RIG TYPE CME 75(206)CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		26"	X	U	3-2-4-6-8			SM		Silty Sand NP grey
		20"	X	U	3-3-3-4-3					
5		19"	X	U	3-3-4-5-7					
		18"	X	U	4-5-6-7-12					
10		19"	X	U	4-5-7-10-11					
		18"	X	U	6-6-6-9-11					
15		20"	X	U	5-4-5-5-8					
		19"	X	U	7-7-9-12-10					
20		17"	X	U	7-5-6-11-35					tailings subbase
		8"	X	U	49-50/2"					Sandstone
25										Auger stopped @ 5' Sampler refused @ 23'2"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/10/82

LOG OF TEST BORING NO. C45

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	Silty, SAND
		20	X	u	5-2-3-2-5			SM		Low plt.
										wkly cemented
		20	X	u	3-4-3-5-7					tan to yellow to white
5										
		20	X	u	3-4-3-5-7					
		21	X	u	4-5-7-7-8					
10										
		21	X	u	7-7-8-8-7					
		18	X	u	6-6-7-7-8					
15										
		19	X	u	9-9-10-7-8					
		20	X	u	5-6-5-6-7					TAILINGS subbase
20		26	X	u	6-5-7-6-11					Bedrock red
		(NR)		u	50/3¼"				dry hard	
25										Auger stopped @ 5.0' sampler refused @ 22'7¾"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/10/82

LOG OF TEST BORING NO. C46

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24"	X	U	3-2-2-3-4			SM	moist	Silty Sand ND grey
		21"	X	U	5-6-7-10-7					
5		19"	X	U	4-3-5-5-7					
		18"	X	U	3-4-1-15-50/3"					tailings subbase
10										Sandstone
15										Auger stopped @ 5' Sampler refused @ 9'9"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/10/81

LOG OF TEST BORING NO. C47

RIG TYPE CME-55 #203

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		20	X	U	4-6-4-4-4			SM	MIST SAT	Silty sand loose. v.f.g. cemented tan to yellowish white.
		21	X	U	3-5-4-6-7					
5		20	X	U	3-2-1-3-2					
		22	X	U	4-5-4-6-7					
10		18	X	U	5-7-6-8-7					
		19	X	U	7-8-8-9-11					
15		20	X	U	9-11-13-16-9					
		19	X	U	10-9-9-9-11					
20		20	X	U	8-7-5-9-7					
		20	X	U	9-9-10-11-12					TAILINGS SUBBASE
25		10	X	U	9-9-12-11-50/5 3/4"				dry HARD	bedrock red
30										Auger stopped @ 5.0' sampler refusal @ 27'5 3/4"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/10/82

LOG OF TEST BORING NO. C48

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		25"	X	U	4-3-3-4-5			SM		Silty Sand
		21"	X	U	4-3-5-7-12					NP
5		19"	X	U	5-4-4-6-9				moist	grey
		20"	X	U	5-4-5-6-9					
10		20"	X	U	5-5-8-7-10					
		20"	X	U	6-6-8-10-9					
15		19"	X	U	5-7-6-10-13					
		18"	X	U	8-7-10-12-17					
20		19"	X	U	11-11-12-15-15					
		20"	X	U	8-8-9-14-20					
25		20"	X	U	11-11-12-13-14					
		18"	X	U	9-10-12-19-22					
30		17"	X	U	12-10-10-12-13					
		18"	X	U	10-7-9-10-11					
35		NR	X	U	(5/5")					tailings subbase Sandstone
40										Auger stopped @ 5' Sampler refused @ 35'5"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican HAT

JOB NO. EB1-63K DATE 1/11/82

LOG OF TEST BORING NO. C49

RIG TYPE CME-55 #203

BORING TYPE 10 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty SAND
		21	X	U	5-6-6-5-5			SM		Low PIT.
										wkly cemented
		20	X	U	6-6-5-4-6					tan to white
5										
		18	X	U	3-2-2-3-3					
		19	X	U	5-6-7-5-11					
10										
		20	X	U	7-7-7-8-7					
		21	X	U	13-10-10-11-12					
15										
		19	X	U	12-11-12-11-10					
		20	X	U	12-10-11-13-15					
20										
		18	X	U	11-10-10-9-11					
		18	X	U	7-8-9-11-11					
25										
		13	X	U	10-11-9-10-11					
		20	X	U	13-11-14-15-19				v. firm	
30										TAILINGS
		24	X	U	9-10-11-12-9					subbase
		16	X	U	10-10-14-24/3"				dry HARD	bedrock red
35										samples refused @ 34'8" auger stopped @ 5.0'
40										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/10/82

LOG OF TEST BORING NO. D50

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		
		21"	X	U	2-3-2-4-6				moist	Silty Sand NP gry
		20"	X	U	2-4-6-6-7					
5										
		19"	X	U	4-4-3-2-7					
		19"	X	U	4-3-4-7-10					[Note: some slims mixed w/sand below 5']
10										
		20"	X	U	5-6-7-10-10					
		19"	X	U	8-9-12-14-14					
15										
		19"	X	U	4-8-8-12-12					
		20"	X	U	8-8-8-13-20					
20										
		19"	X	U	13-12-15-15-20					
		19"	X	U	9-11-13-16-19					
25										
		18"	X	U	12-12-15-17-18					
		19"	X	U	9-11-17-17-17					
30										
		19"	X	U	13-16-18-16-14					
		18"	X	U	9-15-14-14-17					
35										
		19"	X	U	8-8-14-12-14					
		19"	X	U	10-14-22-21-24					
40										
		20"	X	U	14-15-17-24-26					
		19"	X	U	15-16-21-21-20					
45										
		20"	X	U	16-17-16-25-27					
		20"	X	U	26-22-17-16-12					
50										

GROUND WATER

DEPTH	HOUR	DATE
50'	9:00 AM	1/11/81

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T. – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/10/82 - 1/11/82

LOG OF TEST BORING NO. D50

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50									wet	
		14"	X	U	7-10-14-14-15					
		19"	X	U	12-14-12-31-[50/5"]					tailings subbase
55									dry hard	Sandstone
60										Sampler refused @ 54' 9"
65										
70										

GROUND WATER

DEPTH	HOUR	DATE
~ 50'	9:00 AM	1/11/82

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat
JOB NO. E81-63K DATE 1/8/82

LOG OF TEST BORING NO. D51

RIG TYPE CME-55 #203
BORING TYPE 6 1/2" HSA
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		22		U	3-4-3-4-5			SM	moist soft	silty, sand low PI. wicky cemented tan to white
		18"	X	U	5-4-7-6-7					
5		14"		U	2-3-4-4-4					
		18"		U	4-7-6-8-9					
10		18"		U	8-9-10-10-9					
		18		U	6-10-10-9-13					
15		18		U	8-9-9-9-10					
		23		U	7-9-11-10-19					
20		18"		U	8-13-14-17-21					
		18"		U	9-11-14-16-18					
25		14"	X	U	8-10-10-11-13					
		26"	X	U	12-11-16-12-14					
30		24	X	U	11-12-13-14-15					
		21	X	U	4-6-7-8-9					
35		26"	X	U	5-5-7-9-11					
		23	X	U	6-8-9-11-15				firm	TAILINGS SUBGRADE
40		22	X	U	25-35-43-42-50/5"				dry hard	bedrock red
45										Auger stopped @ 35.0 sampling refusal @ 42'5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/11/82

LOG OF TEST BORING NO. D52

RIG TYPE CME 75 (2006) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand NP gray
		21"	X	U	2-3-4-4-5					
		19"	X	U	4-3-5-6-5					
5										
		20"	X	U	3-3-3-3-5					
		18"	X	U	4-5-8-9-10					
10										
		18"	X	U	8-9-9-10-12					
		19"	X	U	7-7-6-12-15					
15										
		19"	X	U	9-9-9-12-12					
		19"	X	U	6-6-8-11-13					
20										
		19"	X	U	11-10-12-16-15					
		19"	X	U	10-11-12-14-14					
25										
		19"	X	U	9-13-13-12-13					
		19"	X	U	10-14-18-20-19					
30										
		16"	X	U	8-13-24-19-19					
		19"	X	U	16-18-18-20-19					
35										
		19"	X	U	15-16-13-13-13					
		19"	X	U	16-15-15-16-19					
40										
		12"	X	U	20-32-[50/3"]					tailings subbase Sandstone
45										Auger stopped @ 5' Sampler refused @ 41'3"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/11/82

LOG OF TEST BORING NO. D53

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X						moist	silty sand
		21	X	S	2-2-3-4-1			SM		wkly cemented
		22	X	S	5-2-4-4-3					Low pl.
5		18	X	S	7-6-6-5-4					tan to white
		19	X	S	5-3-5-3-8					
10		21	X	S	7-6-8-8-9					
		20	X	S	7-6-7-7-8					
15		20	X	S	6-9-9-9-11					tailings subbase
			X		25-50/5"				dry hard	bedrock red
20										Auger stopped @ 5.0' Sampler refusal @ 18'5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/11/82

LOG OF TEST BORING NO. C54

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand NP red-grey [Note: slime layer @ 2'-8']
		23"		U	12-4-6-5-6					
		21"		U	4-4-4-4-5					
5		19"		U	2-3-4-5-7					
		18"		U	10-13-13-13-12					
10		18"		U	8-9-13-12-13					
		19"		U	7-9-10-11-13					
15		18"		U	6-6-8-10-12					
		17"		U	6-8-13-16-18					
20		17"		U	13-12-14-14-15					
		19"		U	15-13-18-18-19					
25		19"		U	9-9-12-15-15					
		17"		U	10-11-13-13-14					
30		18"		U	8-9-11-11-18					
		18"		U	11-12-13-13-50/4"					
35										tailings subbase Sandstone
40										Auger stopped @ 5' Sampler refused @ 34'10"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE 11/11/82

LOG OF TEST BORING NO. D55

RIG TYPE CME-55 #303

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24	X	U	2-3-3-3-3			SM	so + moist	silty sand low F.I. wk cemented tan to white to yellow
		20	X	U	3-4-4-6-8					
5		27	X	U	3-5-2-1-6					
		21	X	U	3-4-6-8-9					
10		21	X	U	6-5-6-8-11					
		22	X	U	5-4-6-7-8					
15		19	X	U	6-7-3-8-15					
		20	X	U	8-10-10-13-16					
20		20	X	U	10-10-11-16-19					
		15	X	U	9-10-11-10-7					
25		19	X	U	5-8-6-8-13					
		20	X	U	7-10-11-14-12					
30		20	X	U	9-8-9-11-13					TAILINGS SUBGRADE
		6	X	U	38-50/1.5"				dry hard	weathered
35										auger stopped @ 5.0' sampler refusal @ 33'1½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/11/81

LOG OF TEST BORING NO. C56

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		23"	X	U	3-4-3-3-4					NP
		19"	X	U	5-5-6-4-5					grey
5		19"	X	U	2-2-3-4-7					[Note: red slime lens
		20"	X	U	6-6-7-6-7					@ 5'-7'].
10		18"	X	U	6-6-6-8-9					
		19"	X	U	6-6-6-11-14					
15		18"	X	U	8-8-8-9-13					
		19"	X	U	8-7-11-14-13					
20		20"	X	U	6-8-13-14-16					
		19"	X	U	9-9-13-15-17					
25		20"	X	U	10-9-11-11-14					
		19"	X	U	9-10-11-13-50/5½"					tailings
30										subbase
										Sandstone
35										Auger stopped @ 5'
										Sampler refused @ 29'11½"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. 281-63K DATE 1/10/82

LOG OF TEST BORING NO. D57

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty sand
		26		U	2-3-6	3-4		SM		loose
										wet, cemented
		22		U	3-4-5	4-2				tint to white to yellow
5										
		20		U	3-3-4	7-7				
		21		U	4-5-7	1-6-8				
10										
		23		U	6-5-7	1-9-12				
		22		U	6-5-6	8-7				
15										
		21		U	5-5-6	8-11				
		20		U	5-6-7	8-10				
20										
		21		U	6-8-7	14-17				
		20		U	11-8-10	9-16				TAILINGS SUBSURFACE
25		16		U	7-11-50/1½"				dry hard	bedrock red
30										Auger stopped @ 5.0' sampler refused @ 26'1½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-63K DATE 1/11/82

LOG OF TEST BORING NO. C58

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		22"	X	U	3-4-2-2-4			SM	moist	Silty Sand NP gray. [Note: red slime layer @ 5'-6']
		19"	X	U	3-5-3-5-5					
5		17"	X	U	4-6-6-7-10					
		18"	X	U	7-7-7-10-11					
10		12"	X	U	12-12-15-10-8					
		20"	X	U	8-10-13-13-14					
15		19"	X	U	9-12-11-12-14					
		18"	X	U	10-12-12-13-11					
20		6"	X	U	6-6-8-11-14					
		18"	X	U	33-24-11-[50/4 1/2"]					tailings subbase
25										Sandstone
30										Auger stopped @ 5' Sampler refused @ 24'4 1/2"

GROUND WATER

DEPTH	HOUR	DATE
NCNE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican HAT

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. D59

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		18	X	6	3-3-5-4-2			SM	moist soft	silty SAND low PI wkly cemented TAN TO GRAY
		23	X	6	5-5-3-2-4					
5		21	X	6	5-3-2-4-2					
		19	X	6	4-6-5-7-8					
10		20	X	6	9-9-7-8-8					
		20	X	6	9-9-9-6-4					
15		18	X	6	8-8-11-12-12					
		21	X	6	9-9-7-11-10					
20		20	X	6	6-9-7-8-14					
		21	X	6	10-10-10-15-15					
25			X	6	10-10-11-14-16					
			X	6	8-9-43-50/4"				dry hard,	bedrock, red (TAILINGS) (SUBBASE)
30										Auger Stopped @ 5' SAMPLER REFUSED @ 29'4"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/11/81

LOG OF TEST BORING NO. C60

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		21"	X	U	6-6-6-4-4			CH	U. moist	Slimes hi PI red
		20"	X	U	4-3-3-3-3					
5		19"	X	U	2-2-2-5-7					
		20"	X		8-8-8-8-11					
10		19"	X		8-9-10-9-11					
		18"	X		7-8-12-14-14			SM		Silty Sand NP gray
15		19"	X		6-10-11-13-17					
		19"	X	U	12-10-11-16-17					
20		20"	X	U	6-6-9-12-13					
		21"	X	U	8-9-12-18-14					
25		19"	X	U	8-9-15-13-12					
		19"	X	U	7-9-11-24-[50/2"]					(TAILINGS) (SUBBASE) Sandstone
30										
35										Auger stopped @ 5' Sampler refused @ 29'8"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Morrison Lot

JOB NO. EB1-63K DATE 1/12/82

LOG OF TEST BORING NO. D61

RIG TYPE CME-55 (#203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23		U	1-2-3-5-4			SM	moist soil	silty sand loose pt. slightly cemented TAN to gray
		20		U	6-5-6-7-5					
5		22		U	2-2-2-2-2					
		21		U	4-5-6-8-7					
10		20		U	7-7-8-11-25				dry hard	bedrock red (TAILINGS) (SUBBASE)
		(NR)		U	50(1")					Auger stopped @ 5.0' sampler refusal @ 12'7"
15										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/11/82

LOG OF TEST BORING NO. C62

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CH		Slimes hi PI red
		23"	X	U	1-2-3-4-6					
		19"	X	U	4-4-3-4-4					
5										
		20"	X	U	2-3-4-3-5			SM		
		18"	X	U	4-5-4-5-6					Silty Sand NP grey
10										
		17"	X	U	7-7-7-8-9					
		18"	X	U	11-11-11-10-11					
1/11 1/12 15										
		19"	X	U	10-10-7-10-10					
		20"	X	U	8-10-11-12-14					
20										
		19"	X	U	12-11-11-13-20					
		20"	X	U	14-13-14-13-14					
25										
		19"	X	U	7-14-15-18-19					
		17"	X	U	13-13-14-14-15					
30										
		19"	X	U	11-13-13-15-13					
		18"	X	U	11-20-31-50/5"					(TAILINGS) (SUBBASE) Sandstone
35										Auger stopped @ 5' Sampler refused @ 34'5"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. EB1-63K DATE 1/12/82

LOG OF TEST BORING NO. D63

RIG TYPE CME-55 4(203)

BORING TYPE 6" L.A. A-A

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty SAND
		23		U	7-3-2-1-1			SM		low pf
										wk'ly cemented
		21		U	2-3-4-5-8					tan to grey
5		20								
				U	4-4-5-8-10					
		21		U	5-4-6-6-6					
10										
		20		U	8-6-7-9-11					
		21		U	11-9-10-4-14					
15										
		18		U	11-10-11-12-13					
		20		U	9-11-14-13-15					(TAILINGS)
20										(SUBBASE)
		14		U	6-11-11-13-15				hard	bedrock
				U	27-17-45-50/1				dry	red
25										Auger stopped @ 5.0
										Sampler refusal @ 24'1"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/12/81

LOG OF TEST BORING NO. D64

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		25"	X	U	2-2-3-4-5			SM		Silty Sand
		19"	X	U	3-3-2-4-6				moist	NP
5		20"	X	U	4-4-5-6-7					gray
		19"	X	U	6-7-8-8-7					
10		18"	X	U	6-8-8-8-11					
		19"	X	U	7-6-7-9-9					
15		20"	X	U	7-8-8-13-13					
		19"	X	U	10-12-12-15-17					
20		20"	X	U	10-10-12-12-13					
		19"	X	U	13-13-15-19-17					
25		20"	X	U	12-11-12-14-18					
		19"	X	U	15-20-18-21-31					
30		19"	X	U	15-15-21-19-17					
		18"	X	U	14-19-21-20-25					
35		13"	X	U	28-16-16-15-16					
		19"	X	U	19-19-21-28-28					
40		17"	X	U	11-12-13-14-15					
		18"	X	U	21-21-24-26-24					(TAILINGS) (SUBBASE)
45		17"	X	U	16-18-42-(50-5")					Sandstone

Auger stopped @ 5'
Sampler refused @ 46'11"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

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PROJECT Morrison Hill

JOB NO. EB1-634 DATE 1/12/82

LOG OF TEST BORING NO. C65

RIG TYPE CME-55 (203)

BORING TYPE 6" - 15A

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23	X	U	7-8-6-6-4			SM	moist soft	SILTY SAND LOW PI Wkly Cemented TAN TO GRAY
		21	X	U	3-3-3-3-3					
5		26	X	U	3-3-3-3-3					
		21	X	U	5-5-5-4-5					
10		26	X	U	4-4-4-6-7					
		17	X	U	6-7-5-7-5					
15		21	X	U	6-6-6-8-13					
		23	X	U	8-10-13-20-14					
20		24	X	U	8-10-10-11-11					
		22	X	U	9-9-9-8-10					
25		23	X	U	8-10-11-12-3					(TAILINGS) (SUBBASE)
		23	X	U	38-2[illegible]-40-49-50/5"					bedrock red
30										Auger stopped @ 5.0' sampler refusal @ 29'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT: Mexican Hat Tailings
JOB NO. 81-63K DATE 1/12/82

LOG OF TEST BORING NO. D66

RIG TYPE CME 75(206) CC
BORING TYPE 6½" HSA
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		25"		U	4-2-3-4-6					NP
		19"		U	3-4-5-5-5				MOIST	grey
5										
		20"		U	3-3-3-5-6					
		18"		U	4-5-4-7-6					
10										
		19"		U	4-6-5-9-10					
		19"		U	6-6-8-10-10					
15										
		15"		U	6-8-11-11-13					
		19"		U	9-8-10-11-15					
20										
		19"		U	9-10-12-14-16					
		18"		U	10-9-10-12-15					
25										
		19"		U	8-9-11-14-17					
		20"		U	12-12-14-16-19					
30										
		19"		U	10-10-13-18-21					
		20"		U	10-10-12-17-14					
35										
		19"		U	9-11-13-14-16					
		18"		U	15-22-15-19-16					
40										
		19"		U	15-15-18-14-11					
		19"		U	14-12-13-14-16					(TAILINGS) (SUBBASE)
45										
		17"		U	13-12-12-12-15 [013"]					Sandstone
										Sample refused @ 47'3"
50										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]
JOB NO. E81-63K DATE [illegible]

LOG OF TEST BORING NO. C67

RIG TYPE CME-55 (203)
BORING TYPE 6½" HSA
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty, SAND
		23	✓	U	3-3-3-5-5			SM		low pl.
										wkly cemented
		19	✓	U	2-2-3-4-3					tan to grey
5										
		21	✓	U	3-5-4-2-3					
		20	✓	U	6-6-6-6-6					
10										
		20	✓	U	2-10-8-7-6					
		21	✓	U	7-7-9-8-7					
15										
		20	✓	U	6-7-9-11-19					
		19	✓	U	8-6-7-5-10					(TAILINGS)
20									dry hard	bedrock (SUBBASE)
		21	✓	U	18-22-34-48-50/5½"					red
										Auger stopped @ 5.0'
										sample refusal @ 22' 5½"
25										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexico Hat Tailings

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. D68

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		26"		U	1-2-1-2-3			SM		Silty Sand NP gray tailings subbase
				U	15-16-50/5"					Sandstone
5										
10										Sampler refused @ 3' 11"
15										
20										
25										
30										
35										
40										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. EB1-63K DATE [illegible] 2 1972

LOG OF TEST BORING NO. C69

RIG TYPE CME-55 (203)

BORING TYPE 1¼" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23"	X	U	1-1-1-2-3			SM	moist soft	silty, SAND low PI w/ly cemented tan to gray (TAILINGS)
		23	X	U	3-2-3-5-9					
5		26	X	U	25-25-25 39-50				hard	SAND & GRAVEL (SUBBASE)
10										auger stopped @ 8.0' sampler @ 7½'
15										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

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PROJECT Mexican Hat Tailings
JOB NO. E81-63K DATE 11/12/82

LOG OF TEST BORING NO. D70

RIG TYPE CME 75 (206) CC
BORING TYPE 6½" HSA
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		25"	X	U	1-1-2-3-4			SM		Silty Sand NP gray
		19"	X	U	2-2-4-6-7					
5		20"	X	U	4-4-5-5-5					
		19"	X	U	5-5-5-5-5					
10		19"	X	U	7-7-5-6-7					(TAILINGS) (SUBBASE)
		19"	X	U	22-26-48-[50/2"]					Sandstone
15										Auger stopped @ 5' Sampler refused @ 14'2"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

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PROJECT Mexican [illegible]

JOB NO. EB1-63K DATE 1/12/82

LOG OF TEST BORING NO. C71

RIG TYPE CME-55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM	moist soft	silty sand loose wk'y cemented tan to gray (TAILINGS)
		26	X	4	10-7-7-8-22					
		(NR)	X	U	25-50/5" =				dry hard	sed rock red (SUBBASE)
5										
										sample refusal @ 3'5"
10										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin walled Shelby tube

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. D72

RIG TYPE CME 75(206)CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X		4-16-(50/3")			SM		Silty Sand NP grey (TAILINGS)
5										(SUBBASE) Sandstone
10										Sampler refused @ 1'3"
15										
20										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

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PROJECT max. KFT

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. C73

RIG TYPE CME-55 (203)

BORING TYPE 6¼" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM	moist soft	Silty sand low PI. wk'ly cemented tan + red (TAILINGS)
				4	15-50/5					
5									hard	bedrock red (SUBBASE)
										sampler refusal @ .11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. D74

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand NP gray (TAILINGS)
		18"	X	U	3-3-28-[50/3"]					(SUBBASE) Sandstone
5										Sampler refused @ 1'9"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. EB-1631C DATE 1/12/82

LOG OF TEST BORING NO. C75

RIG TYPE CME-55 (203)

BORING TYPE 6 1/2" F.S.A.

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24	X	U	3-4-5-3-3			SM	moist soft	SILTY SAND low PI wkly cemented tan to gray (TAILINGS)
			X	U	3-4-4-5-7					
5			X	U	14-24-50(1½")				dry hard	bedrock red (SUBBASE)
										samples refusal @ 6' 1½"
10										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. D76

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM		Silty Sand NP grey
		25"	X		3-3-3-3-5					
		19"	X		5-3-3-5-3					
5			X							
		19"	X		3-3-3-15-21					(TAILINGS)
		4"	X		50/4"					(SUBBASE) Sandstone
10										

Sampler refused @ 7'11"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

[illegible] thin walled Shelby tube.

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84

PROJECT Mexican HAT

JOB NO. EBL-63K DATE 11/12/82

LOG OF TEST BORING NO. C77

RIG TYPE CME-55 #(203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty sand low pl weakly cemented tan to brown
		23	X	U	2-3-3-2-4			SM		
		17	X	U	2-3-3-4-5					
5										
		21	X	U	4-4-5-5-6					
		17	X	U	4-5-4-5-5					
10										
		8	X	U	4-6-5-4-3					
			X	U	4-4-5-6-4					
15										(TAILINGS)
			X	U	14-12-17-19-50/5				dry hard	bedrock red (SUBBASE)
20										Auger stopped @ 5.0' sampler refusal @ 17.5'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/12/81

LOG OF TEST BORING NO. D78

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM		Silty Sand
		25"	X	U	1-2-2-1-3					
			X						moist	ND
		21"	X	U	8-8-4-4-6					
5			X							gray
		19"	X	U	4-4-4-4-4					
		19"	X	U	4-4-4-5-7					
10			X							
		18"	X	U	6-5-6-5-6					
		17"	X	U	6-7-7-8-8					
15			X							
		18"	X	U	9-8-6-5-6					
		17"	X	U	6-6-22-[50/1"]					(TAILINGS) (SUBBASE)
20										Sandstone
										Auger stopped @ 5'
										Sampler refused 19" 1"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin walled Shelby tube

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PROJECT Mexicans RT

JOB NO. BB1-63K DATE 11/2/77

LOG OF TEST BORING NO. C19

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	moist soft	silty sand low PI. wkly cemented tan to grey
		18"	X	U	1-1-1-1-2					
		26	X	U	2-2-4-6-4					
5		18		U	2-2-4-5-3					
		19	X	U	7-6-7-6-7					
10		18	X	U	7-1-5-7-7					
		20	X	U	6-7-7-7-6					
15		23	X	U	7-9-9-8-9					(TAILINGS) (SUBBASE)
			X	U	58-9-19-50/3½"				dry HARD	bedrock reef
20										sampler refused @ 19' 9½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. D80

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		25"	X	U	2-2-4-4-5			SM		Silty Clay
		19"	X	U	3-3-4-8-7				moist	NP
5		18"	X	U	2-3-4-3-4					gray
		19"	X	U	3-5-5-5-7					
10		20"	X	U	4-5-6-5-5					
		19"	X	U	6-6-7-7-7					
15		19"	X	U	6-7-5-7-6					
		13"	X	U	4-(50/5")					(TAILINGS) (SUBBASE) Sandstone
20										

Auger stopped @ 5'

Sampler refused @ 18'5"

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mavicani Hat

JOB NO. EA-63C DATE 11/9/82

LOG OF TEST BORING NO. C81

RIG TYPE CME-55 #203

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		20"	X	U	5-5-4-4		6	SM	moist soft	silty, sand low pt wkly cemented tan to grey
		20"	X	U	5-4-3-3-5					
5		20"	X	U	2-3-6-6-5					
		20"	X	U	3-5-5-5-6					
10		18"	X	U	7-7-8-7-6					
		18	X	U	7-6-7-7-8					
15		23	X	U	8-7-7-7-7					
		21	X	U	7-8-7-8-8					
20		24	X	U	7-10-10-10-12				firm	
		28	X	U	10-9-10-10-8					
25		12	X	U	18-41-50/5"				dm hard	brick red — TAILINGS SUBBASE
										Auger stopped @ 5.6' sampler refusal @ 26'5"
30										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/12/82

LOG OF TEST BORING NO. DB2

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		23"			2-3-3-2-4				moist	NP
		19"			3-3-3-3-4					gray
5										[Note: some slimes
		19"			3-3-4-4-5					@ 13'-20']
		19"			5-5-6-4-7					
10										
		19"			[illegible]					
		20"			5-6-8-8-6					
15										
		18"			5-6-5-6-6					
		7"			4-5-6-6-6					
20										
		19"			5-6-6-19-26					(TAILINGS)
		2"			U (50/2")					(Subbase)
25										Sandstone
										Auger stopped @ 5'
										Sampler refused @ 22'8"

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E81-63K DATE 1/10.82

LOG OF TEST BORING NO. C83

RIG TYPE OME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		20	X	U	1-1-3-4-5			SM	moist soft	Silty, SAND Low plt. wkly cemented tan to grey
		21	X	U	4-4-4-4-4					
5		22	X	U	2-3-5-5-6					
		20	X	U	5-7-6-5-5					
10		18	X	U	5-5-5-6-6					
		23	X	U	6-7-6-7-6				mod firm	
15		22	X	U	5-7-7-7-6					
		23	X	U	5-6-7-6-8					
20		26	X	U	7-7-7-8-9					TAILINGS SUBBASE
		23	X	U	16-18-29-30-50/5				dry HARD	bedrock red
25										Auger is refused @ 5.0' sampler refused @ 24'11"
30										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/19/82

LOG OF TEST BORING NO. D84

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		Silty Sand
		14"		T					moist	NP
										gray
5		27"		T						
		20"		T						[Note: intermittent
		26"		T						thin slime lenses
10										below 2']
		23"		T						
		22"		T						
15										
		17"		T						
		6"		T						
20										
		24"		T						
		23"		T						
25										
		24"		T						
		19"		T						
30										
		24"		T						
		25"		T						
35										
		26"		T						tailings
										subbase
		24"		T						Sandstone
40										w/ interbedded
		22"		T						Shale
		NR		T						
45										
				NX Core						Auger refused @ 45'
										Sampler refused @ 50'
50		3"		S	(50/3")					

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin walled Shelby tube.

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PROJECT Mo[illegible] Hp

JOB NO. E81-63K DATE 1/19/82

LOG OF TEST BORING NO. D85

RIG TYPE CME-55 #203

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth In Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	Silty, sand
		16	X	U	3-3-3-4-U			SM		Low pl.
										wkly cemented
		21	X	U	3-3-3-3-3					tan to gray
5										
		18	X	U	1-2-2-3-16				firm	
			X							TAILINGS
		10	X	U	18-24-50/4"				dry hard	Bedrock red
										SLOBALE
10										Auger stopped @ 5.0'
										sampler refusal @ 8'10"
15										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE 11/20/82

LOG OF TEST BORING NO. B86

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		21"	X	S	2-3-3-4-6			SM	moist soft	silty, sand Low PI. wkly cemented white to tan
		20"	X	S	4-3-11-4-9				med firm	
5		21"	X	S	4-4-6-6-6					
		21"	X	S	3-5-5-8-9				firm	
10		20	X	S	8-8-9-9-11					
		21"	X	S	7-8-11-12-13					
15		18"	X	S	8-10-10-15-16					
		20"	X	S	11-10-11-12-13					
20		20"	X	S	7-7-14-23-25				v. firm	
		21"	X	S	12-17-16-23-20					
25		16"	X	S	11-10-11-13-13					
		21"	X	S	12-17-18-19-20					
30		20	X	U	[illegible]				firm	
		10	X	U	5-6-[illegible]-7-7					
35		15	X	U	[illegible]					TAILINGS SUBGRADE
		16	X	U	9-11-17-30-50/5				dry hard	bolivar red
40										Auger refusal @ 5.. [illegible] refusal @ 39'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Marion HA

JOB NO. E81-63K DATE 1/19/82

LOG OF TEST BORING NO. C87

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty, SAND low P.I. wk'y cemented tan to white & grey
		20	X	S	3-4-3-4-5					
		21	X	S	4-4-5-5-4					
5										
		22	X	U	3-5-3-5-6					
		17	X	U	4-4-4-5-6					
10										
		23	X	U	4-6-5-6-6					
		20	X	U	5-7-9-7-10				firm	TA)2 1/10 0.5
15		10	X	U	16-33-50/3				dry HARD	bedrock red Subbase
20										Auger stopped @ 5½' sampler refused @ 16'3"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican [illegible]

JOB NO. E81-63K DATE 1/19/82

LOG OF TEST BORING NO. B86

RIG TYPE CME-55 #203

BORING TYPE 6 1/4" HSA

SURFACE ELEV.

DATUM

Depth, in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									mois [illegible] soft	silty, sand
		21		u	1-1-5-5-6					low pl
		20		u	5-5-5-5-8				mod	with cemented
5									firm	tan to gray
		22		u	5-6-9-9-9					
		21		u	5-6-1-10-9					
10										
		20		u	9-9-8-12-15				firm	
		21		u	9-6-9-11-8					
15										
		20	X	u	6-6-9-10-10					
		21	X	u	8-7-9-9-10					
20										
		20	X	u	9-10-11-10-13					
		23	X	u	11-11-12-13-18					
25										
		22	X	u	8-8-10-11-15					
		21	X	u	14-14-15-15-15					
30										
		20	X	u	11-11-15-15-18					TAILINGS
		22	X	u	11-13-14-15-17					subface
35		9	X	u	16-50/5"				dry rapid	bedrock red

Auger stopped @ 5.0'
sampler refused @ 35'11"

40

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
[illegible] 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE 1/19/82

LOG OF TEST BORING NO. C89

RIG TYPE CME-55 #303

BORING TYPE 6" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		20	X	U	3-4-5-6-4			SM	moist soft	silty, sand loose. w/ cemented tan to grey
		18	X	U	3-4-6-4-4					
5		21	X	U	2-3-3-4-4					
		23	X	U	4-5-5-5-4				mod firm	
10		26	X	U	5-5-4-5-6					
		27	X		11-10-30-49-50/0				dry hard	bedrock red — tailings subbase
15										Auger stopped @ 5.0' sampler refused @ 14'6"
20										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mesa [illegible]

JOB NO. 81-63K DATE 1/19/82

LOG OF TEST BORING NO. C90

RIG TYPE CME-55 #203

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23	X	U	5-6-6-7-9			SM	moist soft	SILTY, SAND loose cwk's cemented [illegible] to grey TAILINGS
		20	X	U	5-6-7-7-7					
5		9	X	U	3-50/5½"				dry hard	SUBGRADE bedrock red
10										Auger stopped @ 5.0' sampler refusal @ 5' 11½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. EBI-63K DATE 1/19/82

LOG OF TEST BORING NO. D91

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty sand low PI (slightly cemented) tan to grey
		21		S	4-6-7-12-16			SM		
		20			20-17-20-17-20					
5										
		20		S	4-6-7-8-9				mod firm	
		18			8-8-9-18-25/5"					TAILINGS SUBBASE
10									dry hard	bedrock red.
15										Auger stopped @ 5.0 sampler refusal @ 9'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE 1/19/82

LOG OF TEST BORING NO. D92

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		22	X	U	1-2-3-5-7			CL	moist soil	silty sand loose. wk'ly cemented tan to gray
		21	X	U	4-4-6-6-7					
5		20	X	U	2-3-7-8-9				mod. firm	
		21	X	U	4-4-5-7-8					
10		19	X	U	10-11-14-46-50/½				dry - hard	bedrock red
15										Auger stopped @ 5.0' sampler refusal @ 12"½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE 1/20/82

LOG OF TEST BORING NO. B93

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24	X	U	1-3-3-4-5			SM	moist soft	SILTY SAND Loup I.
		21"	X	U	3-5-7-9-8				mod firm wkly cemented	tan to grey
5		21"	X	U	3-3-4-5-6					
		20"	X	U	4-4-5-7-8					
10		21"	X	U	4-4-6-6-9					
		17"	X	U	6-6-6-7-8					
15		20"	X	U	11-8-8-11-12					
		20"	X	U	9-9-9-13-16				firm	
20		18"	X	U	7-9-12-13-15					
		18"	X	U	9-13-17-28-29				HARD	
25		16	X	U	10-11-11-13-14					
		23	X	U	10-11-10-11-11				mod firm	
30		20	X	U	4-4-6-7-6					
		23	X	U	5-6-7-12-16					TAILING
35		5	X	U	50/5"				bedrock red	subbase
40										Auger refusal @ 5.0' sample refusal @ 35'5½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/20/82

LOG OF TEST BORING NO. C94

RIG TYPE CME 75(206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	moist	Silty Sand NP gray.
		24"		T						
		21"		T						
5										
		20"		T						
		23"		T						
10										
		23"		T						
		25"		T						
15										tailings subbase
				T						Sandstone
				NX Core						
20										
25										Auger stopped @ 10' Sample refused @ 15' NX core stopped @ 21'
30										

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E61-67K DATE 7/20/82

LOG OF TEST BORING NO. C95

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth Below Surface	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM	moist soft	silty, sand
		2½	X	T						low PI
										w/ cemented
		2½	X	T						tan to grey
5										
		2½	X	T						
		2½	X	T						
10										
		2½	X	T						
		2½	X	T						
15										
		2½	X	T						
		2½	X	T						tailings subbase
20									dry hard	bedrock red
										Sampler refusal @ 20'3"
25										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/20/82

LOG OF TEST BORING NO. C95

RIG TYPE CME 75 (206) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
5										
10										
15										
20										tailings subback
				NX Core						Sandstone
25										
30										Auger stopped @ 20' NX coring @ 20'6" - 26' Hole sampled previously - re-augered for coring

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT MEXICAN HAT

JOB NO. E81-63K DATE 1/20/82

LOG OF TEST BORING NO. C96

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X					SM	moist — Ex:	Silty, sand
		2½	X	T						Loose
										wk'ly cemented
		2½	X	T						tan to grey
5										
		2½	X	T						
		2½	X	T						
10										
		2½	X	T						
										Tailings
		10	X	T					dry — HARD	Bedrock C
										sub-base
15										sampler refusal @ 13'6"
20										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/22/82

LOG OF TEST BORING NO. C96

RIG TYPE CME 75(200) CC

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
5										
10										
15				NX Core						Sandstone
20										Auger stopped @ 14' NX core stopped @ 19'

GROUND WATER

DEPTH	HOUR	DATE
None		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E91-8316 DATE 11/20/92

LOG OF TEST BORING NO. C97

RIG TYPE CME-55 (203)

BORING TYPE 12 1/8" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty, SAND
		2 1/2'	X	T				SM		low PI
										wkly cemented
		2 1/2'	X	T						tan to grey
5										
		2 1/2'	X	T						(TAILINGS)
										(SLUBBASE)
										sampler stopped @ 7 1/2'
10										
15										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Morenci AZ

JOB NO. 2[illegible]K DATE 1[illegible]52

LOG OF TEST BORING NO. D98

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty, SAND
		2½		T				SM		Low pl.
										wkly cemented
		2½		T						tan to grey
5										
		2½		T						
		2½		T						
10										
		2½		T						
		2½		T						
15										
		2½		T						
		2½		T						
20										
		2½		T						(TAILINGS)
										(SUBBASE)
		2½								bed rock
									air rtfr	rock
25										Completed @ 25.0'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT _____ **LOG OF TEST BORING NO. D99**

JOB NO. K DATE 2

RIG TYPE CME-55 #203

BORING TYPE 6½" HSA

SURFACE ELEV. _____

DATUM _____

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	Silty sand loose. Well compacted tailings
		23"			2-3-5-5-6					
		21"			4-4-5-5-5					
5										
		18"			2-3-3-2-3					
		20			2-3-3-4-7					(TAILINGS)
10										
		18			12-11-10-50(3")				dry hard	bedrock red (SUBBASE)
15										Auger stopped @ 10' sampler refusal @ 11'9"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. [illegible] DATE [illegible]

LOG OF TEST BORING NO. D100

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23"	X		1-2-2-3-4				[illegible] soft	[illegible]
		24"	X	U	2-2-2-3-[illegible]					
5		25"		U	3-4-6-6-7				mod firm	
		22"		U	4-3-4-4-6					
10		21"		U	4-4-4-5-6					
		23"		U	5-4-4-6-7					
15		21"		U	5-4-4-4-7					
		21"		U	6-5-5-7-9					
20		21"	X	U	5-5-6-6-9					
		20"	X	U	6-6-7-7-11					
25		20"	X	U	7-6-[illegible]-9-11					
		20"	X	U	8-8-7-9-13					
30		21		U	6-7-8-11-12					
		22"		U	8-10-10-12-13					
35		20"	X	U	8-9-9-12-15					
		21"	X	U	10-8-9-12-16				firm	
40		20"	X	U	12-8-[illegible]-11-[illegible]					(TAILINGS) (SUBGRADE)
		21"		U	[illegible]-13-10-15-17					
45		12	X	T	14-50/2					
50										

Auger refusal @ 50'

Granite refusal @ 46.2'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. [illegible]K DATE [illegible]

LOG OF TEST BORING NO. D101

RIG TYPE [illegible] (203)

BORING TYPE [illegible]

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		2½							moist soft	SILTY SAND low plastic weakly cemented SAND to gray
		2½		T						
5		2½		T						
		2½		T						
10		2½		T						
		2½		T						
15		2½		T						
		2½		T						
20		2½		T						
		2½		T						
25		2½		T						
		2½		T						
30		2½		T						
		2½		T						
35		2½		T						
		2½		T						
40		2½		T						
		2½		T						(TAILINGS) (SUBBASE)
45		2½								
		2½								
		13								

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible] 45

JOB NO. EB1-63K DATE [illegible]

LOG OF TEST BORING NO. D102

RIG TYPE CME-55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist soft	silty, sand
		23		U	1-4-4-6-7			SM		Low pl
										wkly cemented
		23		U	3-3-4-5-6					tan to grey
5										
		24		U	3-3-3-3-4					
		26		U	3-4-4-4-6					
10										
		23		U	4-4-4-4-6					
		22		U	3-4-4-4-7				mod firm	
15										
		23		U	4-5-4-4-7					
		25		U	5-4-4-6-8					
20										
		24		U	5-5-5-7-10					
		22		U	6-6-7-8-10				firm	
25										
		22		U	6-7-7-9-7					
		21		U	7-8-9-11-14					
30										
		23		U	8-7-8-11-11					
		24		U	7-8-[illegible]-13					
35										(TAILINGS)
		23		U	8-7-[illegible]-22-22					(SUBBASE)
										bedrock red
		20		U	17-17-16-35				dry NAPD	
40										Auger stopped @ 5.0'
										sample refusal @ 39'8"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. EBI-63K DATE [illegible]

LOG OF TEST BORING NO. D103

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
		78		U	1-4-4-7-7			SM	moist soft	silty SAND low plastic with cemented lens to gravel
		24		U	5-4-5-6-6					
5		18		U	3-2-3-4-5				mod firm	
		25		U	5-3-5-3-7					
10		18		U	5-4-5-5-7					
		24		U	4-5-4-5-7					
15		18		U	6-6-7-6-7					
		23		U	6-7-6-6-7					
20		18		U	6-5-6-5-8					
		24		U	6-5-7-5-11					
25		18		U	6-8-6-7-10				firm	
		25		U	6-5-7-5-11					
30		18		U	9-5-7-7-13					
		24		U	9-6-7-9-20					(TAILINGS)
35		7 (NR)		U	13-9-6-7-10				moist	bedrock (SUBBASE)
				U	50/5"					
40										Auger stopped @ 5.0' sampler refusal @ 37'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. EB1-63K DATE [illegible]

LOG OF TEST BORING NO. D104

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		23	X	U	2-3-3-4			SM	moist soft	silty sand low cl. wkly cemented tan to gray
		24	X	U	3-3-5-7					
5		25	X	U	5-2-4-6-4					
		22	X	U	5-4-5-6-8					
10		23	X	U	4-5-4-7-9					
		24	X	U	6-5-5-6-8					
15		18	X	U	6-7-8-9-12					
		24	X	U	9-7-8-11-13					
20		23	X	U	7-8-9-14-14					
		23	X	U	10-9-10-13-14					
25		14	X	U	7-7-8-12-15					
		32	X	U	10-12-14-15-16					
30		24	X	U	9-7-7-9-13					
		21	X	U	7-12-17-17-19					
35		9	X	U	20-50/5					(TAILINGS) (SUBBASE) poorly graded red

Auger stopped @ 5.0'' on [illegible] @ 35''

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. [illegible] DATE 1-22-82

LOG OF TEST BORING NO. D105

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		24	X	U	3-4-5-7-8			SM	moist mod firm	Silty SAND loose to wkly cemented tan to grey
		22	X	U	5-3-3-8-8					
5		21	X	U	8-8-7-6-8					
		22	X	U	5-5-6-6-10				firm	
10		23	X	U	6-7-10-11-12					
		24	X	U	9-9-7-11-13					
15		18	X	U	10-8-5-12-14					
		18	X	U	13-14-13-14-14					
20		23	X	U	10-9-11-13-15					
		21	X	U	9-9-10-12-16					
25		21	X	U	7-9-10-12-18					
		20	X	U	15-13-13-13-15					
30		14	X	U	16-12-11-17-19					
		21	X	U	15-15-18-19-21					
35		20	X	U	12-14-16-18-20					
		21	X	U	[illegible]					
40		23	X	U	15-13-15-14-20					
		23	X	U	16-12-14-18-19					
45		21	X	U	11-10-11-18-21					
		23	X	U	14-17-12-18-22					
50										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. [illegible] DATE [illegible]

LOG OF TEST BORING NO. D10.5

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50										
		21	X	U	16-15-16-22-23					(TAILINGS)
		16	X	U	16-15-16-23-5.3/3½"				dry NFRD	Bedrock red (SUBBASE)
55										Auger stopped @ 5.0' sampler refusal @ 54' 9½"
60										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T. – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E81-63K DATE [illegible]

LOG OF TEST BORING NO. 106

RIG TYPE CME-55 (203)

BORING TYPE 1½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		7	X						dry hard	bedrock red
				4	17-50/5"					
5										sample refusal @ 11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E81-63K DATE [illegible]

LOG OF TEST BORING NO. 107

RIG TYPE CME-55 (203)

BORING TYPE [illegible]

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		17	X		4-11-34-47-50/4"				dry	bedrock (SUBBASE) red
5										sampler refusal @ 1'10"
10										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat

JOB NO. E81-63K DATE 1/23/82

LOG OF TEST BORING NO. 108

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		13'							dry hard	bedrock red
			U		31-31	50/5"				
5										sample refusal @ 1'5"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mohicans HFT

JOB NO. [illegible] DATE 1/23/82

LOG OF TEST BORING NO. 109

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X						dry HARD	bedrock
		23	X	U	8-11-10-35-15					red
		19	X	U	14-13-11-18-50/5"					
5										sampler refused @ 4' 11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E81-63K DATE [illegible]

LOG OF TEST BORING NO. 1

RIG TYPE CME-55 (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth In Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									dry natural	bedrock red subbase
5										
10										
										auger refusal @ 11.0' piezometer hole - (no piez. set.)

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample.
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. EB1-63K DATE [illegible]

LOG OF TEST BORING NO. 4

RIG TYPE CME-55 (203)

BORING TYPE 6" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									dry	bedrock (sulfate) fr.
5										Auger stopped @ 8' piezometer not set.
10										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. [illegible] K DATE [illegible]

LOG OF TEST BORING NO. 200

RIG TYPE Ome 55 (203)

BORING TYPE [illegible]

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		1½'	X	T				-	dry hard	bedrock subbase red
5										Sample refusal @ 1'6"
10										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63 K DATE 1/24/82

LOG OF TEST BORING NO. CSU 200

RIG TYPE CME 75 (206)

BORING TYPE

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
5										Sandstone & Siltstone
10				NX Core						
15										
20										
25										Auger stopped @ 3' NX core stopped @ 23'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible] KM

JOB NO. E81-63K DATE 11/23/82

LOG OF TEST BORING NO. 201

RIG TYPE CME-5- (203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		2½	X	T					dry nARD	bedrock red
	—			4	50/0"					
5										sampler refusal @ 2½' auger refusal @ 4.0'
10										
15										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexicano Rft

JOB NO. E81-63K DATE 1 23 82

LOG OF TEST BORING NO. 202

RIG TYPE CME-55 #(203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		2½	X	T				SM	moist soft	silty sand low ρ= w/c'g cemented tan to grey
5		18	X	S	2-4-3					
10		18	X	S	3-3-3				v. moist	
15		2.0	X	T					hard dry	bedrock rec (Tailings) (subbase)
20		NR			50/6"					Auger slipped @ 19'6" sampler refused @ 19'8"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. EB-63K DATE 1/22/82

LOG OF TEST BORING NO. 203

RIG TYPE CME-55 #(203)

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		14	X	S	2-1-1			SM	moist soft	Silty SAND low PI w/ly cemented tan to yellow
5		2.0'	X	T						
10		18"	X	S	2-3-3				v. moist	
15		19	X	S	3-3-2					
20		18"	X	S	4-5-6					
25		2.0'	X	T						
30		16"	X	S	14-17-48				moist hard	bedrock (TAILINGS) (SUBBASE) rei
35					50/0"					Auger refused @ 34'6" sampler refused @ 34'6"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. EB-63K DATE [illegible]

LOG OF TEST BORING NO. 204

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		14	X	S	1-2-2			SM	moist soft	silty, SAND Low PI. w/ly cemented tan to gray
5		18	X	S	3-5-5					
									½ moist	
10		2½	X	T						
15		18"	X	S	4-4-6					
20		18"	X	S	5-7-8					
25		18	X	S	11-16-17					
30		2½"	X	T						
35		18	X	S	5-6-8					(TAILINGS) (SUBGRADE) bedrock red
									moist	
40		NR			50/1"					auger stopped @ 39'6" sampler refusal @ 39'7"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E81-63K DATE 1-22-[illegible]

LOG OF TEST BORING NO. 205

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	moist loose	silty, SAND Low PI wkly cemented tans to gray (TAILINGS)
		2½		T						
		2½		T					dry hard	bedrock (SUBBASE) red
5										
										Sampler refused @ 5.0'
10										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/23/82

LOG OF TEST BORING NO. 205

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
5										
10				NX Core						Siltstone some interbedded shales and sandstones
15										
20										
25										
30										Auger stopped @ 5 1/2' NX coring stopped @ 25 1/2'

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E81-631K DATE [illegible]

LOG OF TEST BORING NO 206

RIG TYPE CME-55 (203)

BORING TYPE 6¼" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		0½	X	T				SM	moist SOFT	Silty, sand low p= widely cemented tan to grey.
5		17'	X	S	4-6-4					
10		19'	X	S	4-3-3					(TAILINGS) (SUBBASE)
									bedrock red	
15		14½'	X	T					dry HARD	
										Auger stopped @ 14'6" sampler refusal @ 16.0'
20										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT Mo-E (Pa) [illegible]

JOB NO. E81-63K DATE 1/22 81

LOG OF TEST BORING NO. 207

RIG TYPE CME-55 (203)

BORING TYPE 6¼" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		16	X	S	3-3-2			SM	moist soft	silty, SAND Low P.T. wkly cemented. tan to grey
5		21½	X	T						
10		14	X	S	1-2-1					
15		16	X	S	3-3-4					
20		12	X	S						(TAILINGS)
		N.R.		S	50/1				dry HARD	bedrock (SUBBASE) red
25										Auger stopped @ 24'6" sample refusal @ 24'7"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

S B

132'

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PROJECT [illegible]

JOB NO. E81-631C DATE 1/20/92

LOG OF TEST BORING NO. 208

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		2½'		T				SM	moist soft	silty, sand Low PI. wkly cemented tan to grey
		2½'		T						
5		2½'		T						
		2½'		T						
10		2½'		T						
		2½'		T						
15		2½'		T						
		2½'		T						
20		2½'		T						
		2½		T						(tailings) (subbase)
25		2½		T						bedrock red
		2.0'		T					dry HARD	
30										Sampler refusal @ 29½'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE

PROJECT Mexican Hat Tailings

JOB NO. E81-63K DATE 1/22/82 - 1/23/82

LOG OF TEST BORING NO. CSU 208

RIG TYPE CME 75 (206) CC

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										
5										
10										
15										
20										
25										
30				NX Core						Siltstone some interbedded sands and mudstone
35										
40										
45										
50										Auger stopped @ 27' NX core stopped @ 47'

GROUND WATER

DEPTH	HOUR	DATE
NONE		

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

S B

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PROJECT [illegible]

JOB NO. E81-63K DATE [illegible]

LOG OF TEST BORING NO. 209

RIG TYPE CME-55 #203

BORING TYPE 6 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		2 1/2	X	T				SM	moist	SOIL: SAND [illegible] [illegible] [illegible]
5		18	X	S	2-2-3					
10		20	X	T						(TAILINGS) bedrock (SUBBASE). hard
										hole plugged @ 10.0' sample refusal @ 12.0'
20										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E91-63K DATE 11/2-/82

LOG OF TEST BORING NO. 210

RIG TYPE CME-55 (203)

BORING TYPE 6½" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		1R	X	S	2-1-3			SM	moist soft	Silty, SAND Low pl. wkly cemented tan to white + grey (TAILINGS)
				S	50/0"				dry hard	bedrock red (SUBBASE)
										Auger stopped @ 50' Sample refusal @ 2'6"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. E81-63K DATE [illegible]

LOG OF TEST BORING NO. 211

RIG TYPE CME-55 #(203)

BORING TYPE 1 1/2" HSA

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		18	X	S	2-2-2			SM	moist soft	silty sand loose. well cemented tan to gray
5		18	X	S	3-4-4					
10		18	X	S	4-4-4					
15		18	X	S	3-3-3					
20		18	X	S	5-5-4				mod firm	
25		18	X	S	3-4-6					(TAILINGS) (SUBBASE)
										bedrock real
30		16	X	S	3-5-5-5				dry hard	
										Auger stopped @ 29'6" sampler refused @ 30'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

SERGENT, HAUSKINS & BECKWITH

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PHOENIX · ALBUQUERQUE · SANTA FE · SALT LAKE CITY

PROJECT [illegible]

JOB NO. E81-63K DATE 1/23/82

LOG OF TEST BORING NO. 212

RIG TYPE CME-55 (203)

BORING TYPE [illegible]

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
5		13	X	U	1-4-6			SM	moist soft	silty sand low pt. with cinders tan to gray
6		18	X	U	3-2-3					
10		18	X	U	5-4-5				med firm	
15		18	X	U	6-6-7					
20		17	X	U	6-5-6					
25		16	X	U	6-5-6				firm	
30		17	X	U	6-6-7					
35		13		U	3-4-6				hard	bedrock (TAILINGS) (SUBBASE) lead
		[illegible]		U	50/5"					Auger refusal @ 37'6" sample refusal @ 37'11"
40										

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT [illegible]

JOB NO. [illegible]-63K DATE [illegible]

LOG OF TEST BORING NO. 214

RIG TYPE CME-55 (203)

BORING TYPE [illegible]

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		18	X	S	2-2-2			SM	moist SST	silty sand loose w/ g concreted tan to white to yellow
5		13	X	S	2-2-1				V. moist	[Note: slime layers from 4½ to subbase]
10		17"	X	S	2-2-2					
15		18	X	S	3-3-3					
20		18	X	S	2-3-4					
[illegible]		17	X	S	3-4-[illegible]				mod firm	(TAILINGS)
									moist	(SUBBASE) [illegible]
		NR			[illegible]				HARD	
30										Auger stopped @ 29'6" Sampler refusal @ 29'9"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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TEST PIT LOGS OF COVER BORROW AREA

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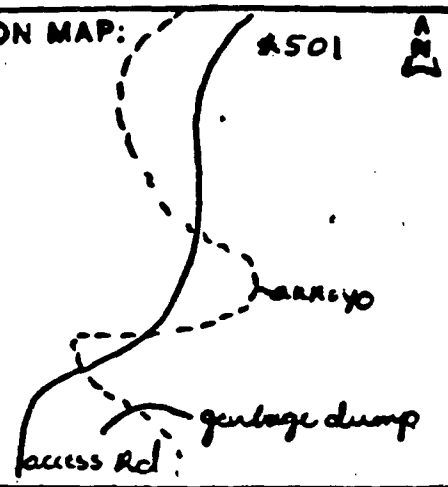
JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

Page 1 of 1

LOCATION MAP:



SITE ID: Hot-01 LOCATION ID: 501
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/14
BACKHOLE TYPE: Case 580
CONTRACTOR: Blake Cont
FIELD REP: McKenzie
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION on east side of access road ≈ 100 yds N-NE of garbage dump
SITE CONDITION Sage brush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC. (Gr F to Cs)
	X	L	001	~~SM~~ SP-SM	~~Silty~~ Sand, ~~trace~~ fines, little or no clays, N.P. ~~to low plasticity~~, 5YR 6/8 reddish yellow
	X	B	002		
3.0					
	X	B	003	~~GW~~ GP	well graded gravel & sand mixture, ~~some~~ silt, little or no clay, gravels up to 3" max. N.P. ~~to low plas.~~ 5YR 6/8 reddish yellow
5.0					
	X	B	004	SM	Silty Sand, trace silt, trace gravel, little or no clays, N.P. ~~to low P.~~ 5YR 6/8 reddish yellow
	X	B	005	GP	
	X	L	006	~~GW~~	
	X	B	007		
10.0					~~well graded~~ gravel & sand mix, ~~some~~ silt, little or no clay, gravels are increasing to max of 6", ~~no~~ N.P. ~~to low P.~~, 5YR 6/4 light reddish brown
					Stop digging backhoe extended

COMMENTS: L: large sample disturbed wards mix
B: Bag sample
Soils (F.E.S.) Fi to V. Fi

SAMPLE TYPE
~~B - Undisturbed Block Sample~~
D - Disturbed Bulk Sample

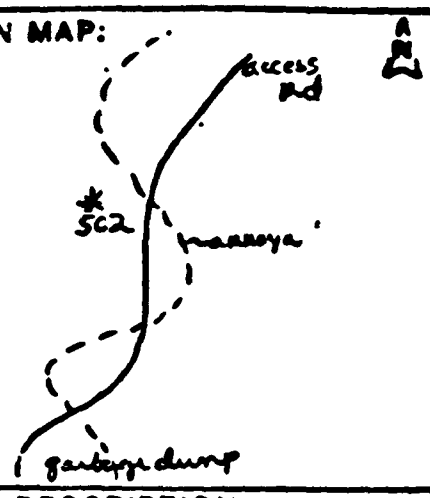
JEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

Page 1 of 1

LOCATION MAP:



SITE ID: H.T-01 LOCATION ID: 502
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/14
BACKHOLE TYPE: CASE
CONTRACTOR: Blake Ent
FIELD REP: McKenzie
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION on point bar ≈ 400 yds N-NE of garbage dump
SITE CONDITION Scrub brush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
	X	D	001	SP-SM	~~Sandy~~-Sand, ~~fine fine~~ F silty, little or no clay Some rootlets, N.P. ~~to low P~~, SP MST 5YR 6/8 reddish yellow
	X	B	002		
	X	B	003		
					TD 3" CS + o Fi TR
~~7.0~~	X	L	004A 004B	~~GW~~ GP	~~well graded~~ gravel ~~&~~ sand ~~with~~, ~~some~~ silt, little or no clay, N.P. ~~to low P~~. 5YR 6/8 reddish yellow
	X	B	005		
					stop digging backhoe extended

COMMENTS: SANDS PRED Fi to V Fi

SAMPLE TYPE
B - ~~Undisturbed Block~~ Bag Sample
D - Disturbed Bulk Sample

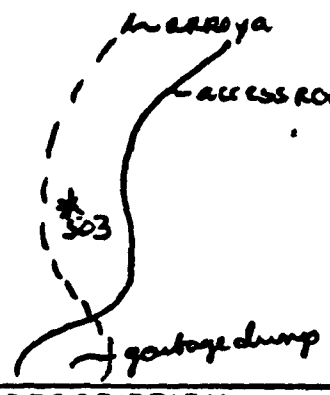
JEG-AL-ENG-7 (8/84)

4

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: Hot-01 LOCATION ID: 503
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/15
BACKHOLE TYPE: case
CONTRACTOR: Blake Entp
FIELD REP: M Runyan
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION ≈ 500 yds N-NW of garbage dump
SITE CONDITION Sagebrush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
	X	D	001 *	~~GM~~ GP	well graded gravel w/ Sand Cs to Fi ~~mix, predominately~~ ~~Sandy Sand~~, some silts, little or no clay gravels to 2½", 5YR 6/8 reddish yellow N.P. ~~to low~~, SI Mst,
2	X	B	002		
	X	D	003		
	X	B	004		
8					gravels increasing to max of 4" also quantity of gravels increasing
	X	B	005	SD	~~gravels still increasing to 2½"~~.
					stop digging backhoe extended
					Sa, Fi to Cs Gvly, Tr Slt, NP, SI Ms 5YR 6/8 R-Yel

COMMENTS: SANDS PRED Fi to V Fi
* SAMPLE 001 NOT SHIPPED TO K. ROSERS
(illegible)

SAMPLE TYPE
B - Undisturbed Block Bag Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

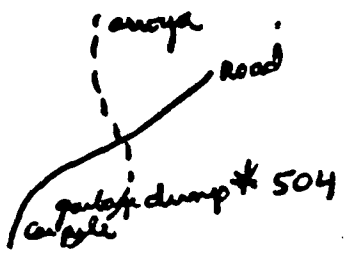
5

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

Page 1 of 1

LOCATION MAP:



SITE ID: Hat-01 LOCATION ID: 504
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/15
BACKHOLE TYPE: Case
CONTRACTOR: Blake Contrp
FIELD REP: McWhinge
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION ≈ 50 yds East of unused car pile
SITE CONDITION Sagebrush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
	X	D	001	~~GM~~ SP	~~gravel~~, sand, ~~silt~~ gv/ 5 SIE ~~moisture~~, med. F. sand
2	X	B	002		fsd, none nonplastic little or no clay, N.P. ~~to~~ SI Mst ~~low P.~~ 5YR 6/8 reddish brown
				ML	
	X	B	003		~~sandy~~ - silt NP to LP, some fine sand, Trace clay ~~low plasticity~~ 2.5YR 6/8 light red
					Dry to SI Mst
10.6	X	B	004		
					Stop digging backhoe refused

COMMENTS: SANDS PRED. Fi to V Fi

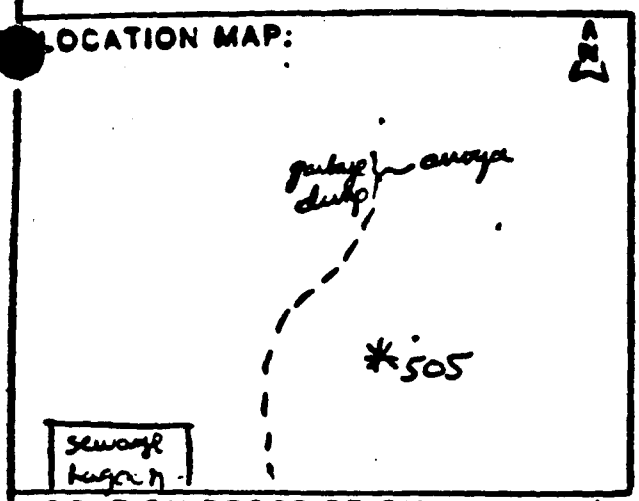
SAMPLE TYPE
B - Undisturbed ~~Block~~ Grab Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (9/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: Hot 01 LOCATION ID: 505
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/15
BACKHOLE TYPE: case
CONTRACTOR: Bliss Enterprise
FIELD REP: M. Kunz
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION ≈ 100 yds NE of sewage lagoon
SITE CONDITION Sewage lines

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, +o 3" Cs +o Fi PLASTICITY, CONDITION, ETC.
	X	D	001	~~GM~~ GP	Gravel, Sand, Silt, ~~omptine~~, ~~some gravel~~, ~~gravel~~
	X	B	002		~~Sand matt~~, some rocklite, 5YR 6/8 reddish yellow
20	X	B	003	~~GW~~	little or no clays N.P. ~~[illegible]~~
				~~GW~~	~~with gravel & sand omptine, some~~
	X	B	004		~~well, little or no clay N.P. to low P~~
	X	D	005		~~5YR 6/8 reddish yellow~~
100	X	B	006		Stop digging @ 10' large boulder from 10' down

COMMENTS: SANDS FRED Fi to V Fi

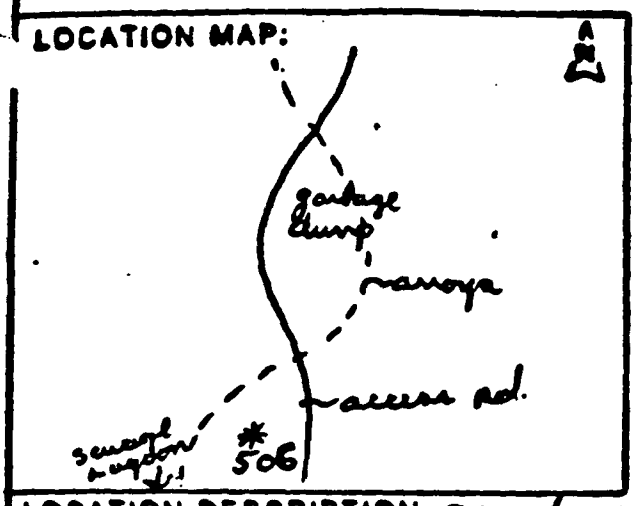
SAMPLE TYPE
B - Undisturbed ~~Bulk~~ Grab Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: 7/of-01 LOCATION ID: 506
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/15
BACKHOLE TYPE: Case
CONTRACTOR: Blake Patterson
FIELD REP: M. Mengel
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION ≈100 yds south of garbage dump ≈200 yds North of
SITE CONDITION Sewage lagoon; Sagebrush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
	X	D	001	~~SM~~ GP	Gravel; Sandy, SILT ~~sand~~, some ~~not~~ little or no clay, NP ~~to tough~~ dry to slightly moist, gravel to 4" 5YR 6/8 reddish brown.
	X	B	002		
	X	B	003		note: quantity and size of gravels increasing silt decreasing ~~[illegible]~~
9	X	B	004		
10	X	B	005	ML	~~Sandy~~-SILT, ~~some~~ trace very fine sand, ~~some~~ trace clay, low PI, dry to slightly moist 10YR 7/4 very pale brown
					stop digging backhoe extended

COMMENTS: SANDS FINE to V Fi

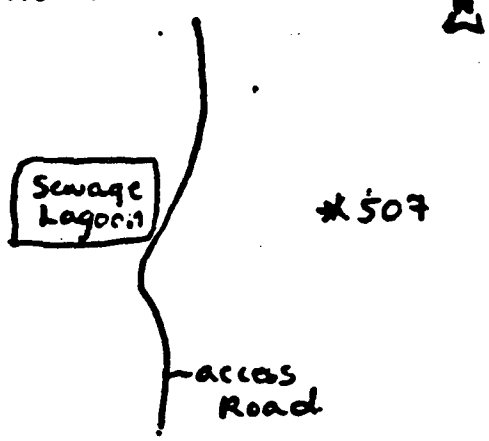
SAMPLE TYPE
B - ~~[illegible]~~ Undisturbed ~~[illegible]~~ Bag Sample
D - Disturbed Bulk Sample

IEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: Hat-01 LOCATION ID: 507
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/15
BACKHOLE TYPE: Case
CONTRACTOR: Blake Enterprises
FIELD REP: M Chenjse
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION ≈ 5 cycle ~~pc~~ North of Hwy 163 east of sewage lagoon
SITE CONDITION Sage brush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC. Fi to V Fi
	X	D	001	SP-SM	~~[illegible]~~ Sand with some gravel, Tr Silt, trace clay
	X	B	002		Some roots to NP Silt Mst ~~[illegible]~~. 5YR 6/8 reddish yellow
					GRAV INCREASING W/ DEPTH
	X	B	003		
4.0	X	B	004	GP ~~GW~~	~~well graded~~ gravel, To Sand, Lt to Tr to No Silt ~~mixture~~, ~~little~~ Tr to no clay, NP ~~to low~~ P. 5YR 6/8 reddish yellow
	X	D	005		
	X	B	006	GP	Sa, Fi, No SH or Cl, NP, Lt Gr W, Dry
8.0	X	D	007	GP ~~GW~~	~~well graded~~ gravel, Fi Sand mix. ~~little or~~ Tr to ~~no fines~~ Silt or Cl, N.P., cobbles to 8", 10YR 7/6 yellow
	X	B	008		

COMMENTS: SANDS PRED Fi to V Fi

SAMPLE TYPE
B - Disturbed Bag Sample
D - Disturbed Bulk Sample

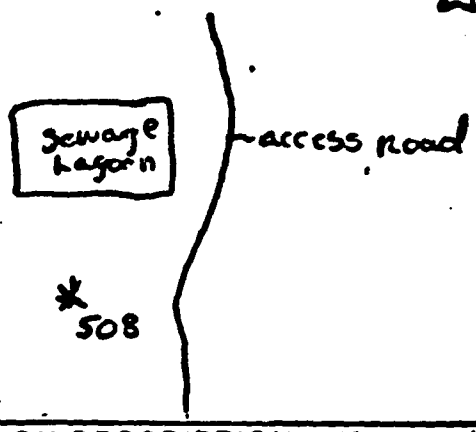
JEG-AL-ENG-7 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

Page 1 of 1

LOCATION MAP:



SITE ID: Hol-01 LOCATION ID: 508
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/15
BACKHOE TYPE: Case
CONTRACTOR: Blake Enterprises
FIELD REP: M. Kenzie
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION 75 yards South of Sewage Lagoon (on East)
SITE CONDITION Sagebrush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
	X	D	001	GM	Gravel, Sandy Silt ~~mix~~, gnd. sand & silt ~~well graded~~, little or no clays, NP. ~~tenacious~~ 5YR 6/8 reddish yellow, some rootlets
	X	B	002		
	X	B	003		
6.0				GP	gravel quantity and size increasing → GW
8.0	X	B	004		
	X	D	005	SM	Silty F Sand, ~~some~~ Gv'ly fine gravels, Trace clay, NP ~~Low~~ P. 5YR 6/8 reddish yellow
	X	B	006	SP-GP	
					Stop digging backhoe extended

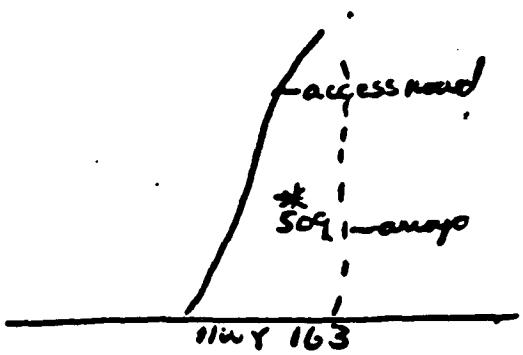
COMMENTS: SANDS PRED Fi to VFi

SAMPLE TYPE
B - Undisturbed ~~Bulk~~ Bag Sample
D - Disturbed Bulk Sample

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: HGI-01 LOCATION ID: 509
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 95/5/15
BACKHOLE TYPE: Case
CONTRACTOR: Blake Enterprises
FIELD REP: McKenzie
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION ≈ 300 yds North of HWY 163
SITE CONDITION Sagebrush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
	X	D	001	SM	~~Silty~~ - Sand, F to VF, some silt, ~~some~~ ~~silt~~, ~~little~~ ~~to no~~ clay, N.P to low P. 5YR 6/8 reddish brown. Slm st. to Mst
	X	B	002		
	X	B	003		
6a	X	D	004		C Horizon, Ca layer, took large sample
9	X	B	005		~~well graded~~ gravel, F Sandy ~~mixture~~, ~~some~~ ~~fines~~ silt little or no clay, N.P ~~to low P.~~ gravels to 3"
10	X	B	006	GP	
					Stop digging backhoe fully extended

COMMENTS: _____

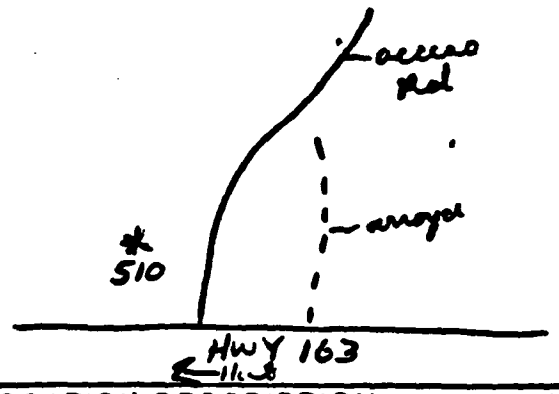
SAMPLE TYPE
B - ~~Undisturbed~~ ~~Bulk~~ Bag Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: Hat-01 LOCATION ID: 510
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 45/5/15
BACKHOLE TYPE: Case
CONTRACTOR: Blake Construction
FIELD REP: M. Hengile
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION ≈ 100 yds North of HWY 163 on West Side of access rd
SITE CONDITION Sagebrush

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
	X	D	001	~~GW~~ GP	~~well graded~~ gravel, / Sandy mixture, ~~some~~ silt, gravels to 4", ~~little or no clay~~, some rock lits, N.P. ~~to soft~~, 5 YR 6/8 reddish yellow
	X	B	002		
5.0	X	B	003		
					Refusal @ 5' Bedrock

Tr to N.

COMMENTS: _____

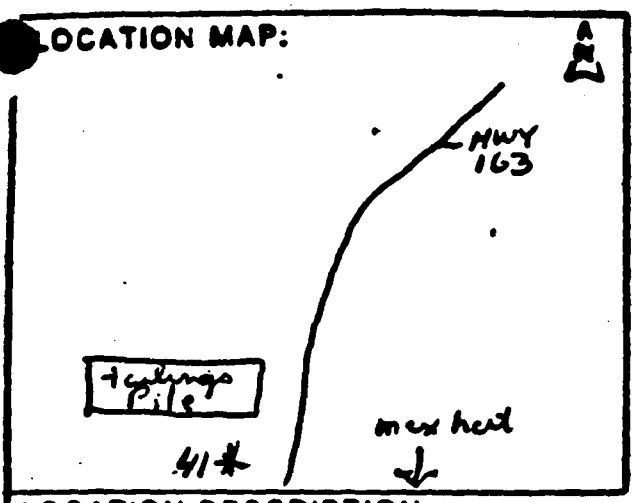
SAMPLE TYPE
B - ~~Undisturbed Bulk~~ Grab Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:



SITE ID: Hit-01 LOCATION ID: 41
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/16
BACKHOLE TYPE: N/A
CONTRACTOR: N/A
FIELD REP: McHenjoe
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
		D	001		surface outcrop sample; siltstone, fine grained, ≈ 100 pd retained

COMMENTS: _____

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (8/84)

ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

TEST PIT LOG

LOCATION MAP:

SITE ID: H.S-01 LOCATION ID: 12
APPROX. SITE COORDINATES (ft)
N _____ E _____
GROUND ELEV. (FT. MSL) _____
DATE EXCAVATED: 85/5/16
BACKHOLE TYPE: NA
CONTRACTOR: NA
FIELD REP: McKinzie
REHAB. DATE: _____

GROUNDWATER LEVELS			
DATE	TIME	DEPTH (ft)	EST. FLOW (GAL/MIN)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (ft.)	SAMPLE INT	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
		D	001		surface sample from outcrop: limestone some dolomite, fined micaceous retained ≈100 pds

COMMENTS: _____

SAMPLE TYPE
B - Undisturbed Block Sample
D - Disturbed Bulk Sample

JEG-AL-ENG-7 (9/84)

ADDENDUM D5

PARTICLE SIZE DISTRIBUTION CURVES

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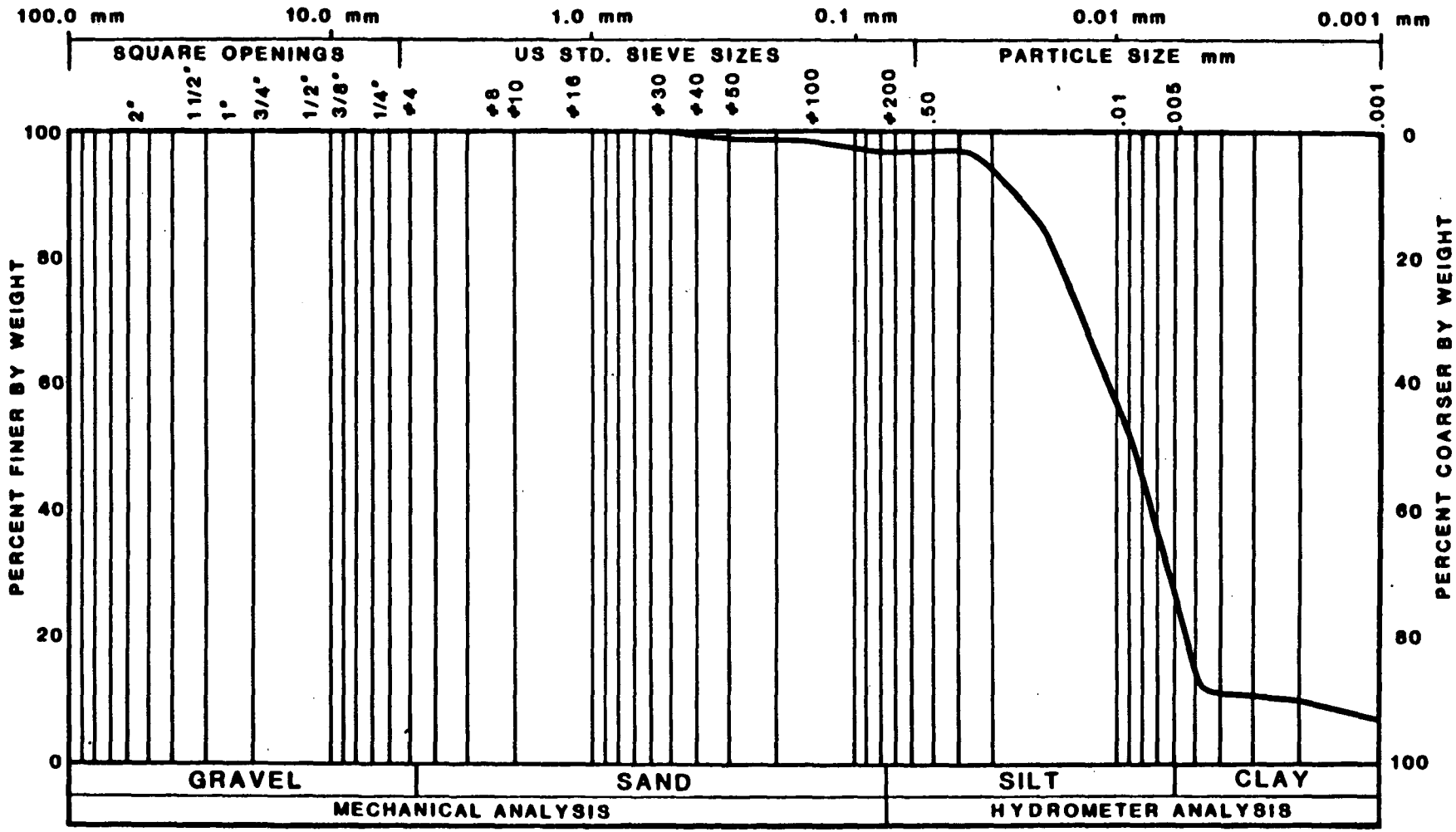
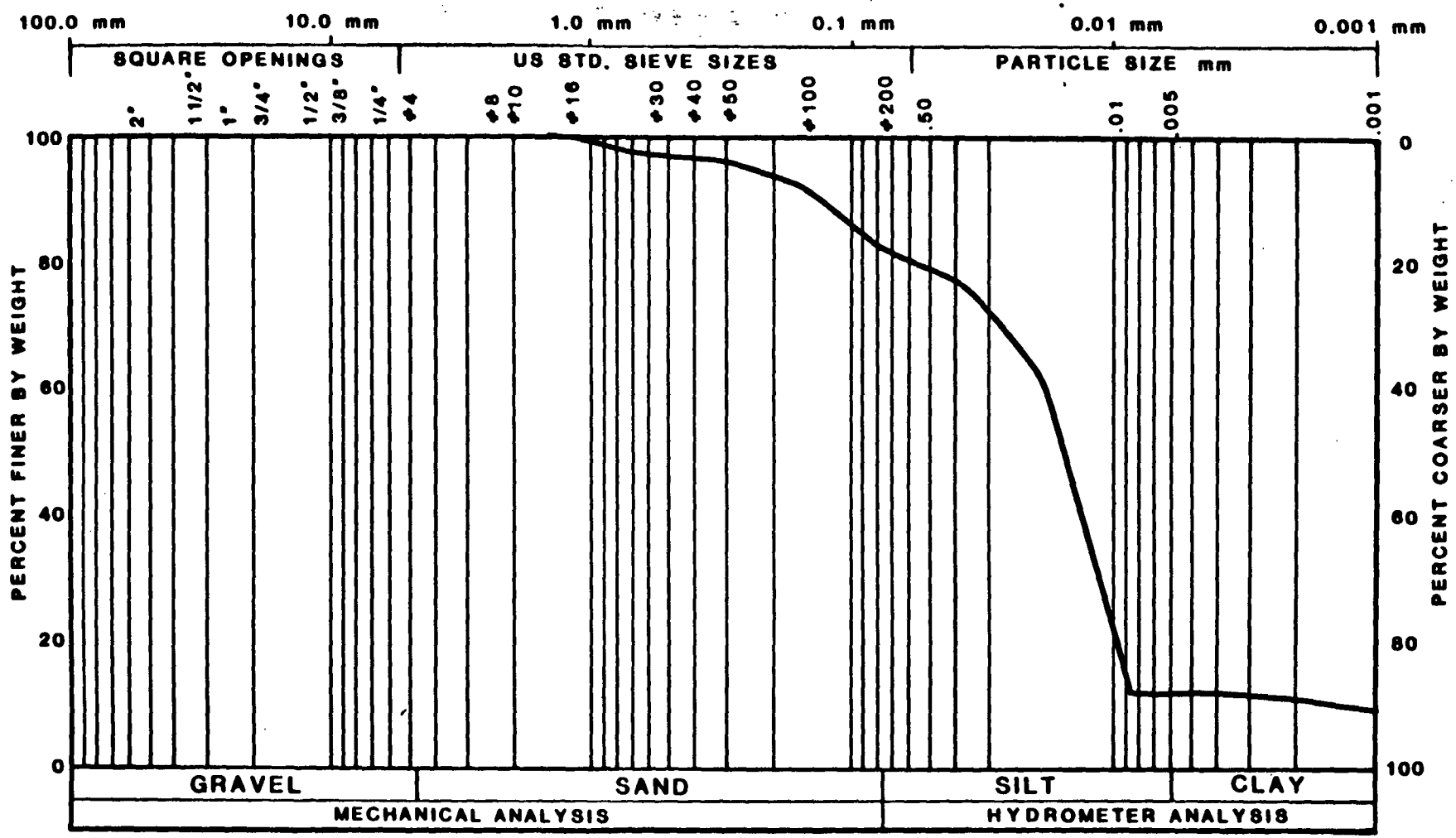


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
126	3.0-5.5	CL

FIGURE D5.1
PARTICLE SIZE DISTRIBUTION CURVE

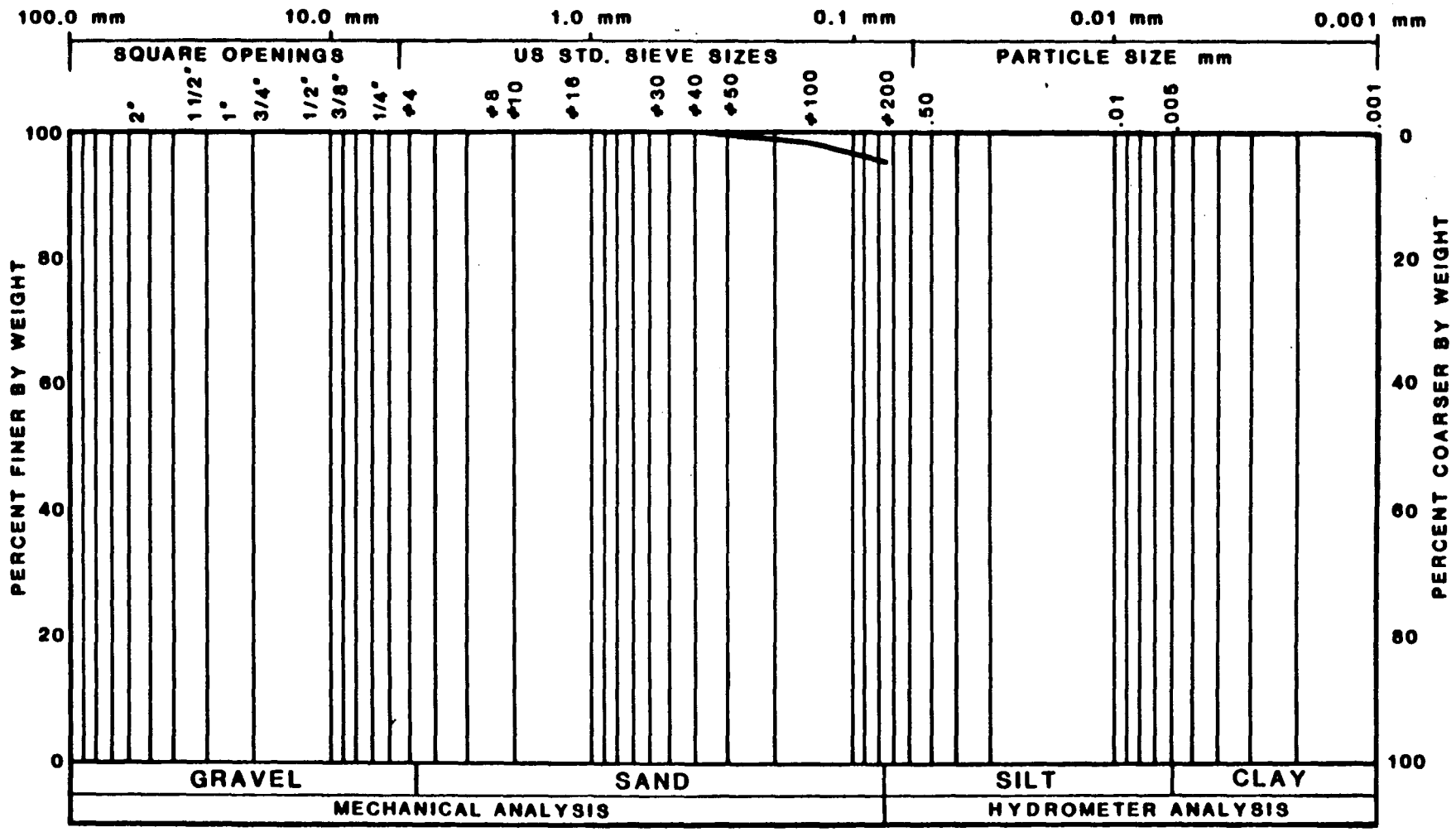
3



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
126	15.0-17.5	CL

FIGURE D5.2
PARTICLE SIZE DISTRIBUTION CURVE

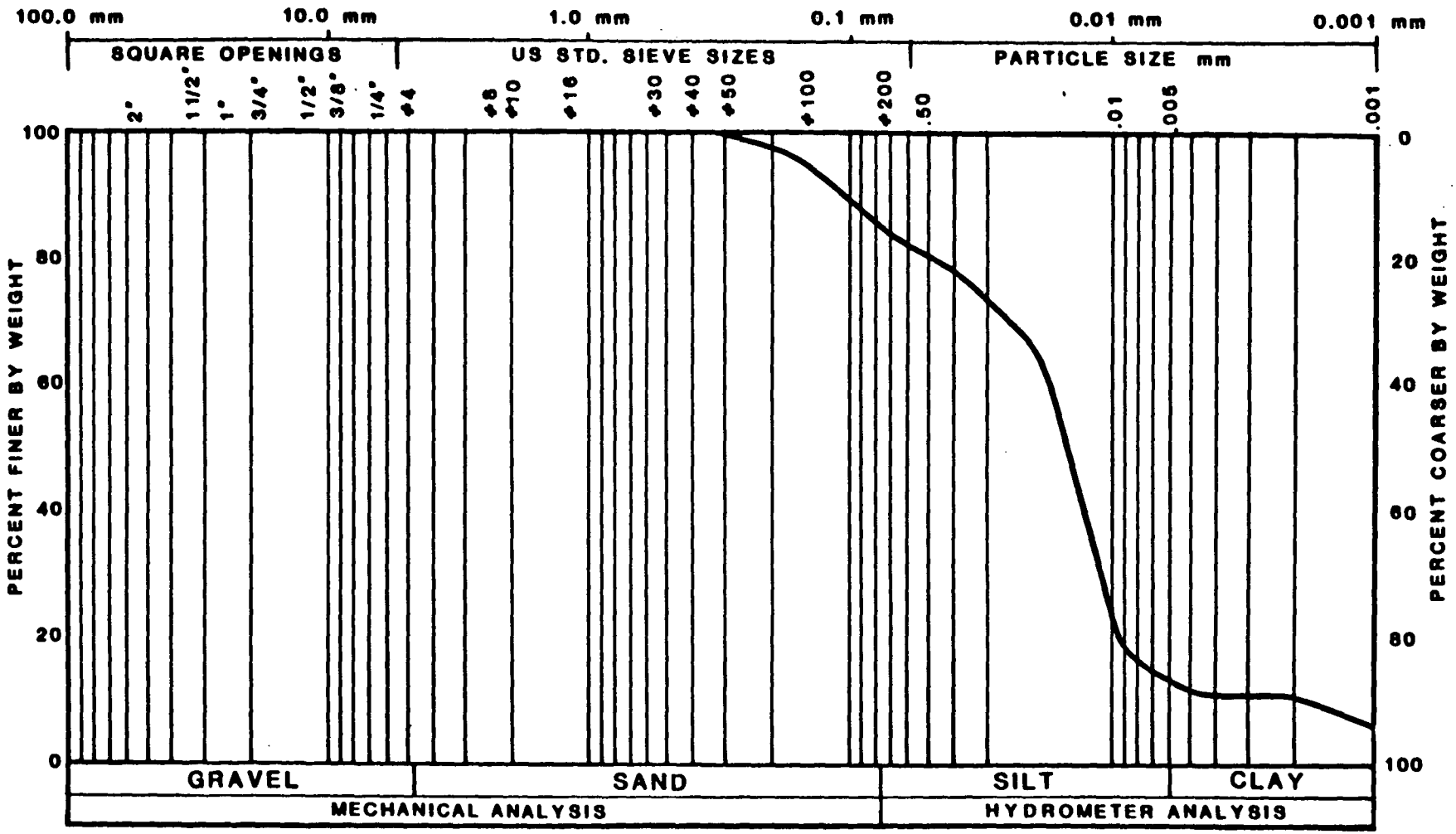
4



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
126	19.0-20.5	

FIGURE D5.3

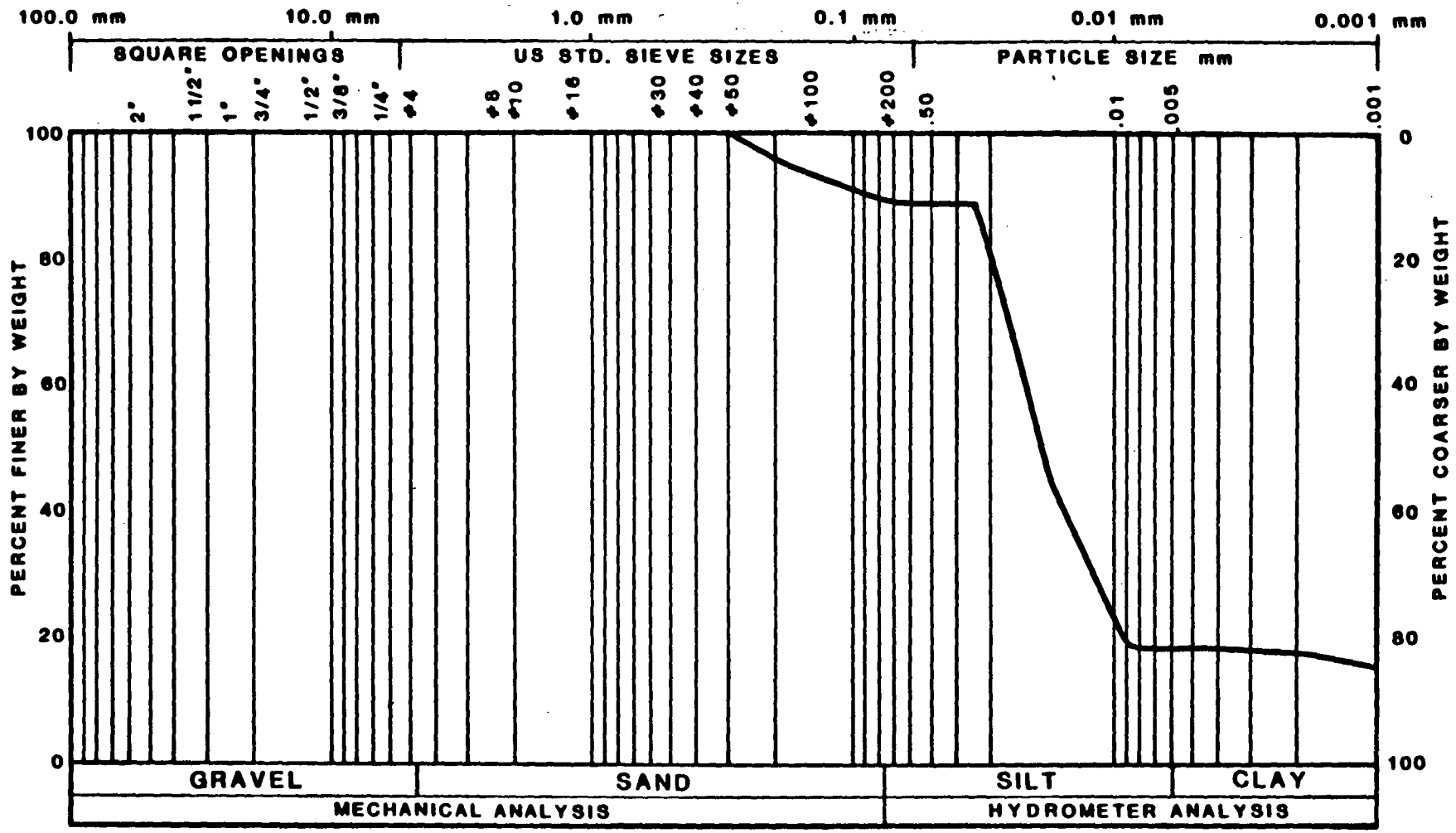
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	126	22.5-25.0	ML

FIGURE D5.4

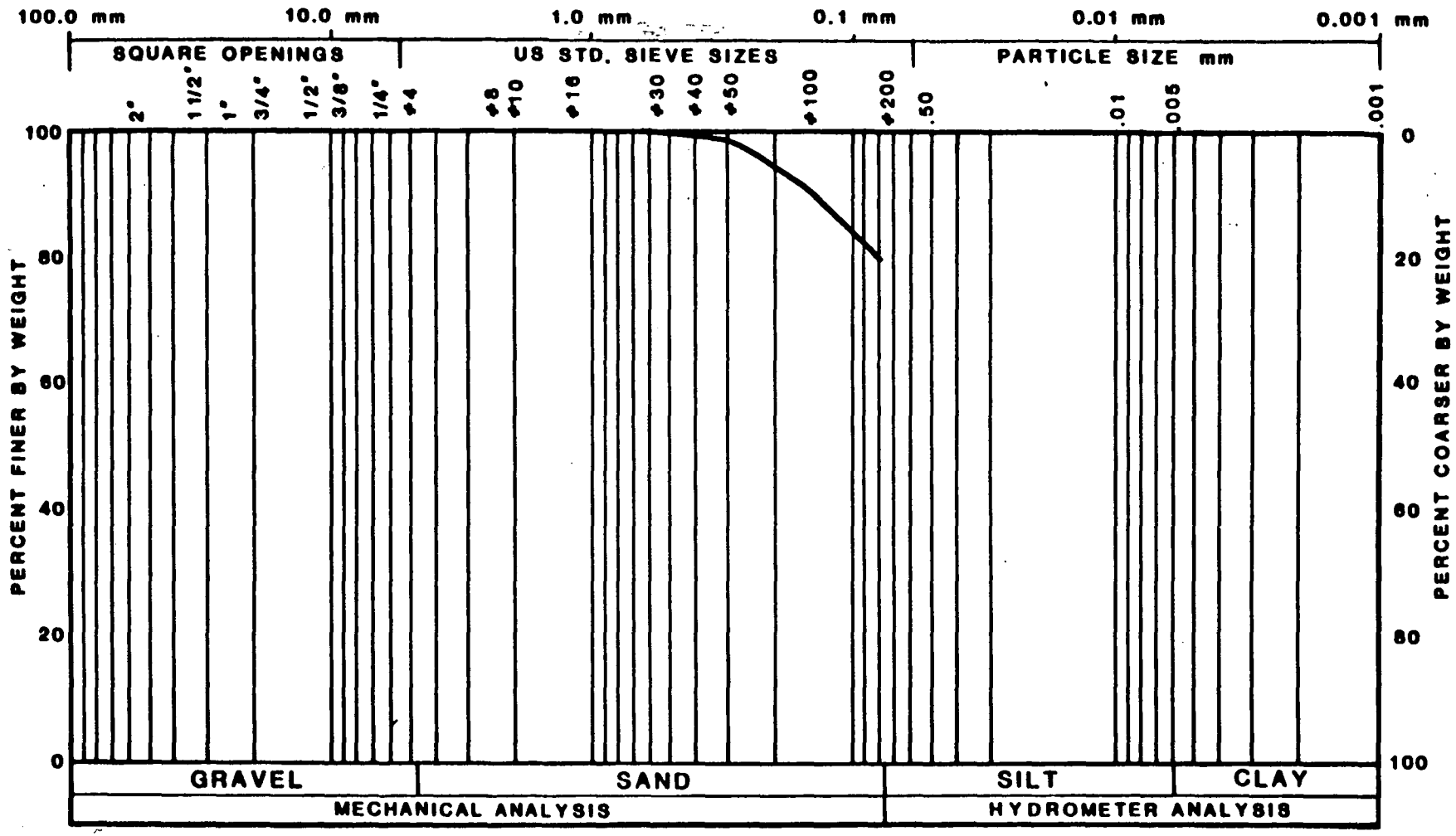
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	127	0.0-2.5	ML

FIGURE D5.5

PARTICLE SIZE DISTRIBUTION CURVE

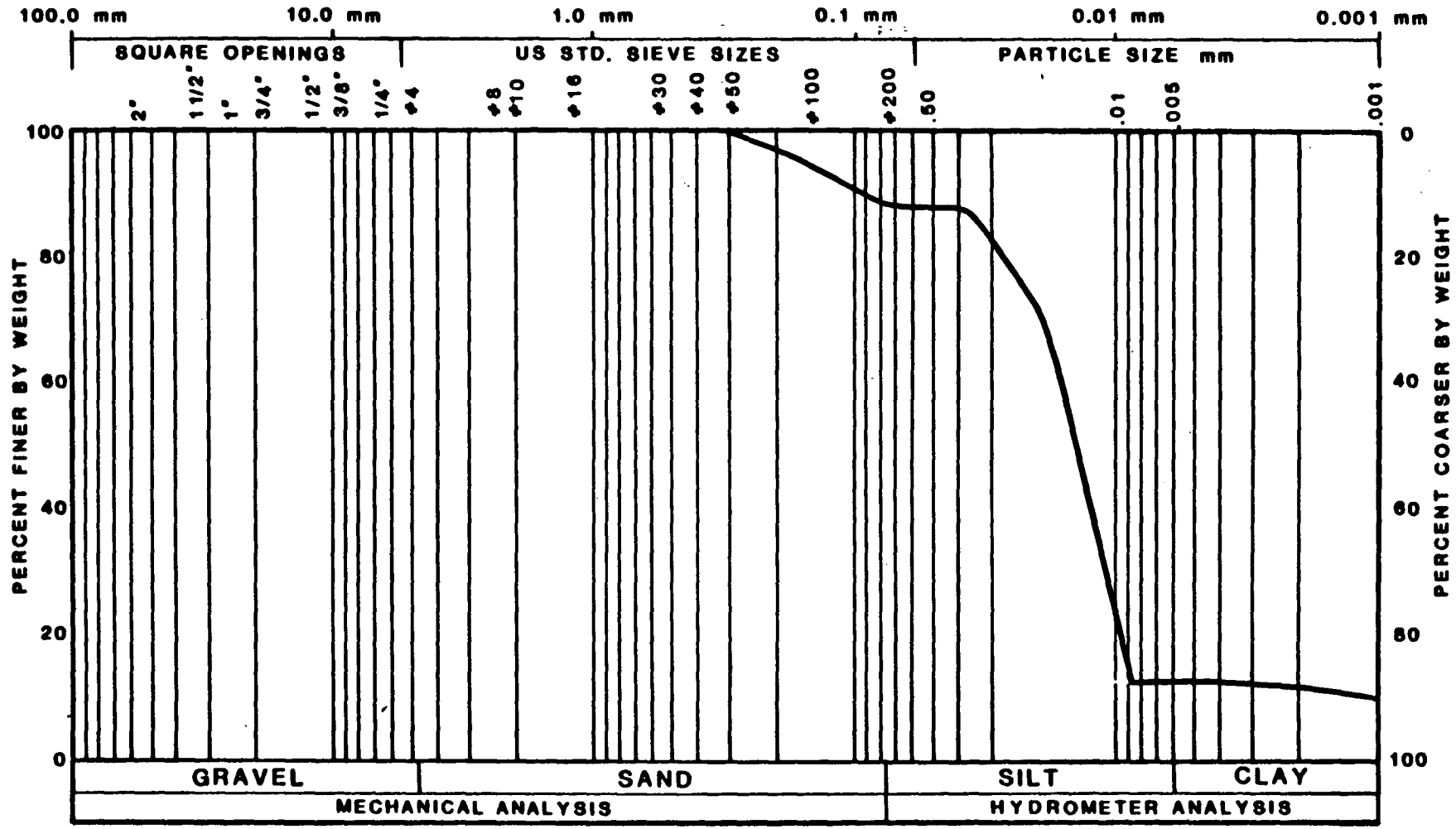


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	127	14.5-16.0	CL

FIGURE D5.6

PARTICLE SIZE DISTRIBUTION CURVE

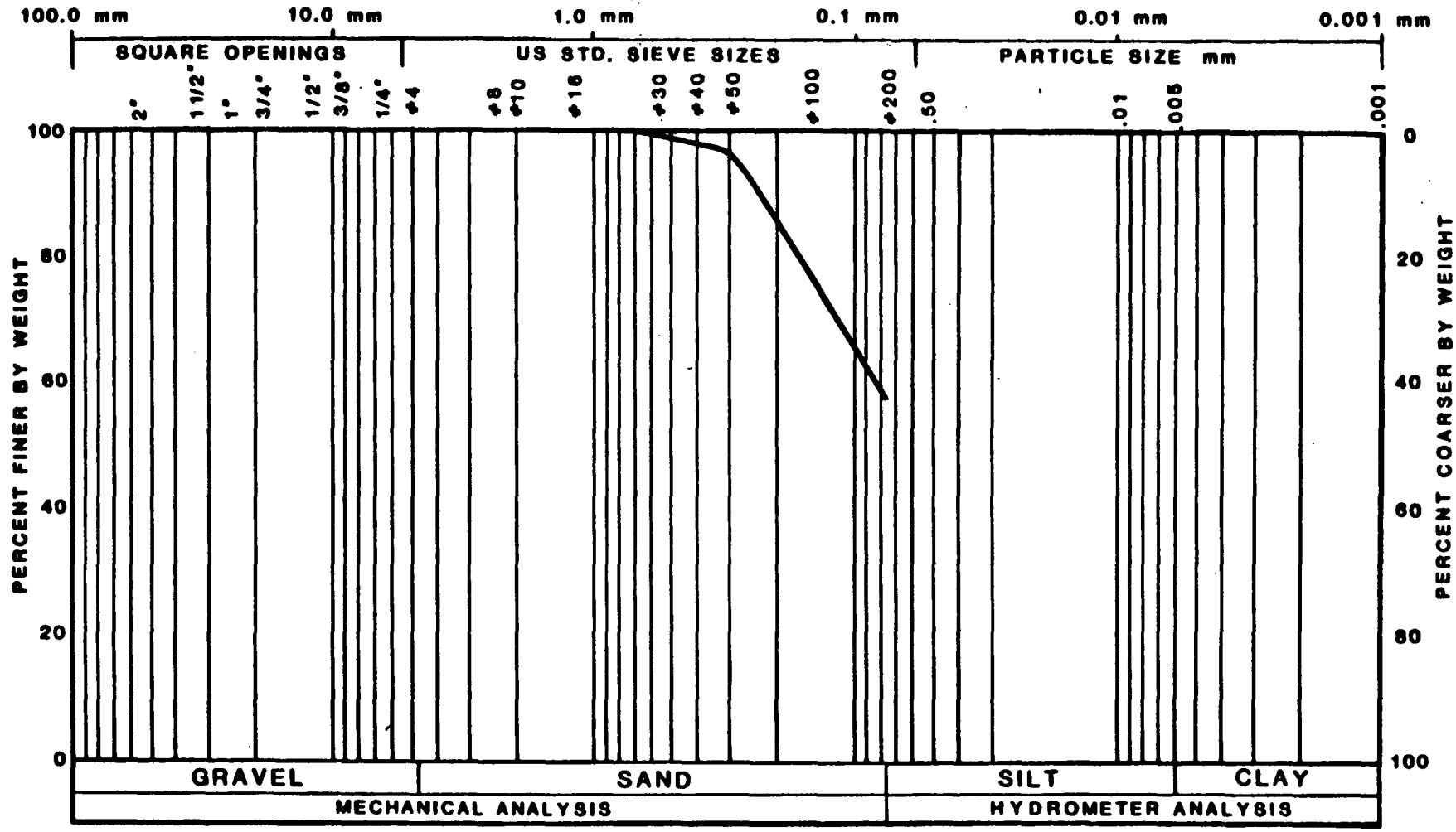
8



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
127	16.0-18.5	CL-ML

FIGURE D5.7

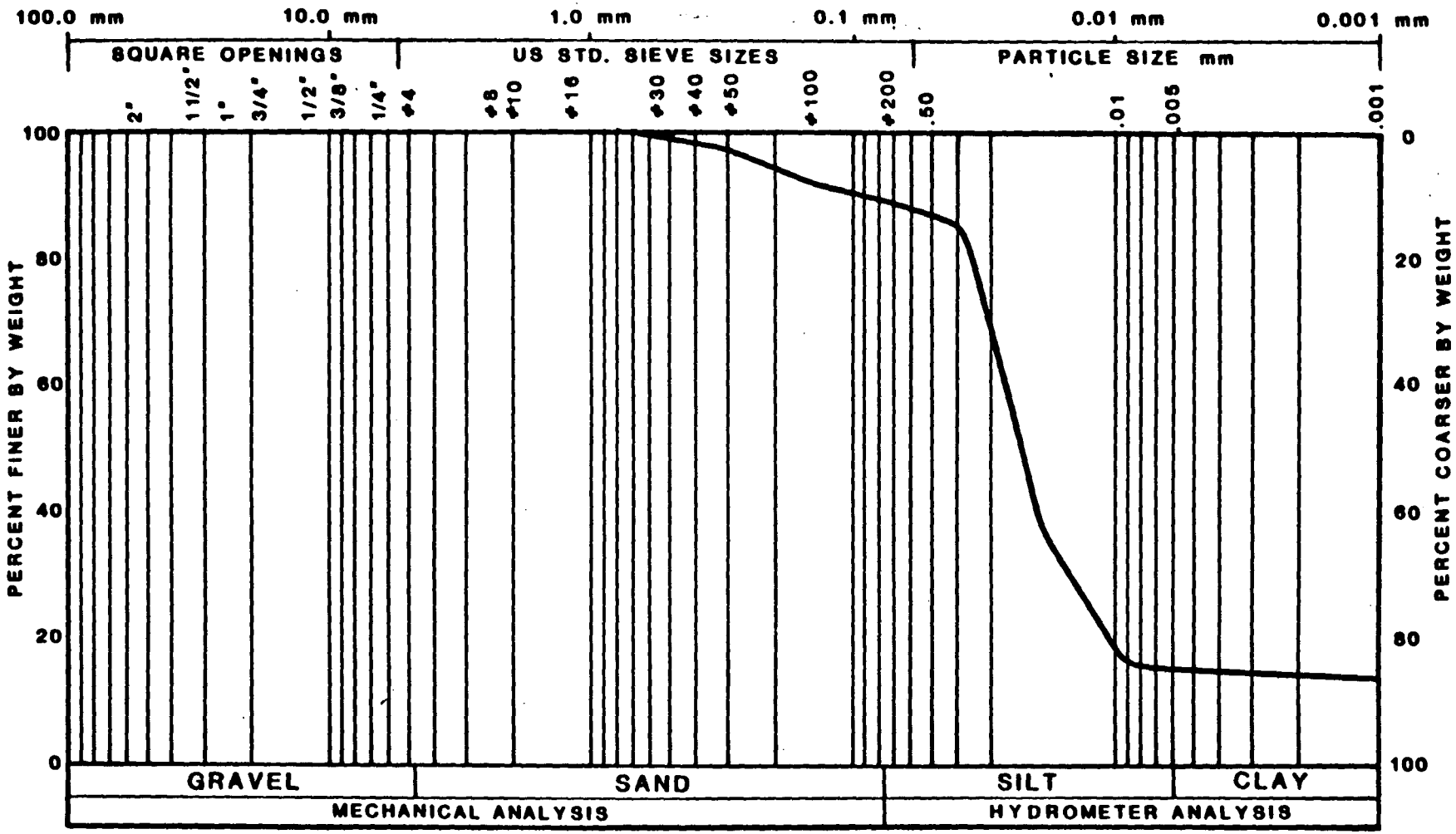
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
127	19.0-20.5	ML

FIGURE D5.8

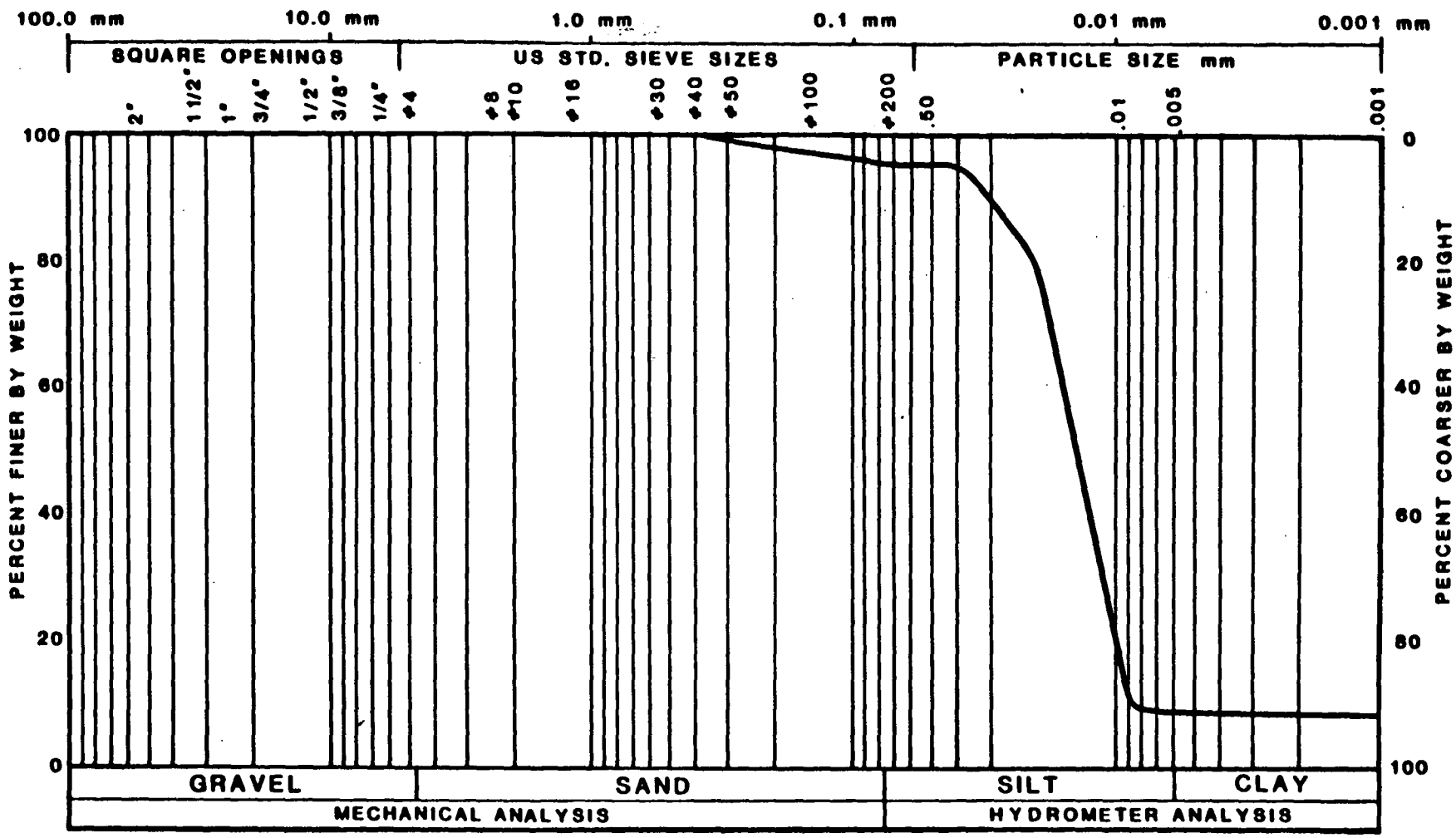
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
128	0.0–1.5	ML

FIGURE D5.9

PARTICLE SIZE DISTRIBUTION CURVE

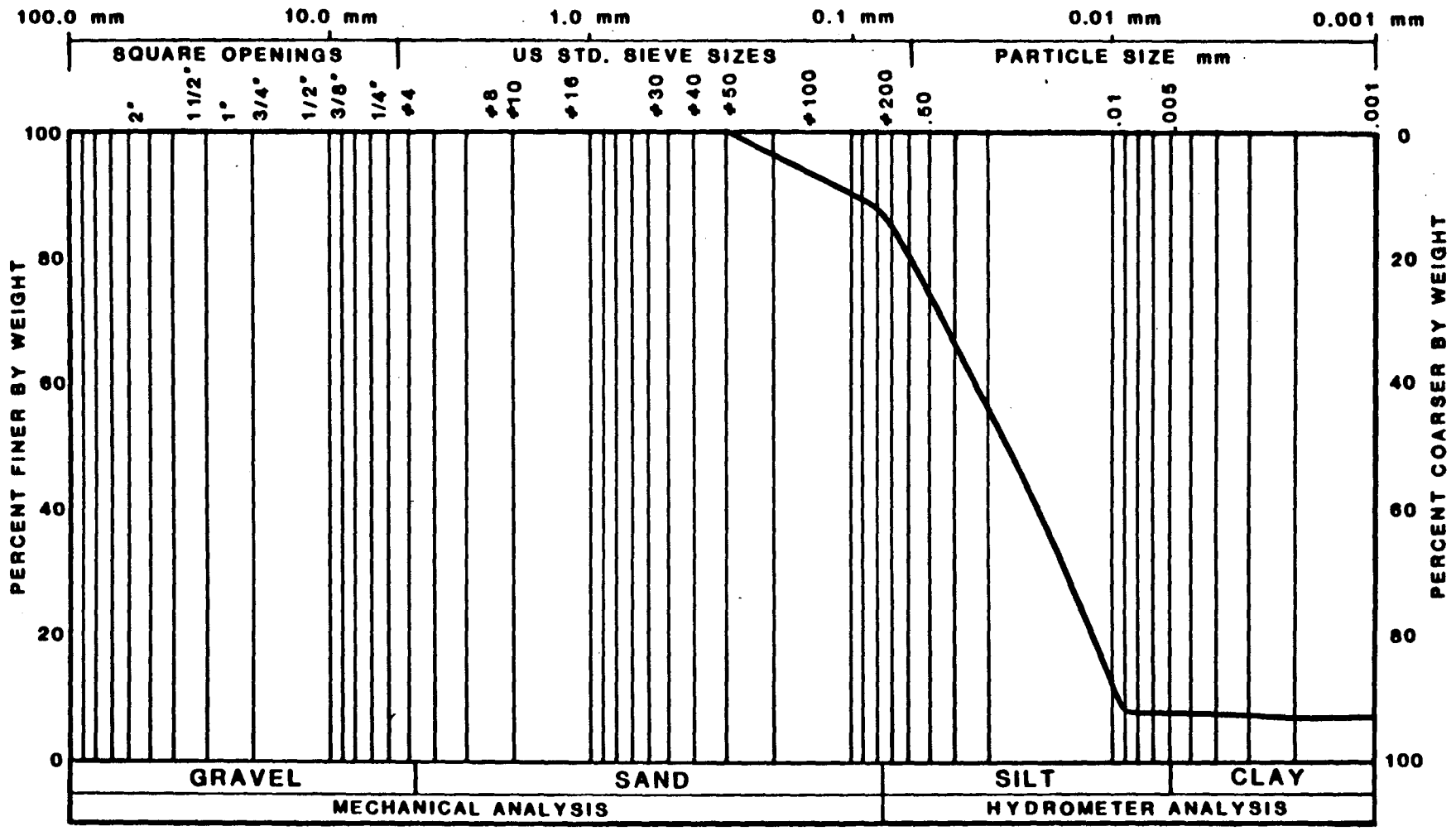


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
128	16.5-18.0	ML

FIGURE D5.10

PARTICLE SIZE DISTRIBUTION CURVE

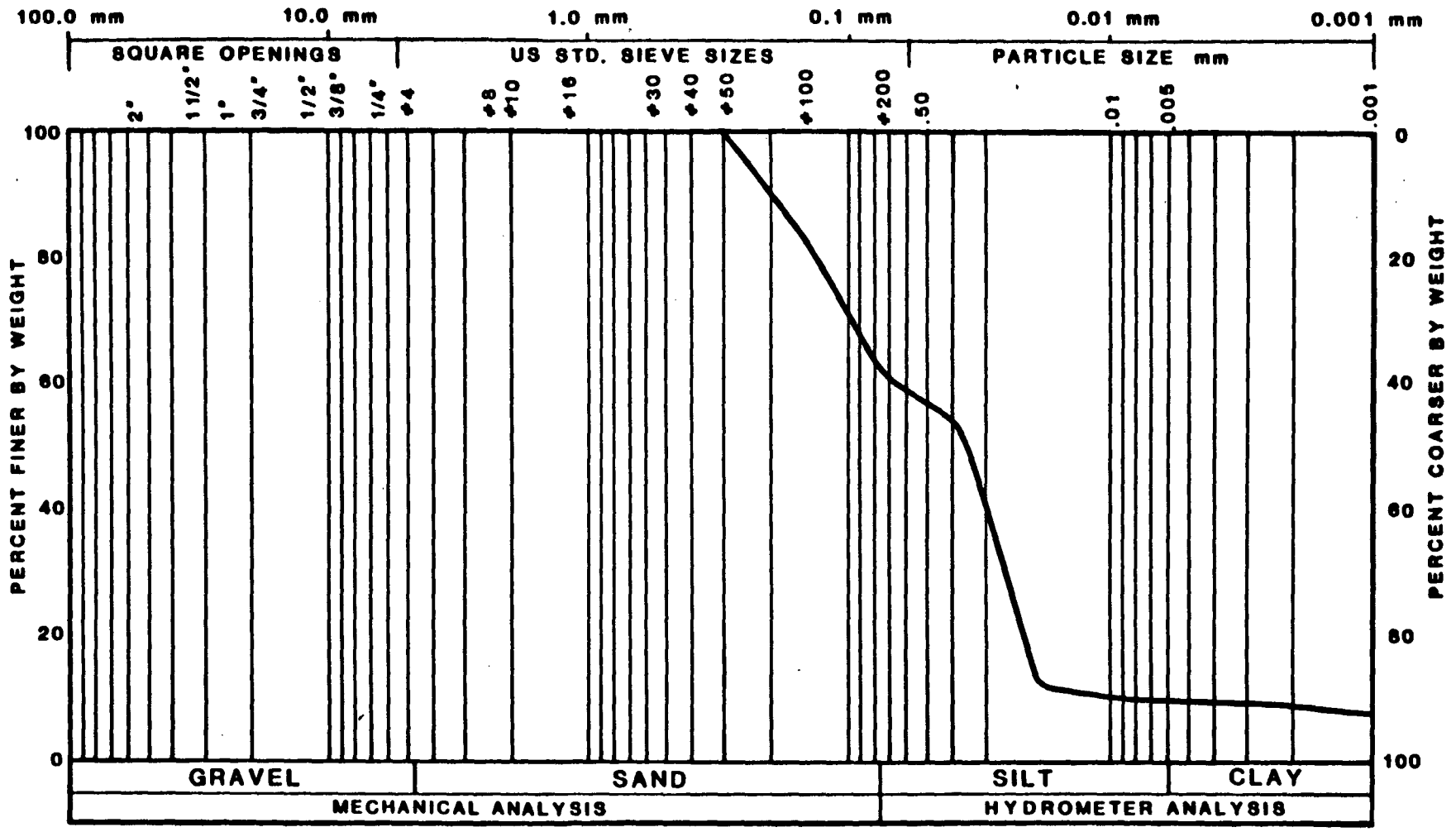
12



LEGEND		
SAMPLE HAT-01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
129	7.0-8.5	ML

FIGURE D5.11

PARTICLE SIZE DISTRIBUTION CURVE

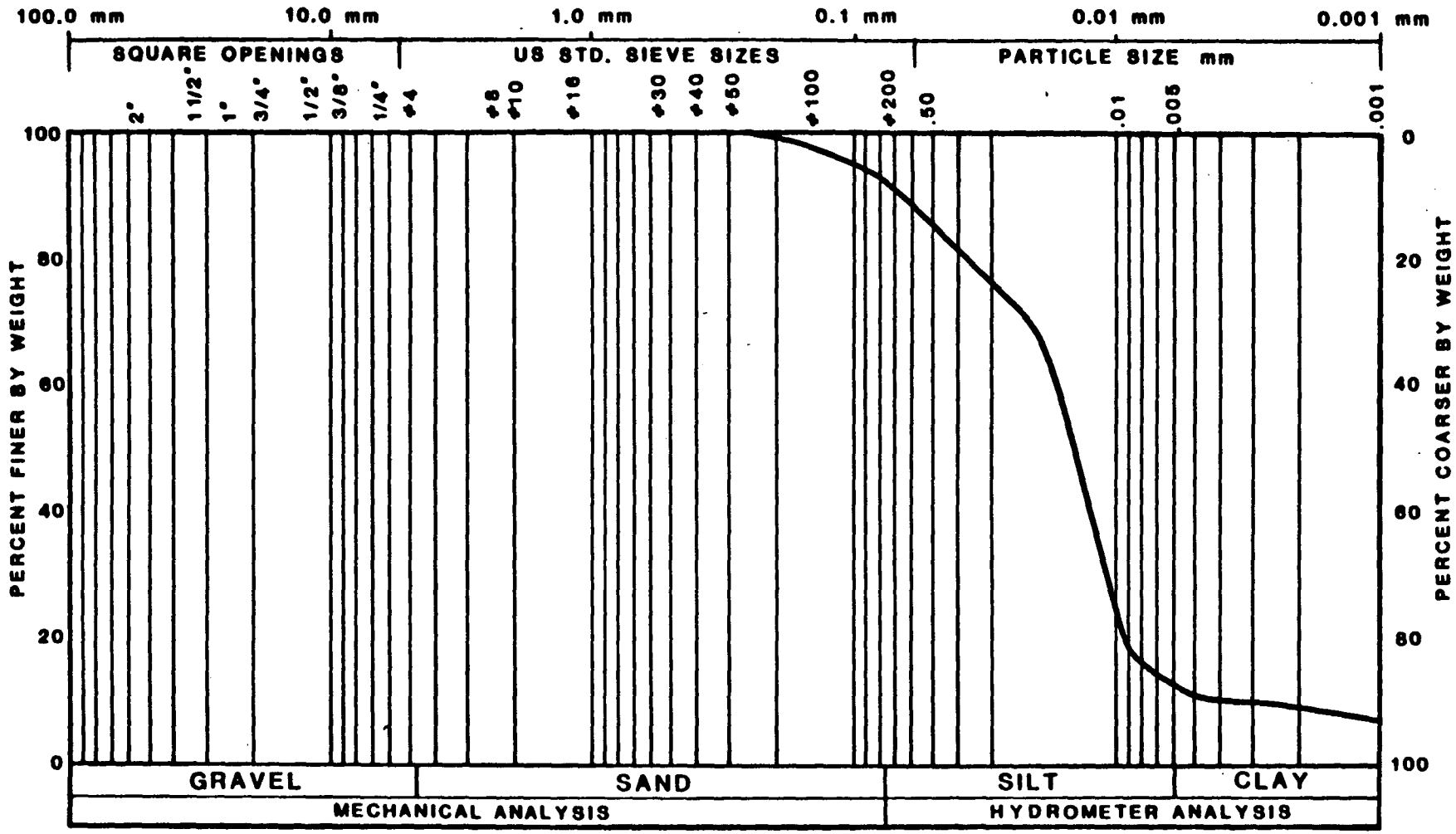


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
130	4.0-5.5	ML

FIGURE D5.12

PARTICLE SIZE DISTRIBUTION CURVE

14

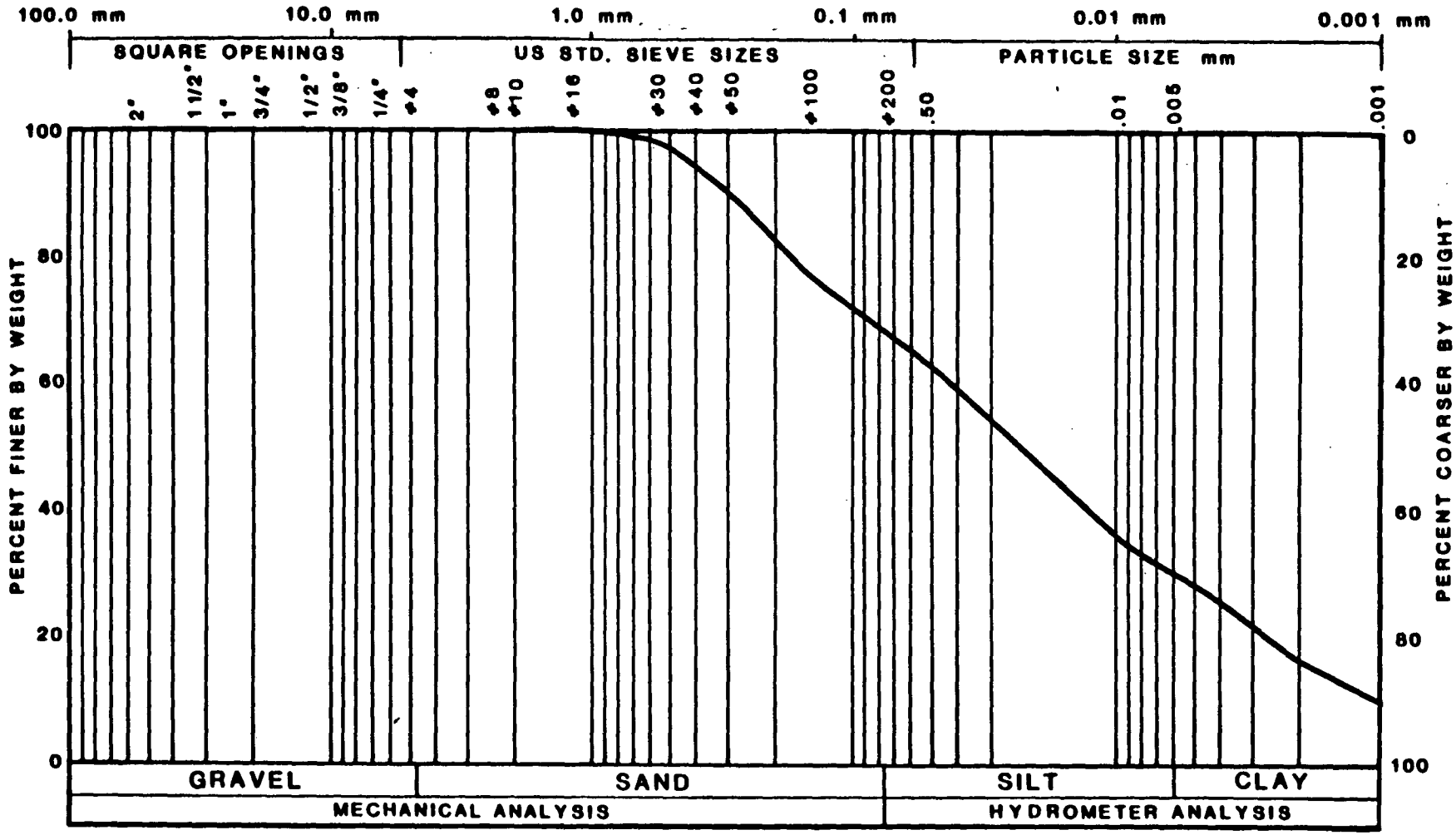


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	131	10.0-17.0	CL

FIGURE D5.13

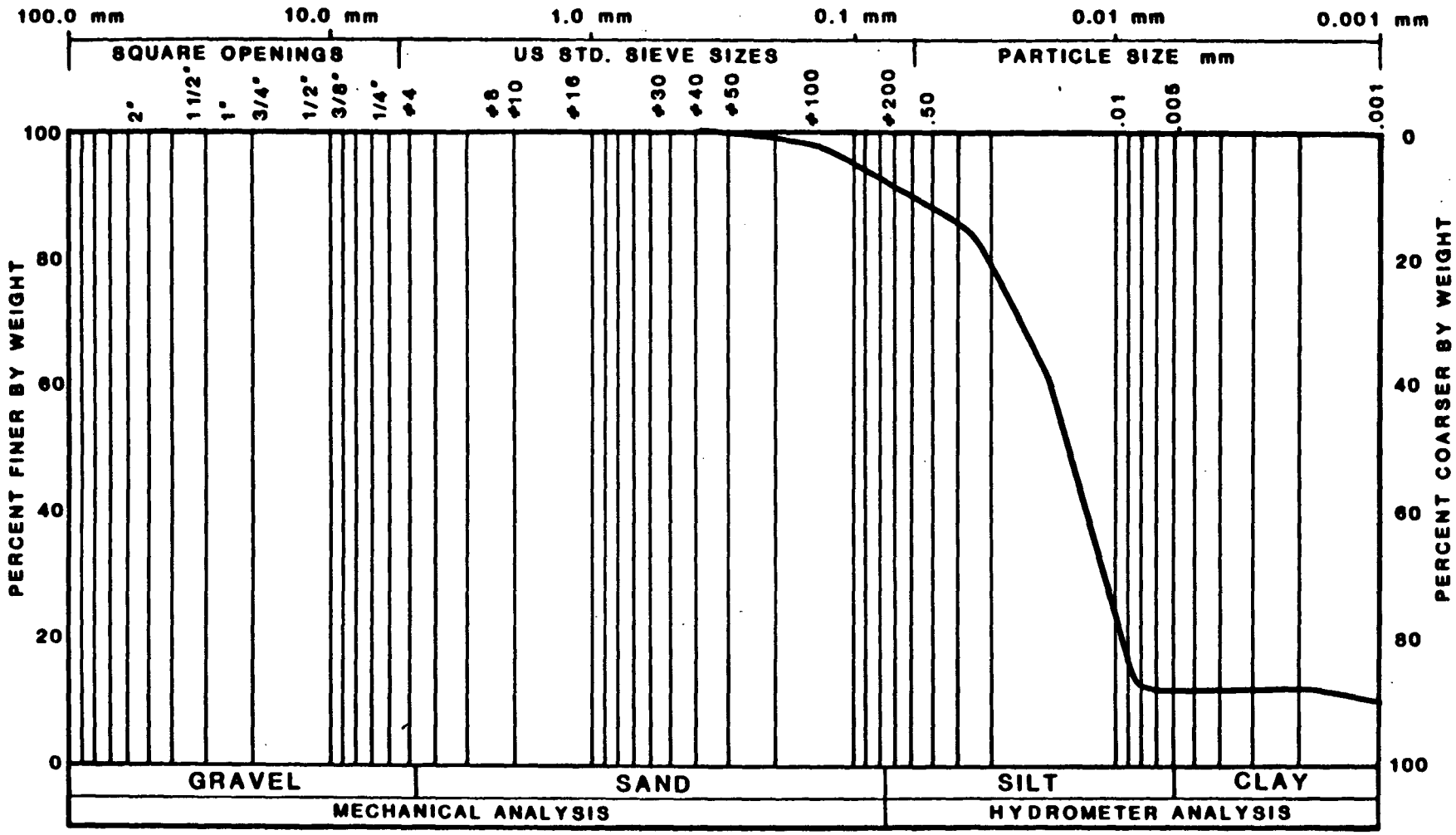
PARTICLE SIZE DISTRIBUTION CURVE

15



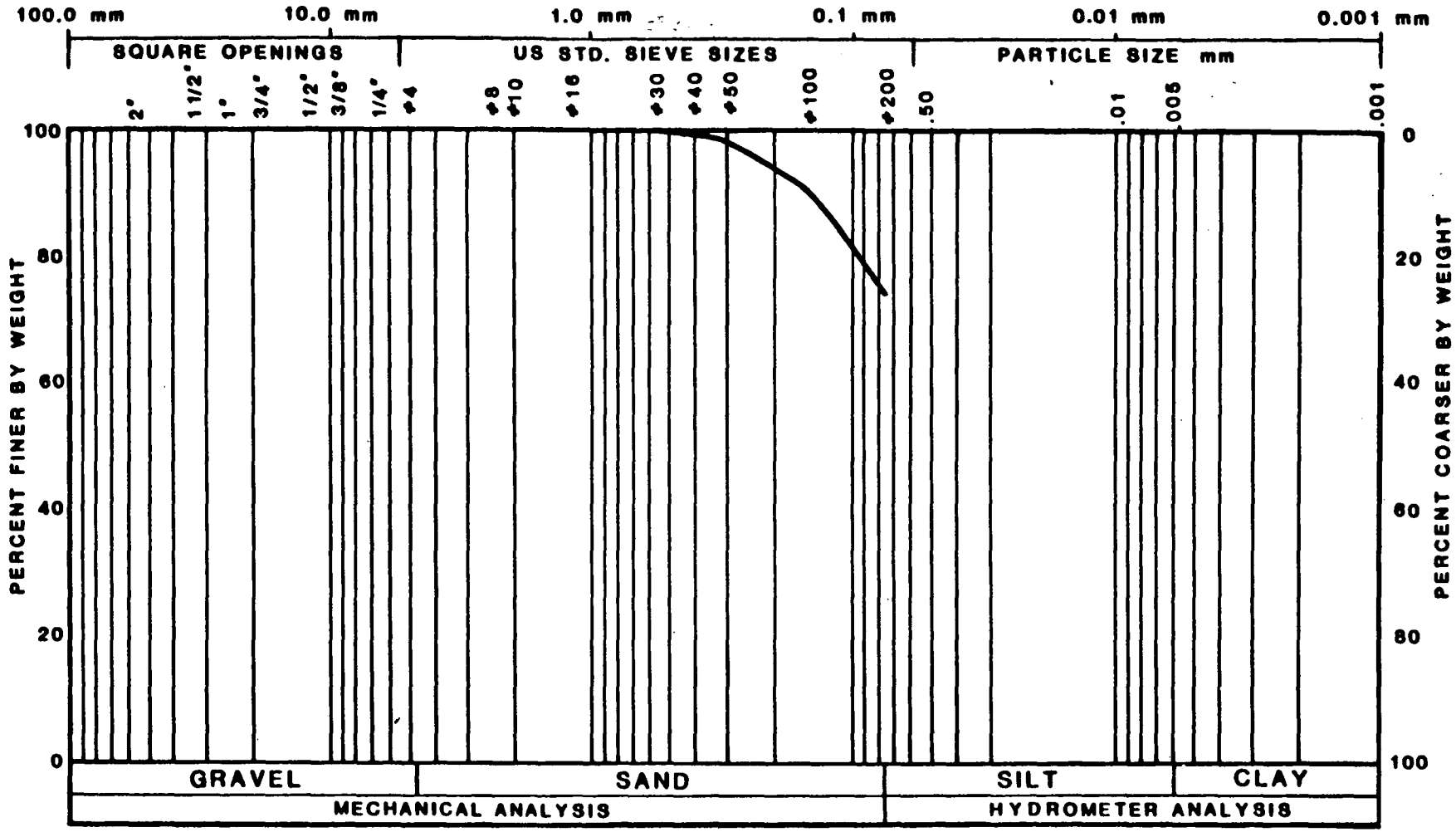
LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
131	16.5-17.0	ML

FIGURE D5.14
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	132	1.5-4.0	CL

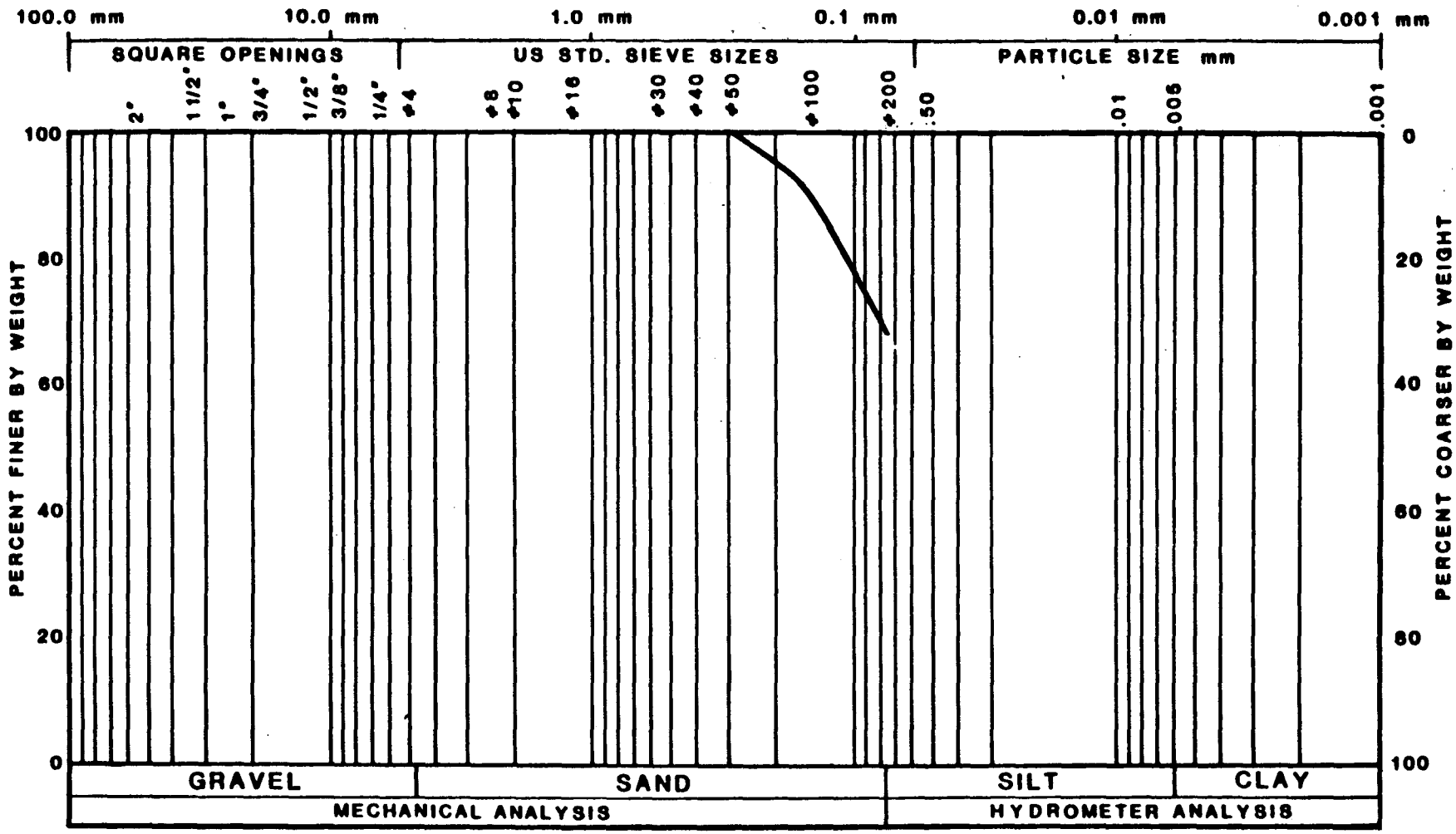
FIGURE D5.15
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
132	7.0-8.5	

FIGURE D5.16

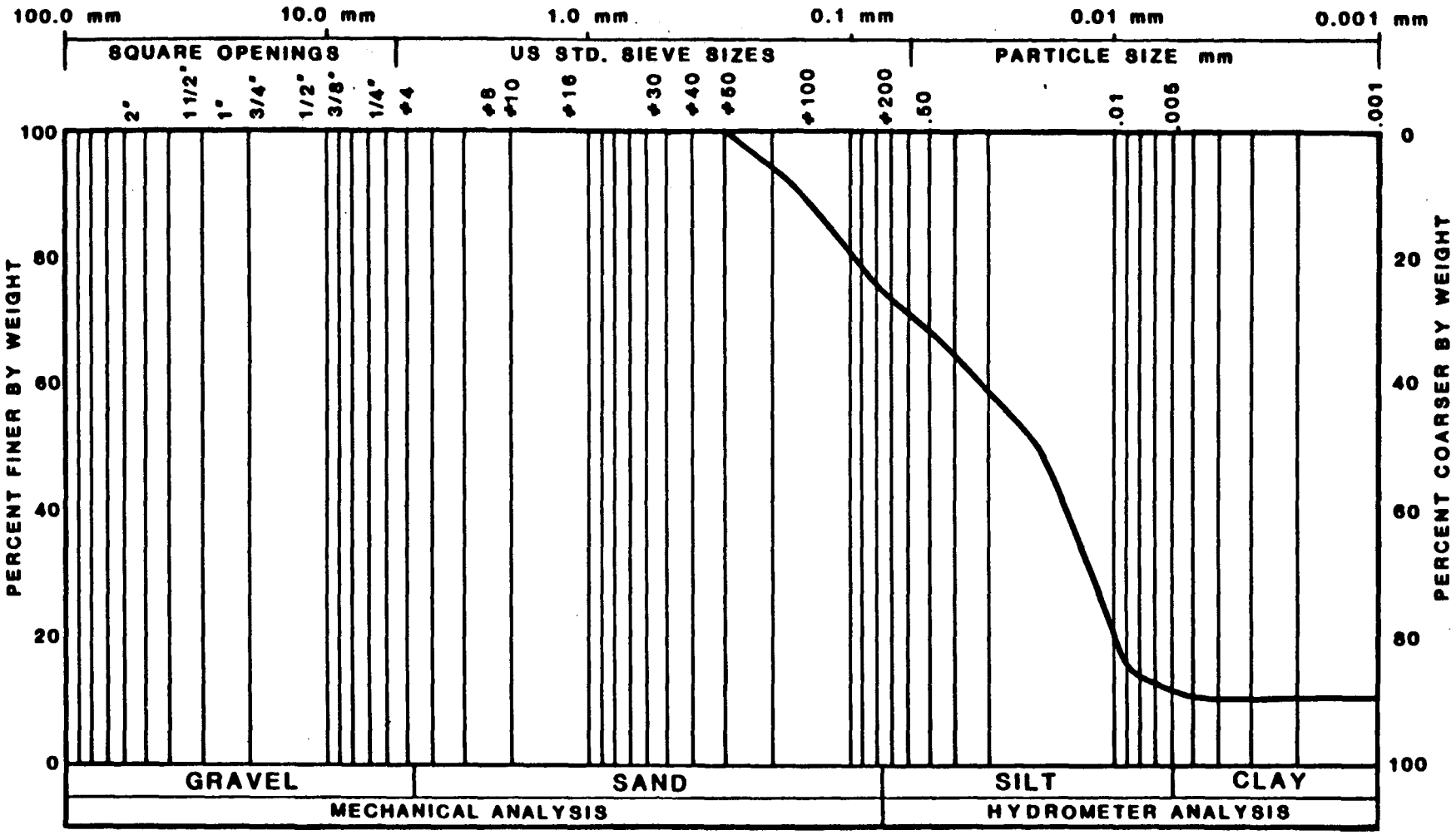
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	132	11.5-14.0	

FIGURE D5.17

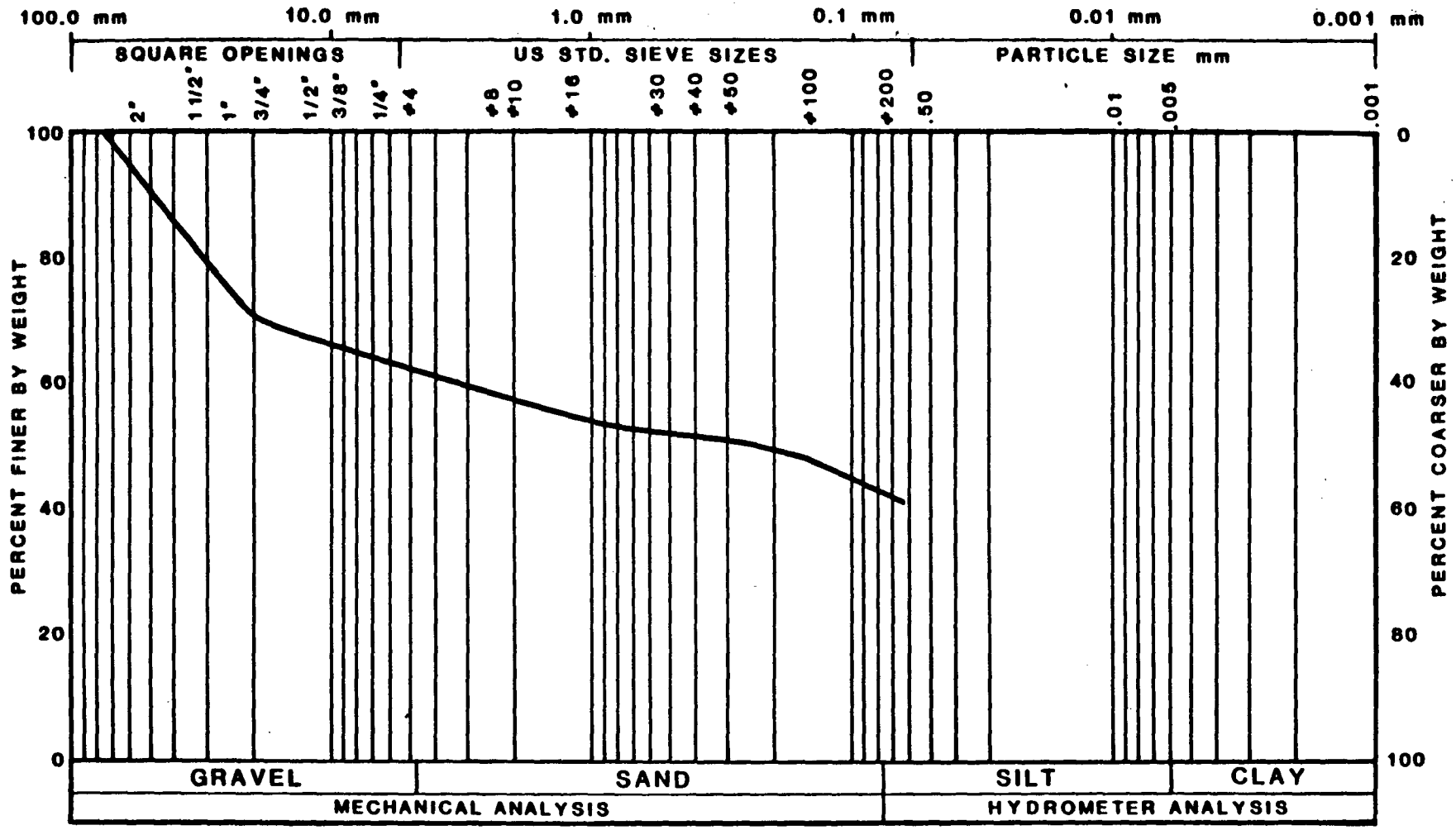
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	132	24.5-26.5	ML

FIGURE D5.18

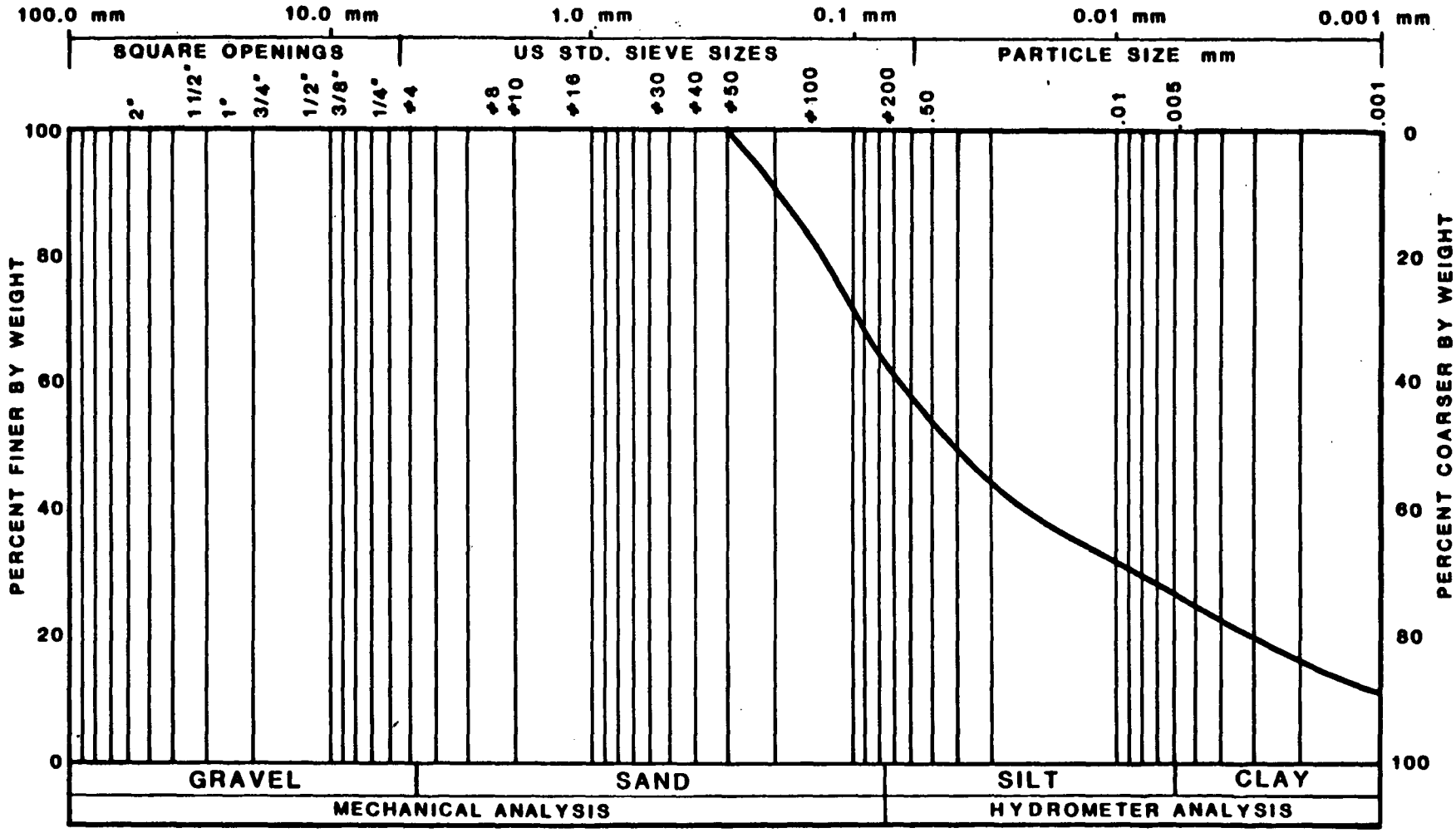
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	132	27.0-28.0	

FIGURE D5.19
PARTICLE SIZE DISTRIBUTION CURVE

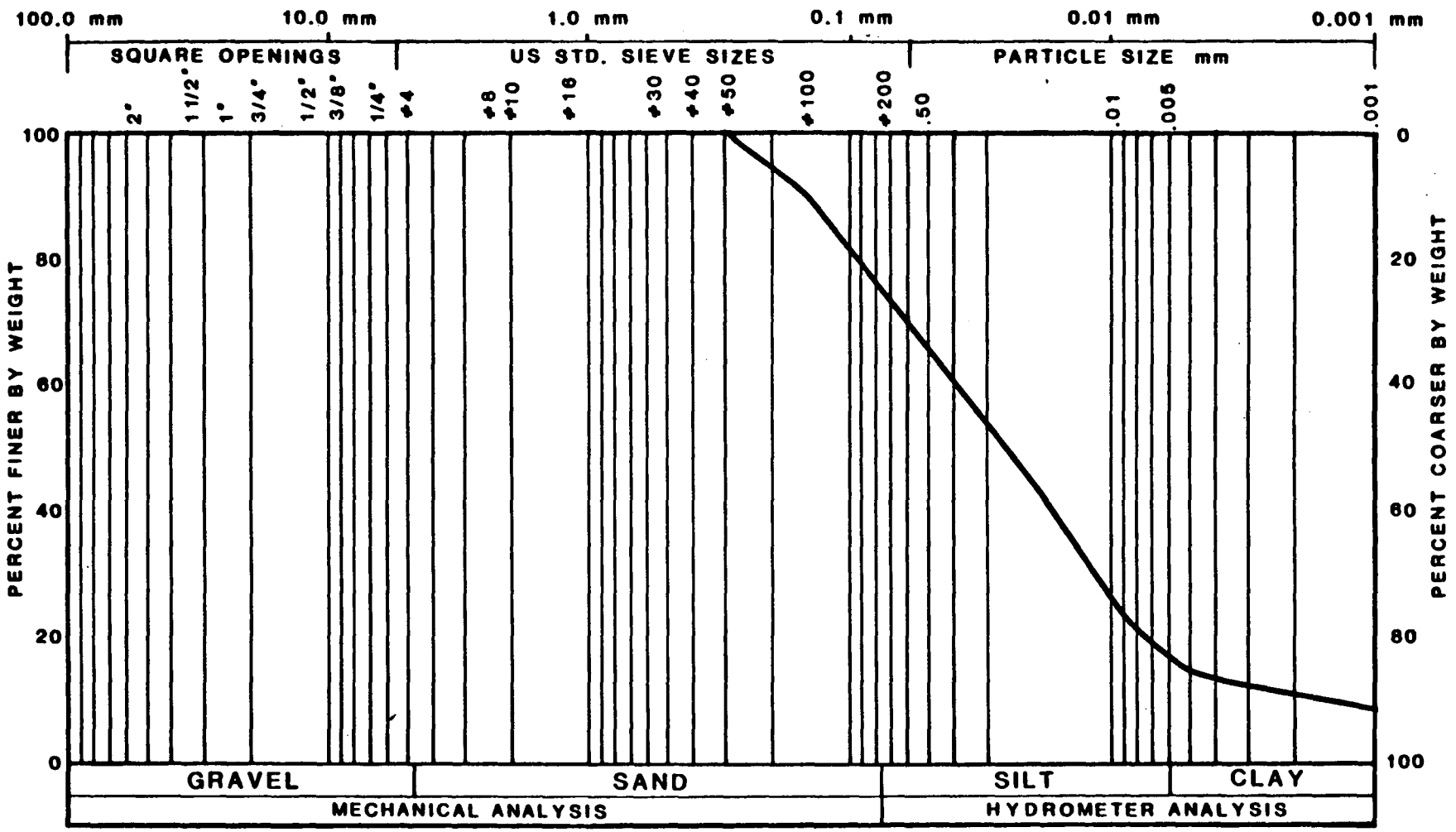
12



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	133	1.5-4.0	

FIGURE D5.20

PARTICLE SIZE DISTRIBUTION CURVE

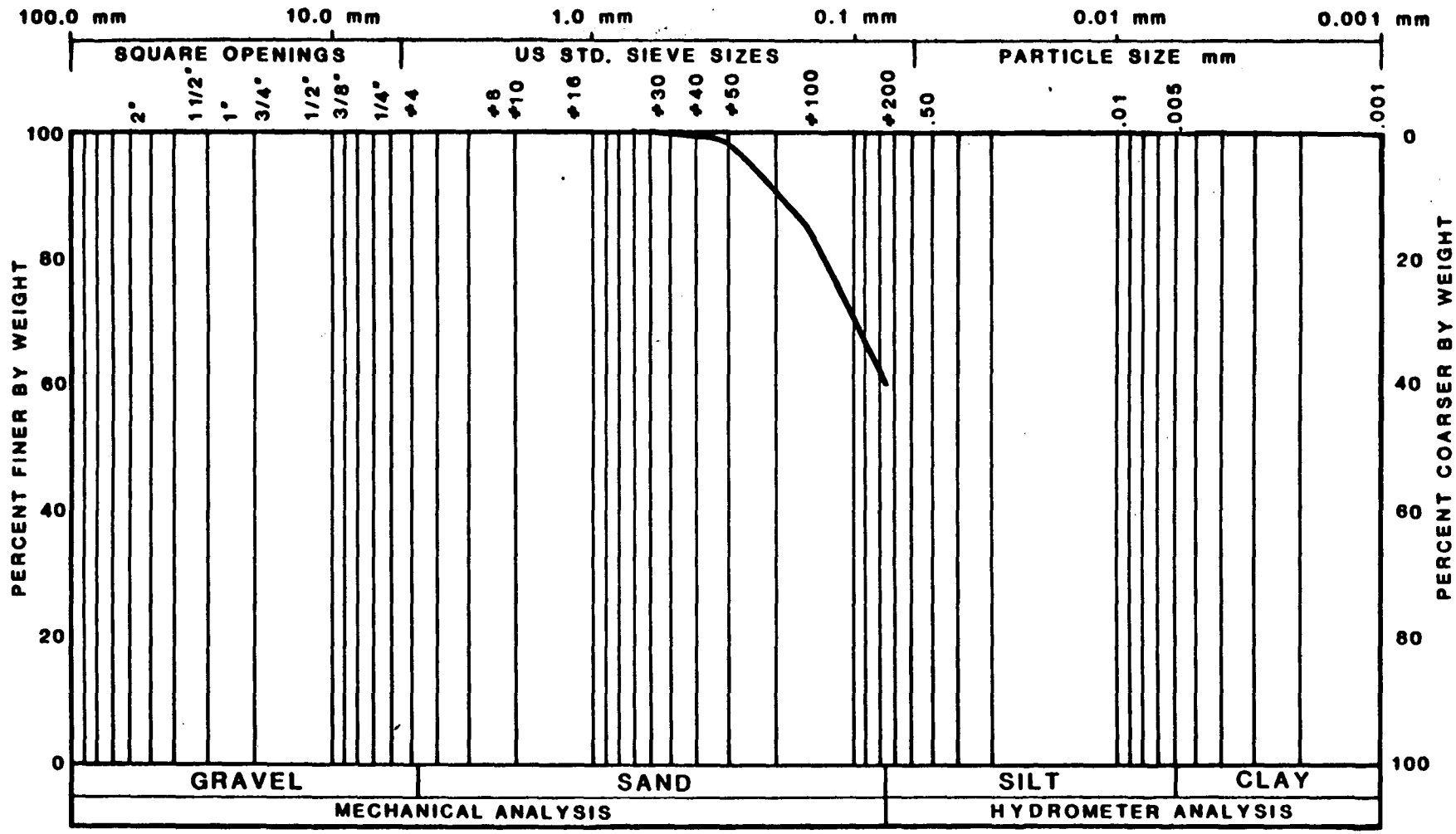


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	133	8.5-11.0	

FIGURE D5.21

PARTICLE SIZE DISTRIBUTION CURVE

29

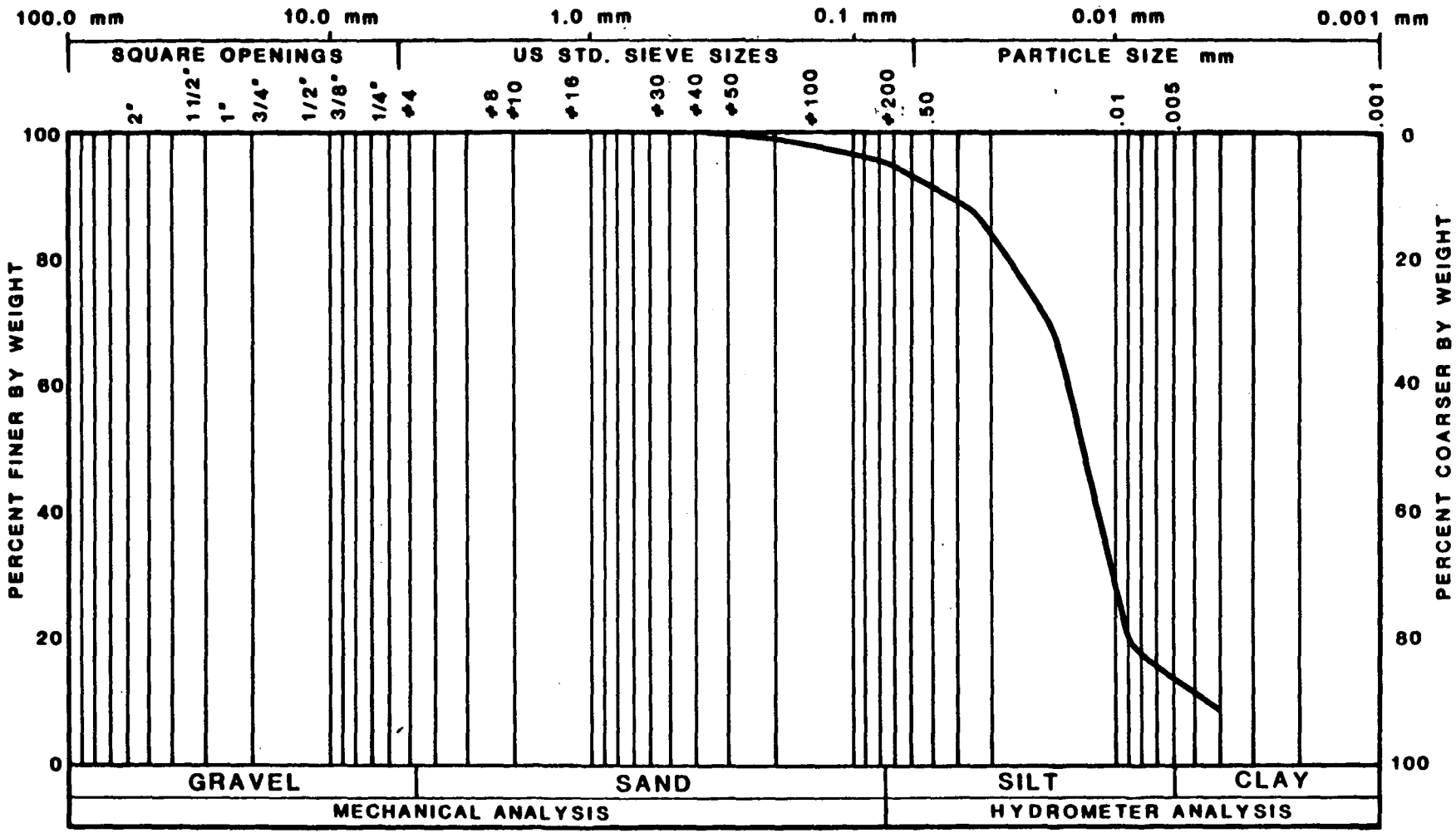


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
133	15.5-17.0	

FIGURE D5.22

PARTICLE SIZE DISTRIBUTION CURVE

24

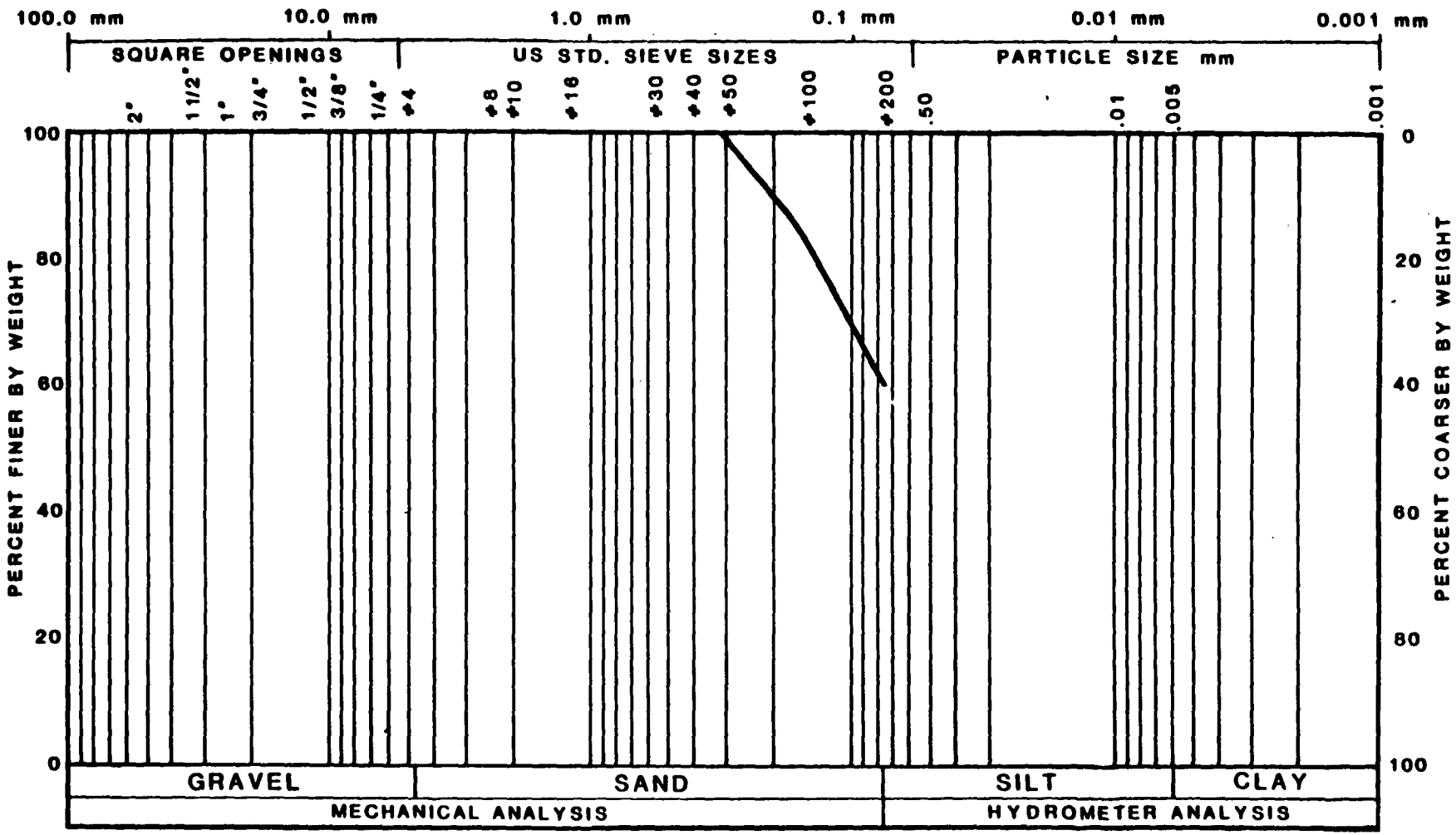


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	133	27.0-28.5	CL

FIGURE D5.23

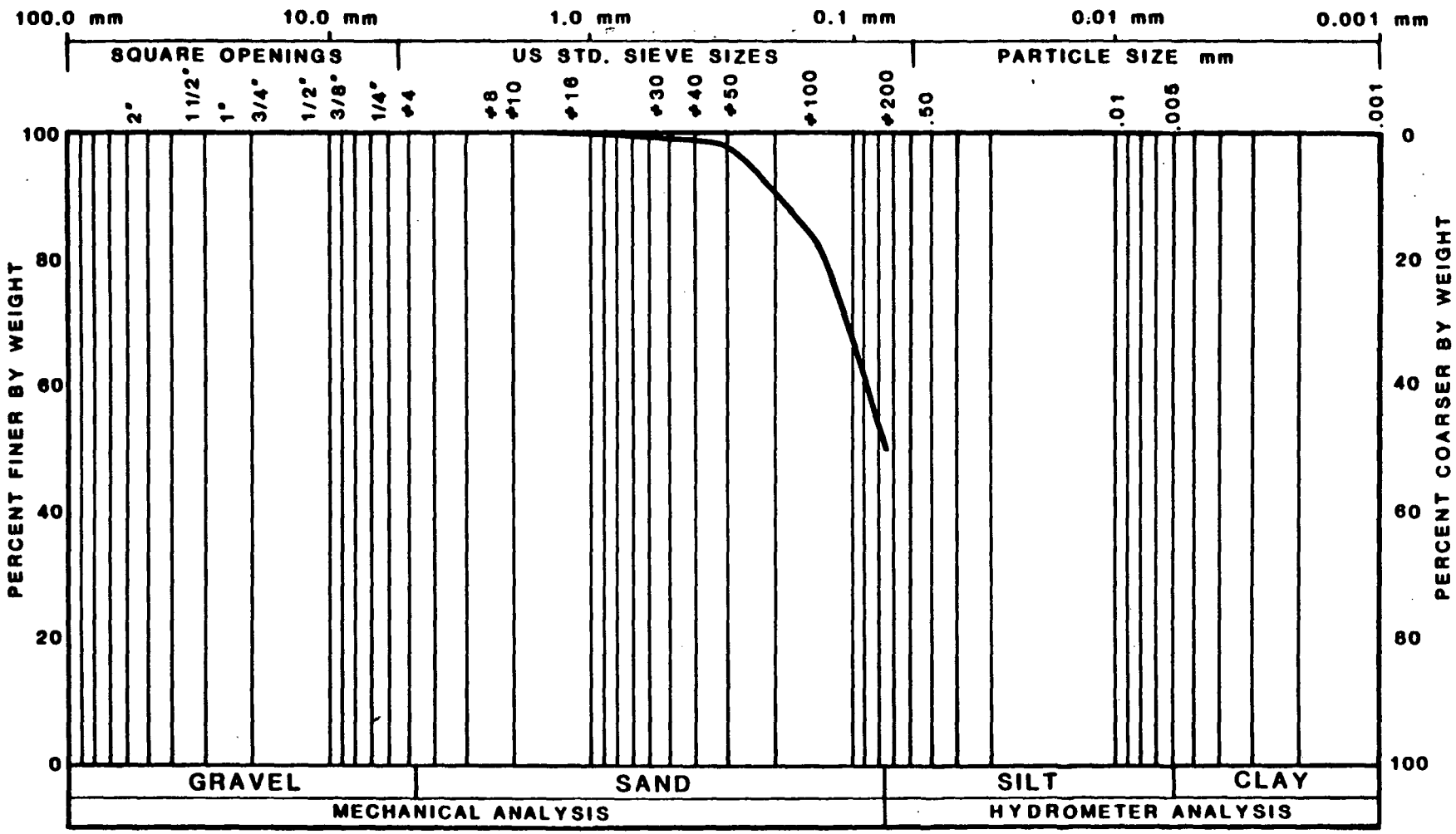
PARTICLE SIZE DISTRIBUTION CURVE

25



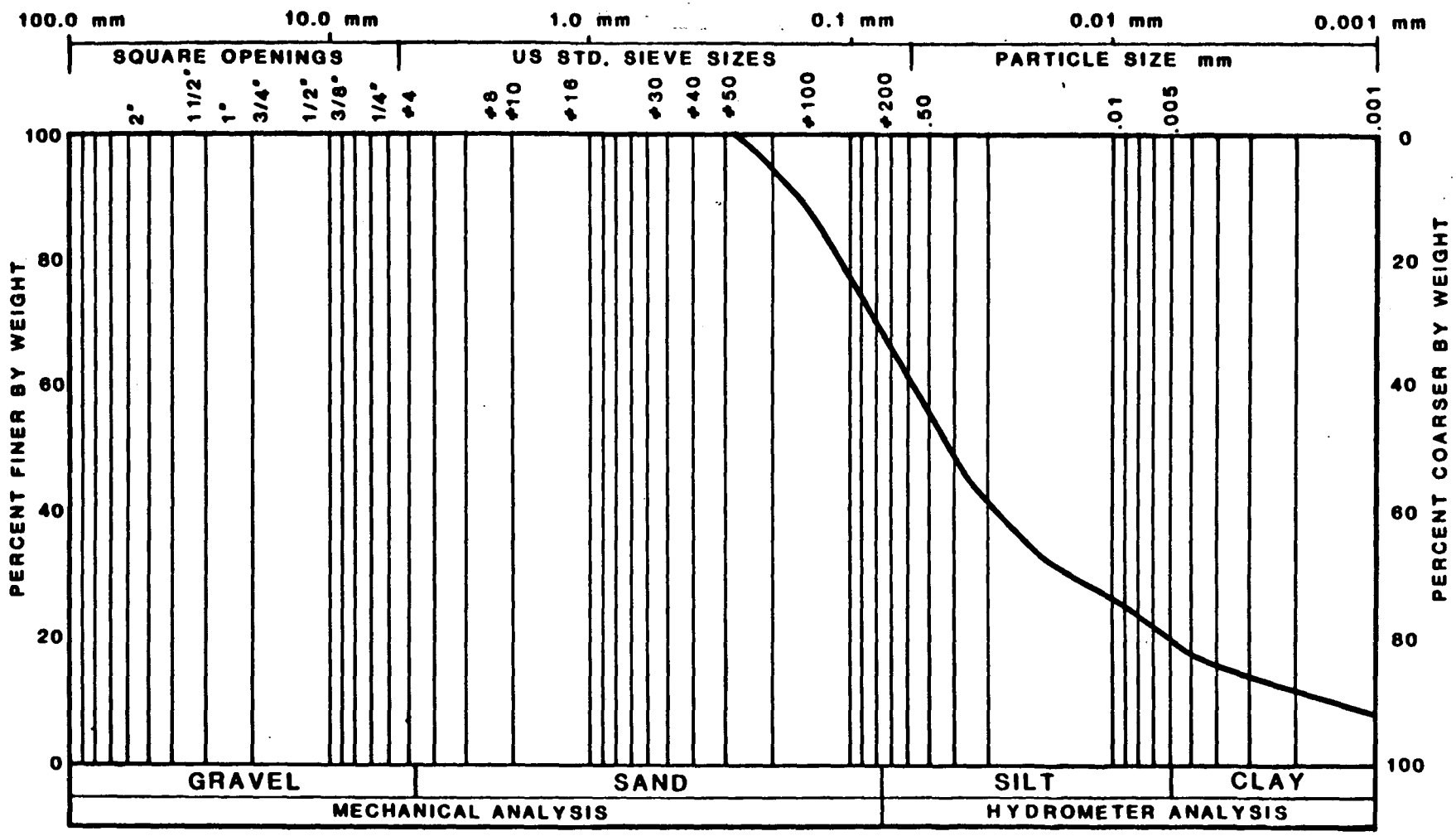
LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	134	1.5-3.0	

FIGURE D5.24
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT-1	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	134	4.5-6.0	

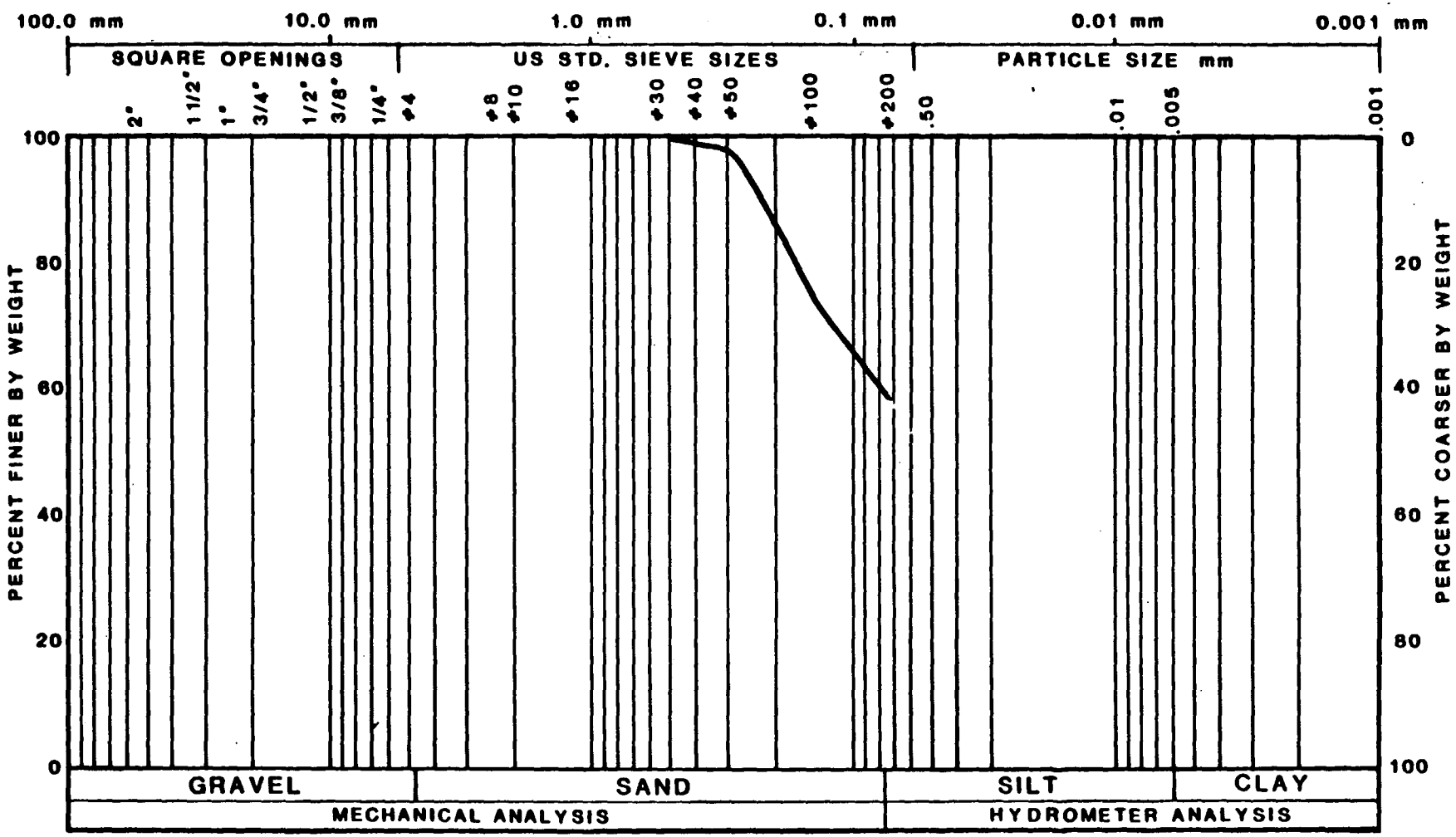
FIGURE D5.25
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
134	9.0–11.5	ML

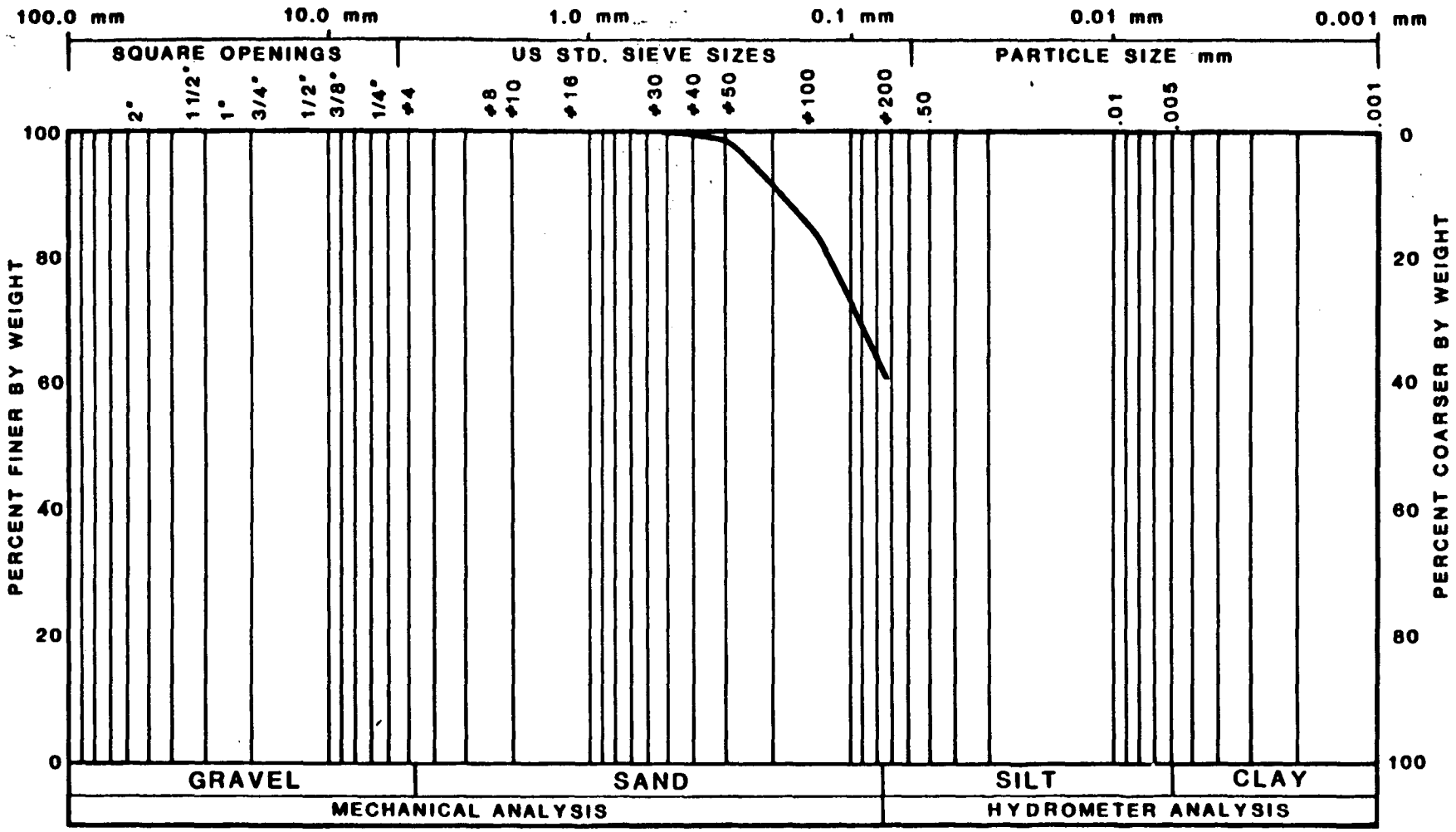
FIGURE D5.26

PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	134	22.0-23.5	

FIGURE D5.27
PARTICLE SIZE DISTRIBUTION CURVE

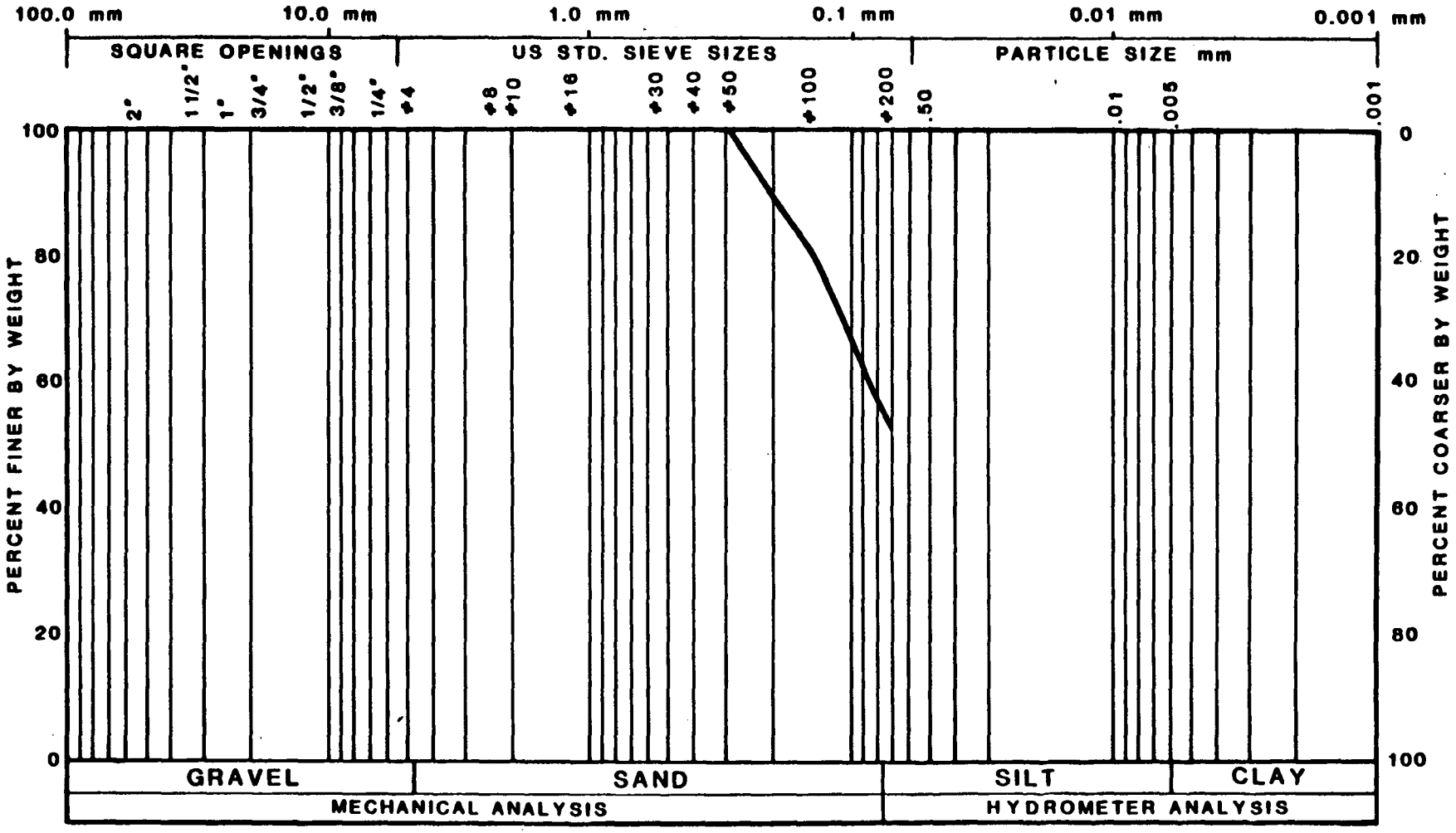


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	134	35.0-37.5	

FIGURE D5.28

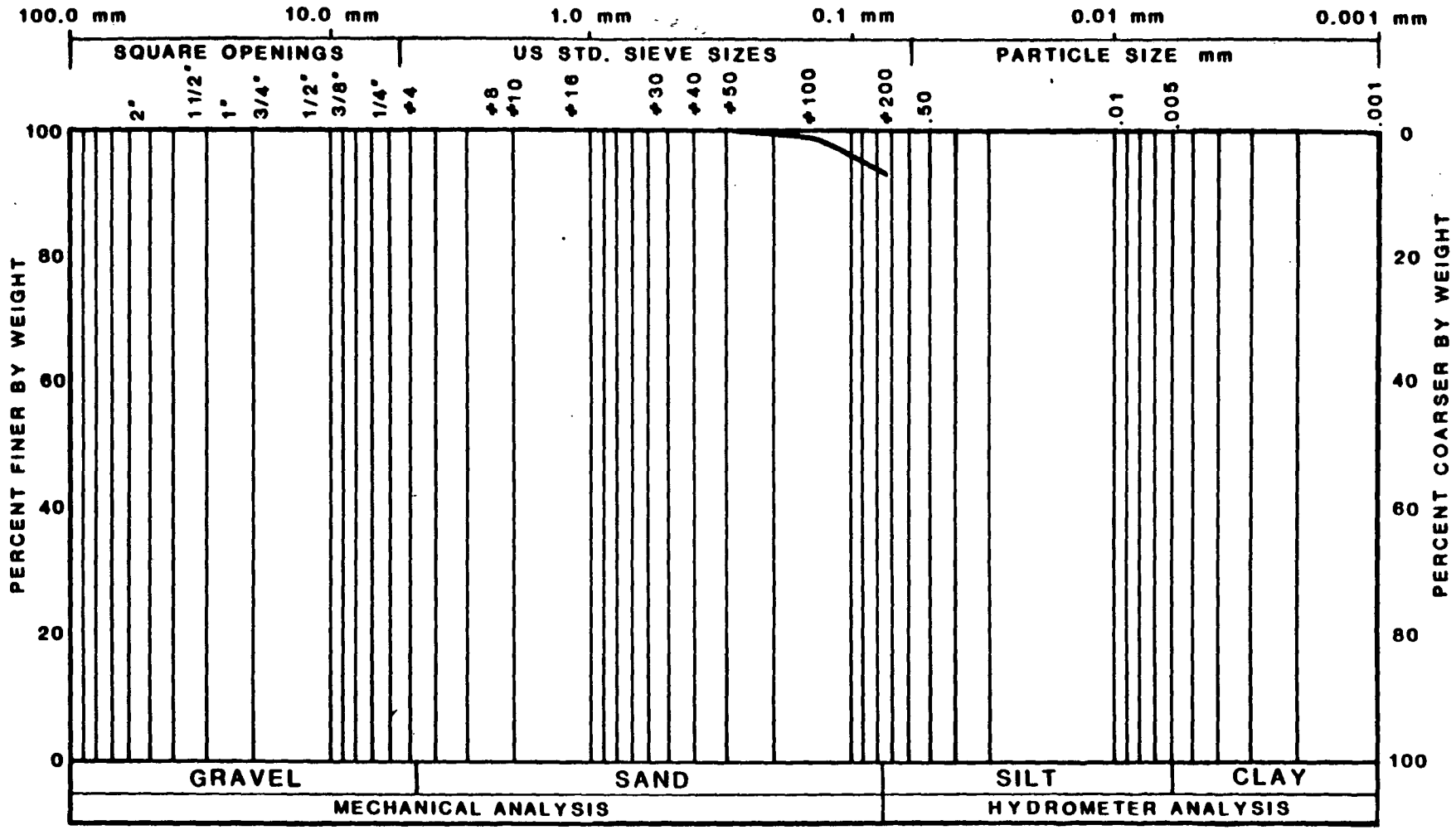
PARTICLE SIZE DISTRIBUTION CURVE

30



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
134	42.0-43.5	

FIGURE D5.29
PARTICLE SIZE DISTRIBUTION CURVE

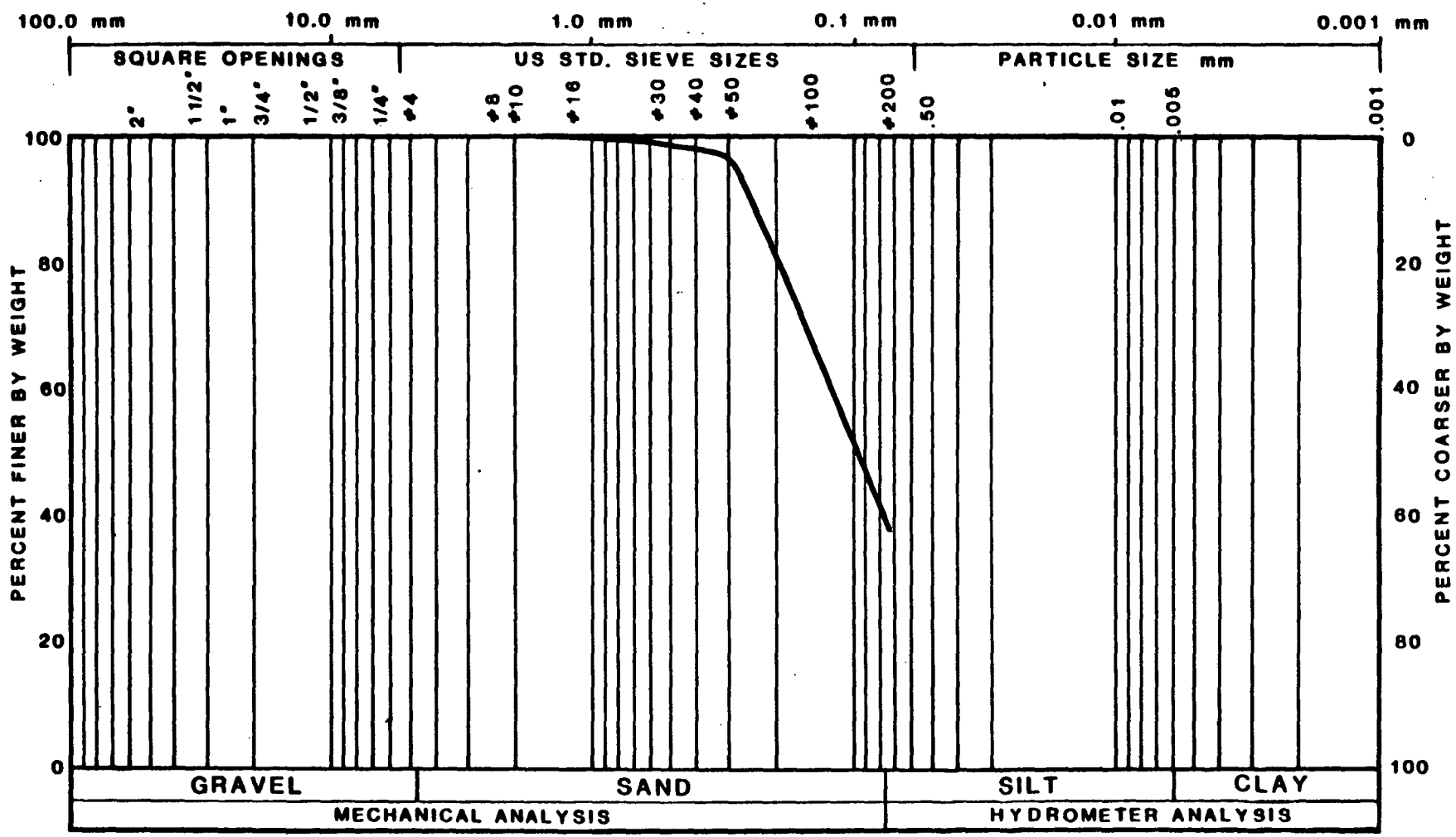


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	135	3.0-5.5	ML

FIGURE D5.30

PARTICLE SIZE DISTRIBUTION CURVE

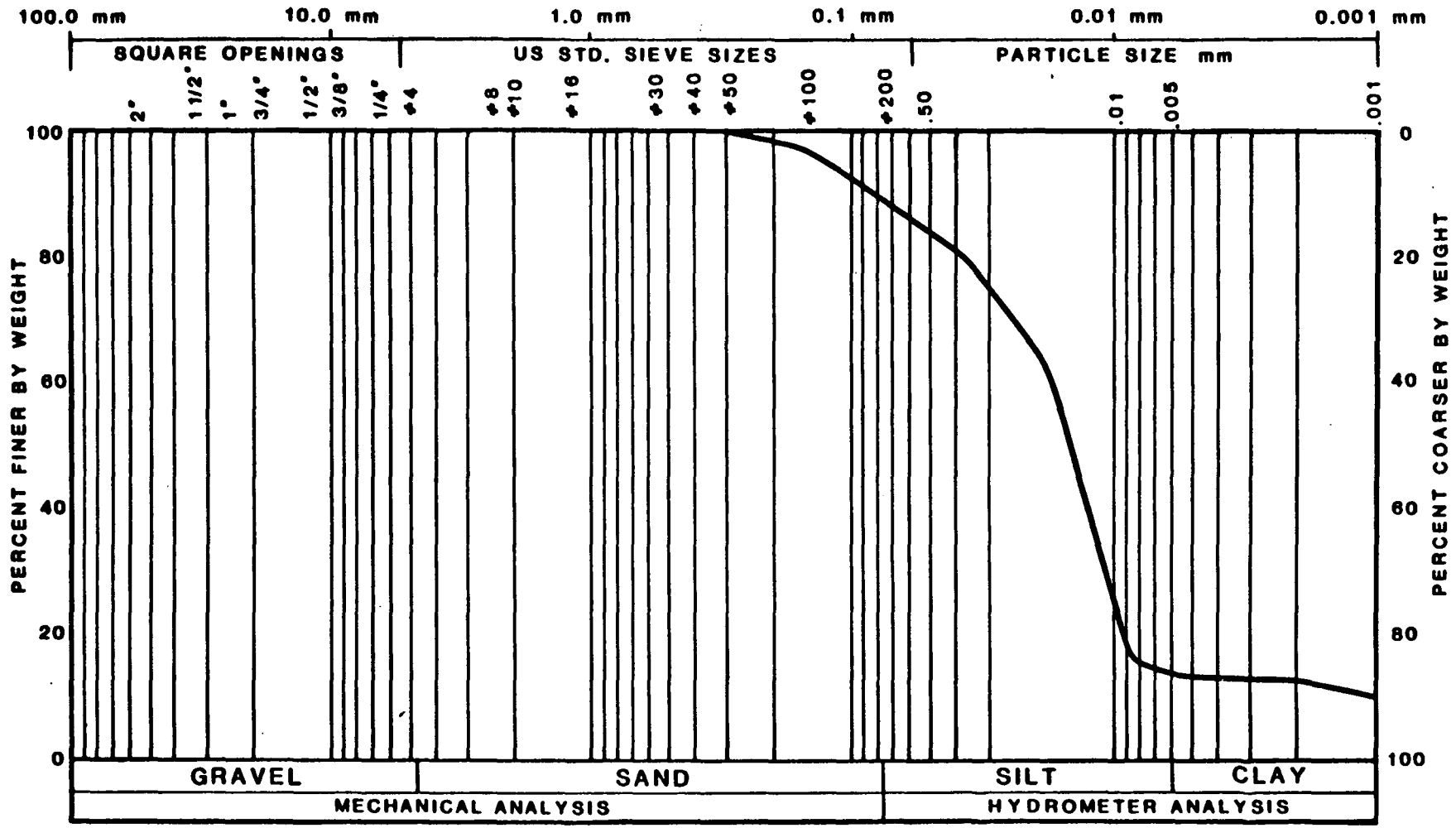
32



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	135	8.5-10.0	

FIGURE D5.31

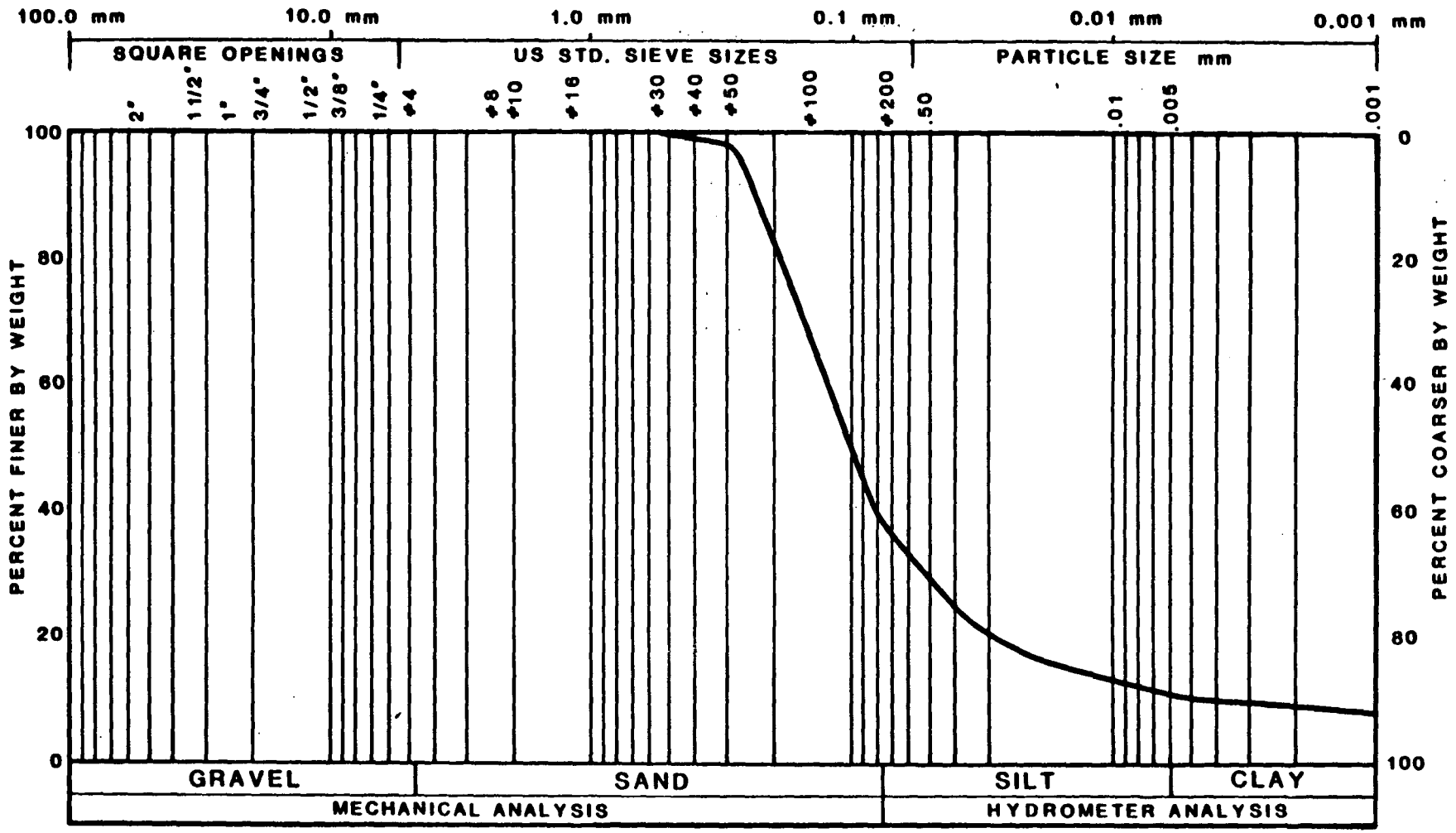
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
135	20.0-22.5	CL

FIGURE D5.32

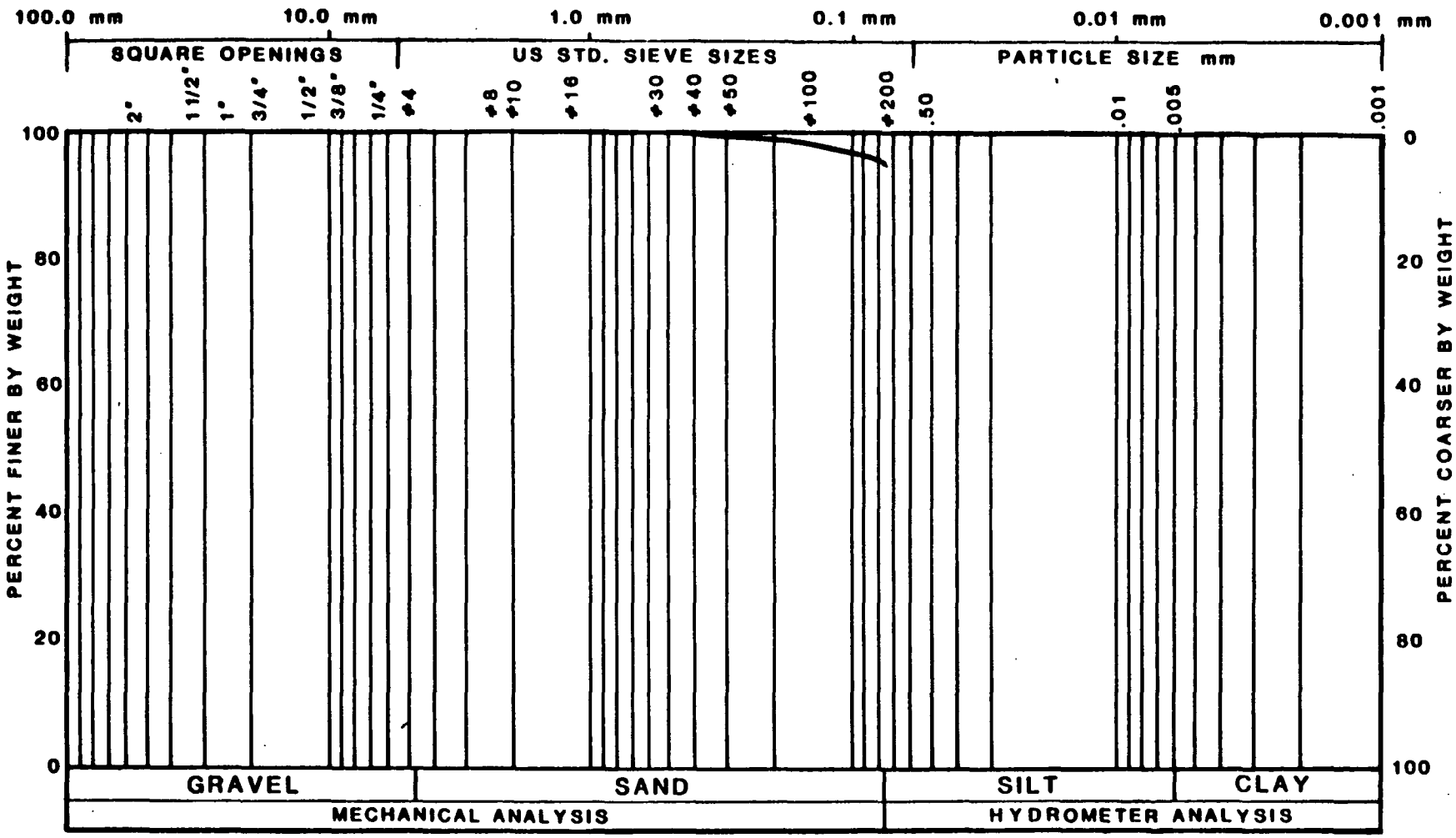
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	135	30.0-32.5	SM

FIGURE D5.33
PARTICLE SIZE DISTRIBUTION CURVE

35

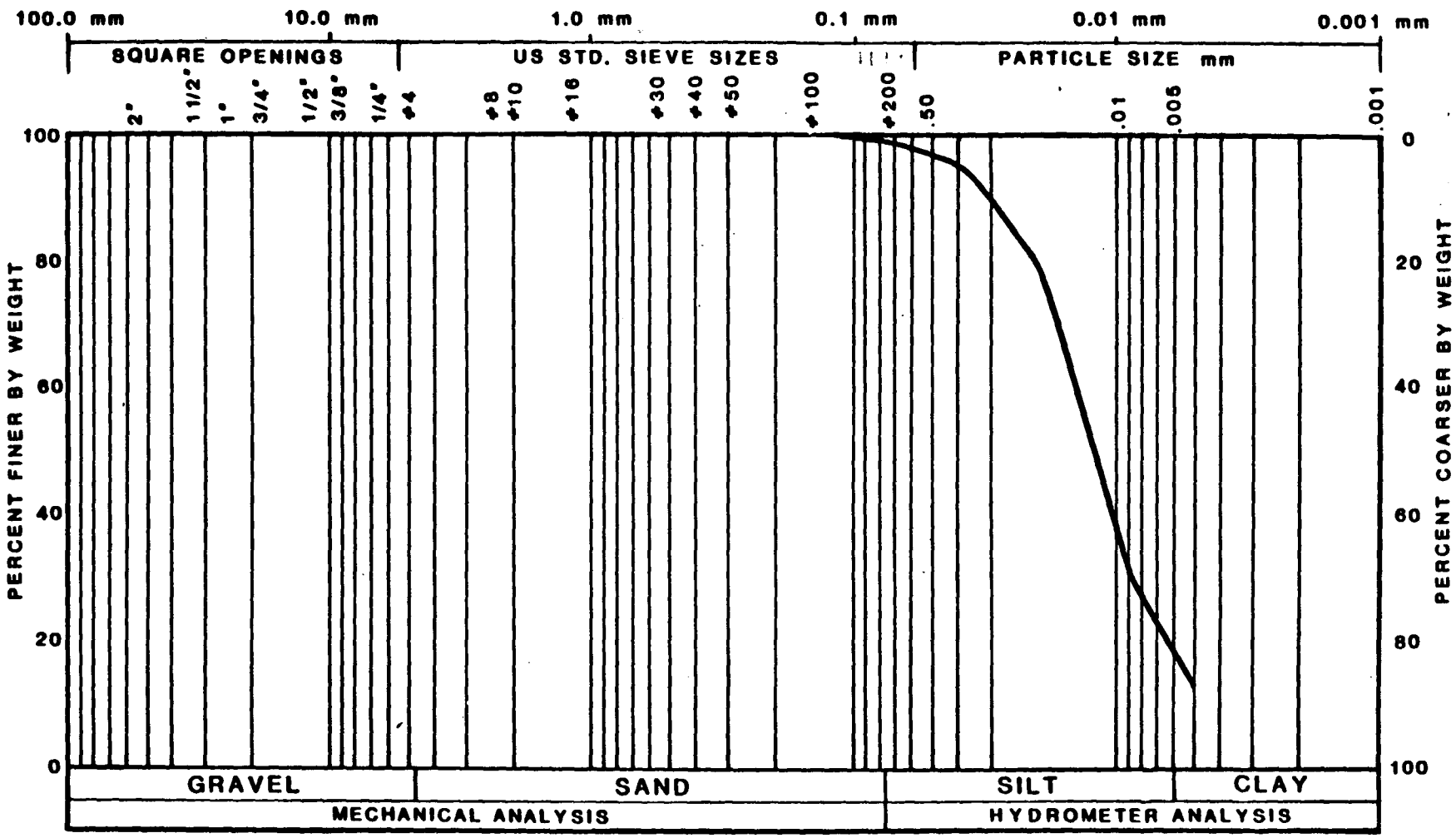


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	135	38.5-40.0	

FIGURE D5.34

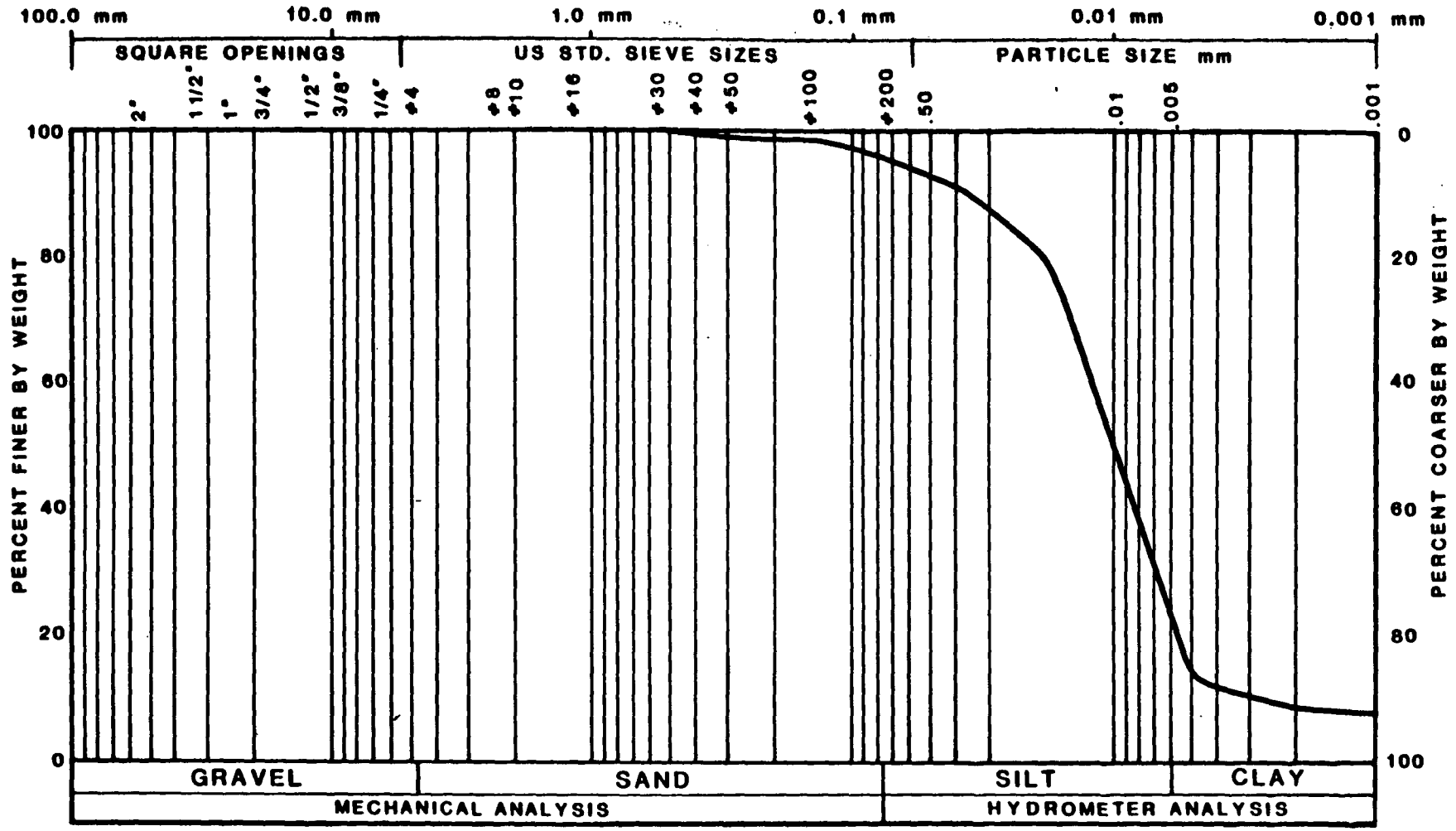
PARTICLE SIZE DISTRIBUTION CURVE

36



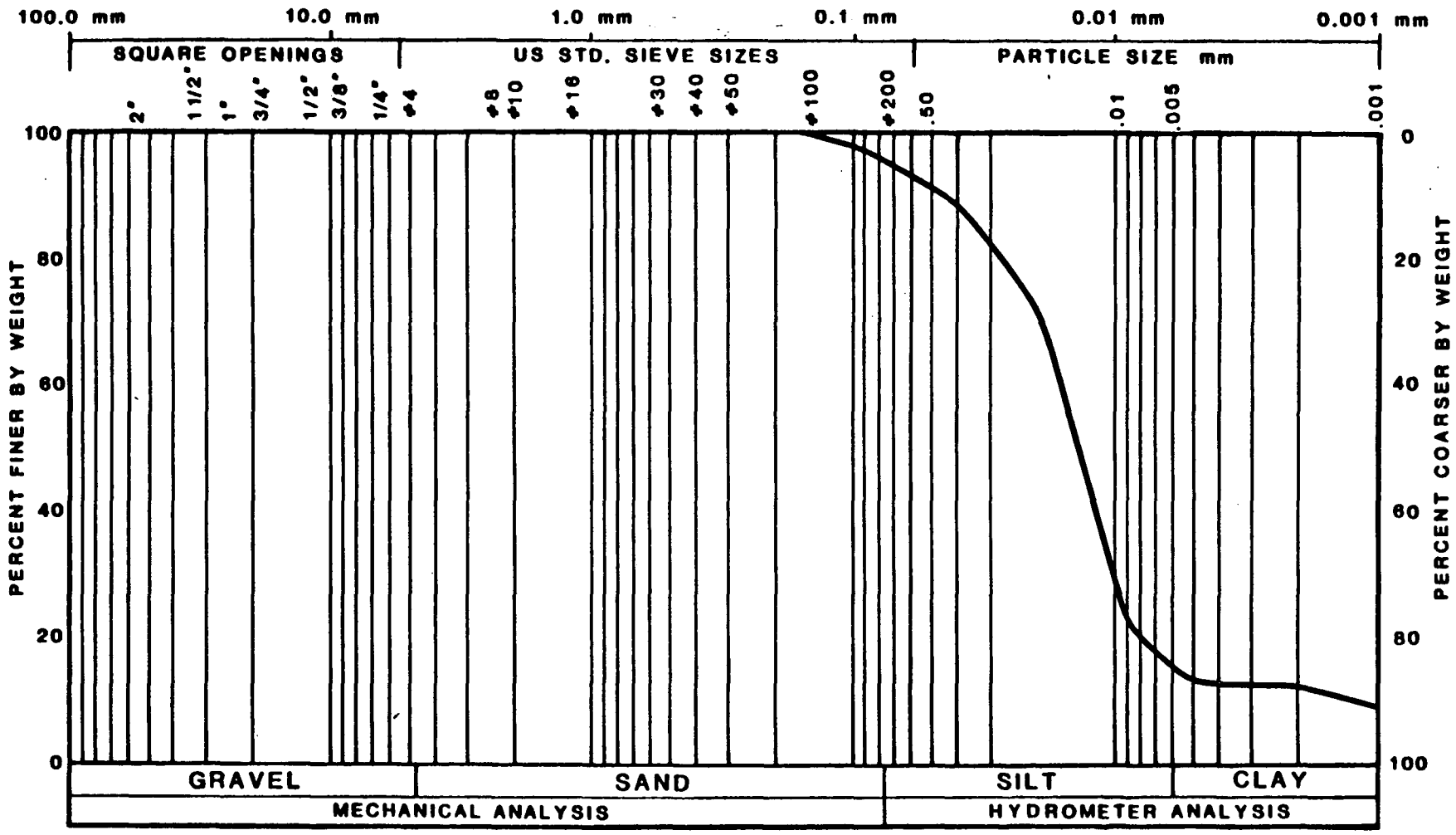
LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	136	3.0-5.5	CL

FIGURE D5.35
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
136	13.0–15.5	CH

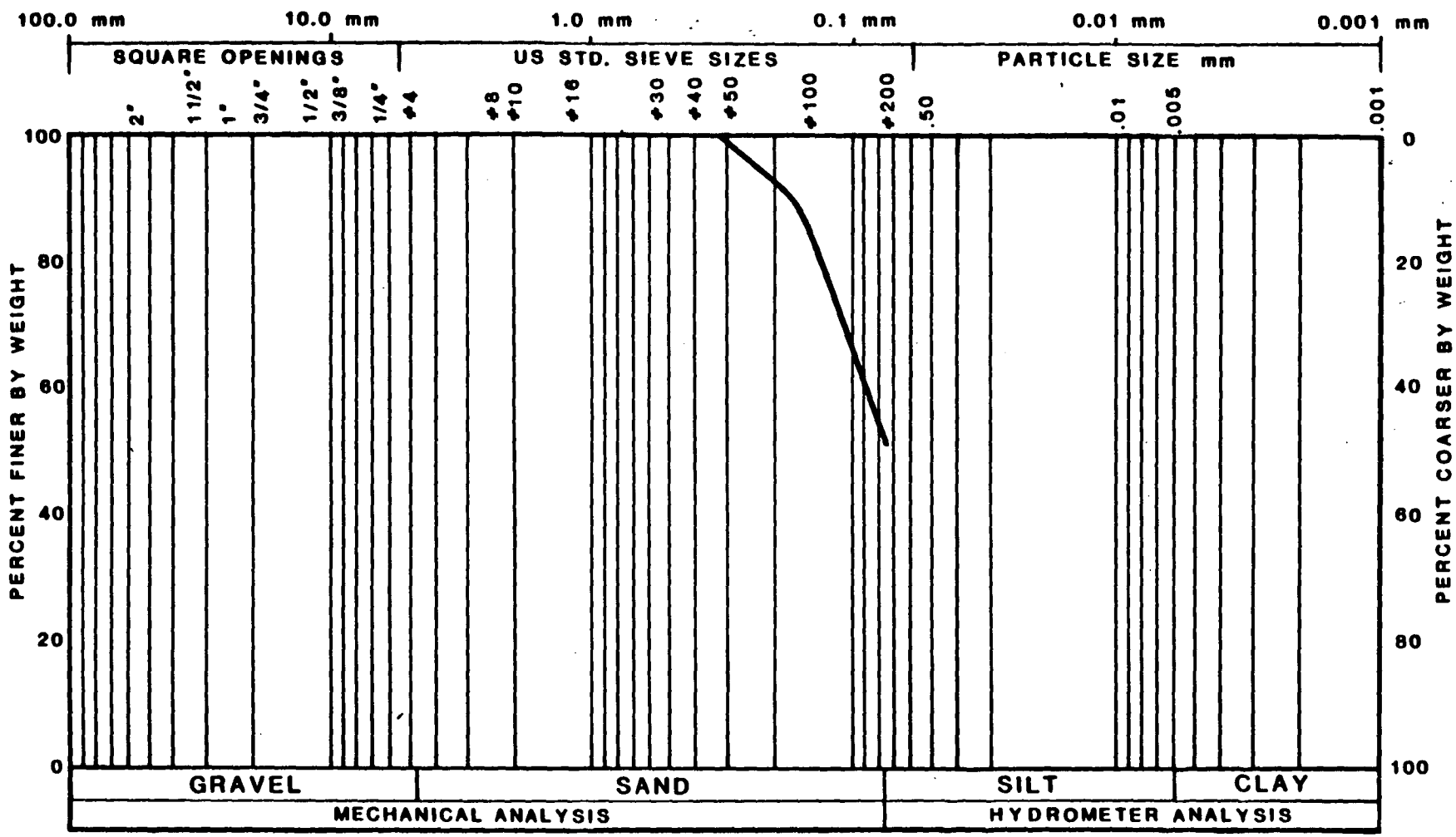
FIGURE D5.36
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
136	20.0-22.5	CL

FIGURE D5.37

PARTICLE SIZE DISTRIBUTION CURVE

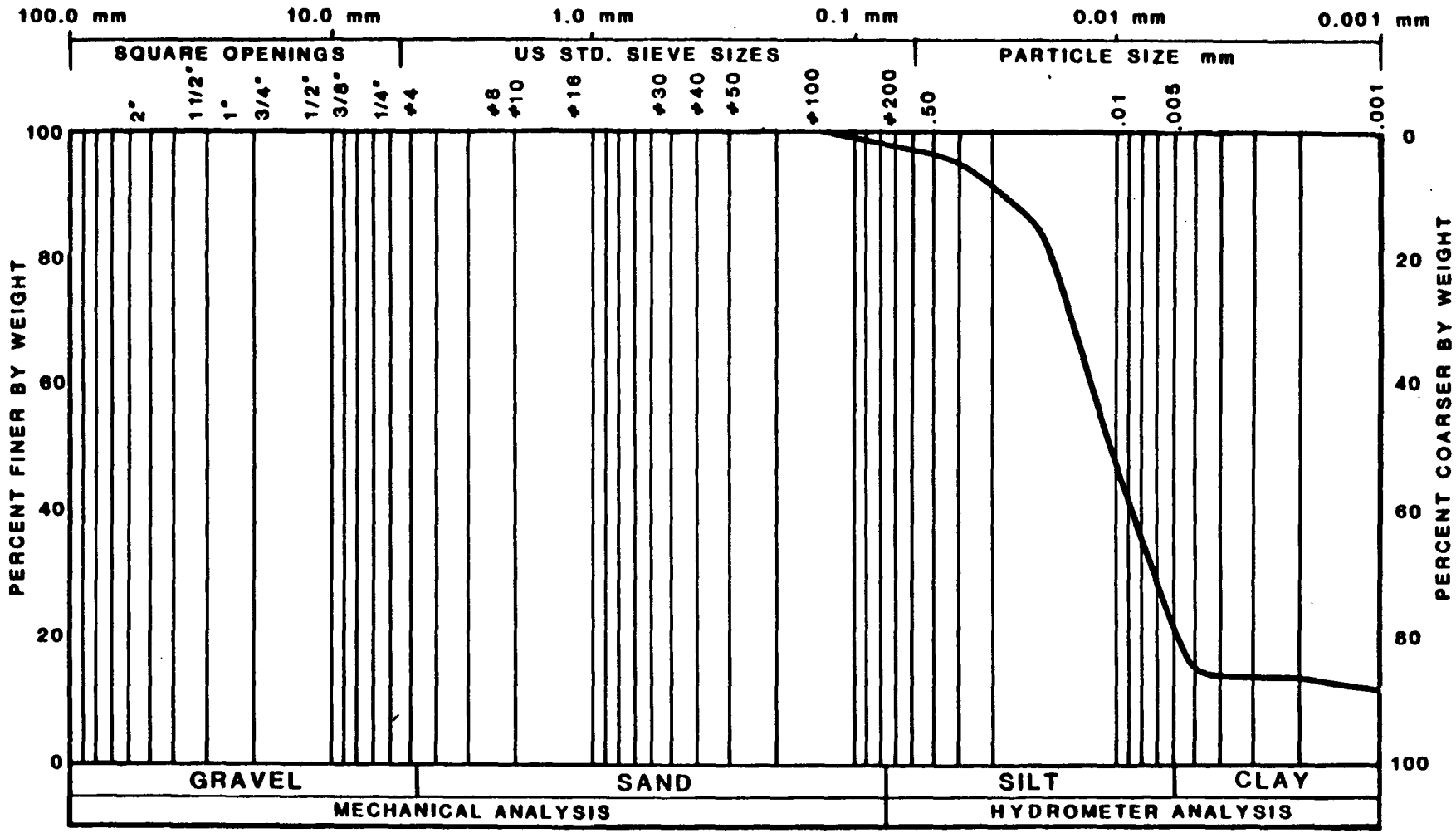


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	137	1.5-3.0	

FIGURE D5.38

PARTICLE SIZE DISTRIBUTION CURVE

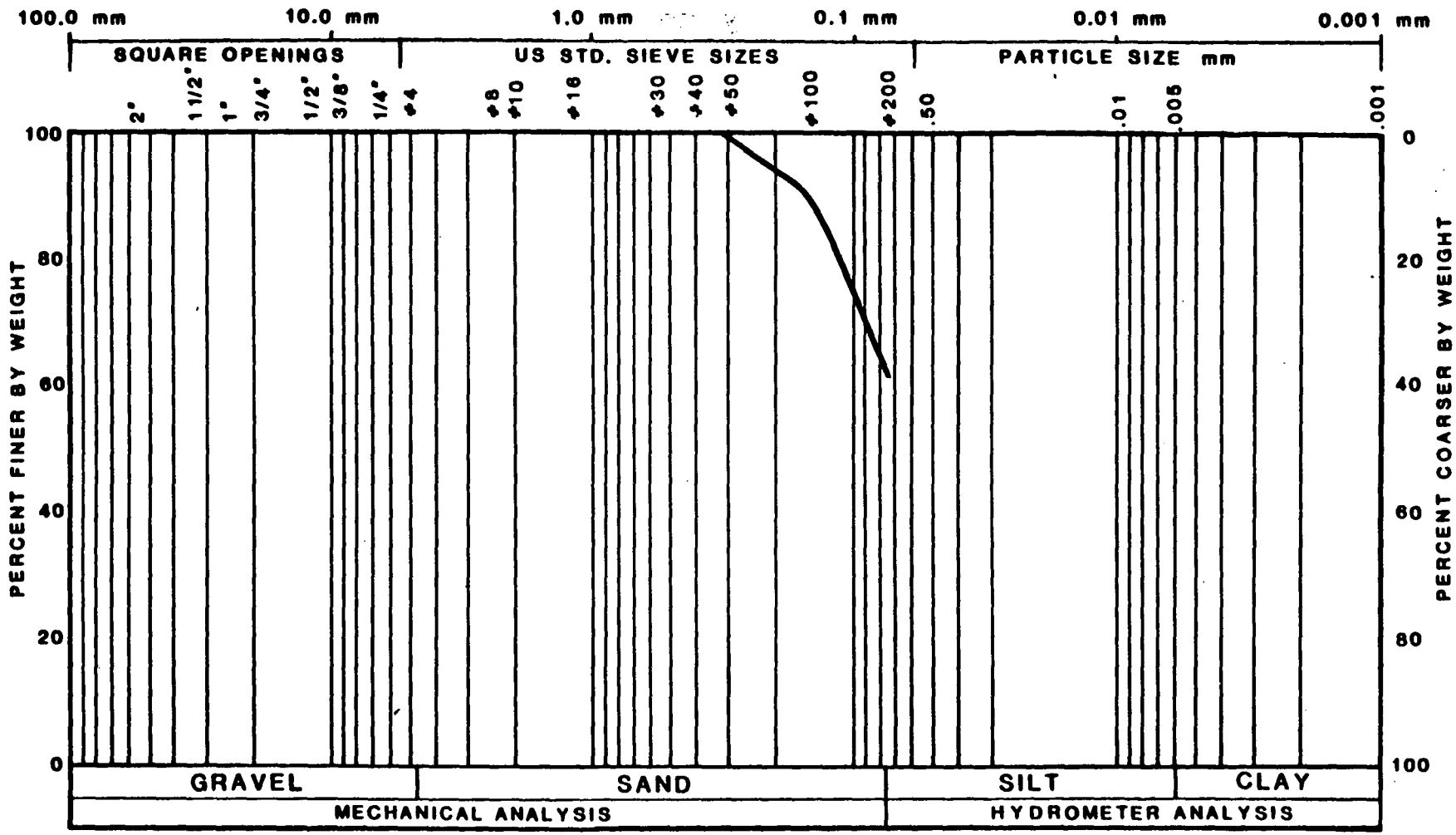
ah



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
137	6.5-9.0	CL

FIGURE D5.39

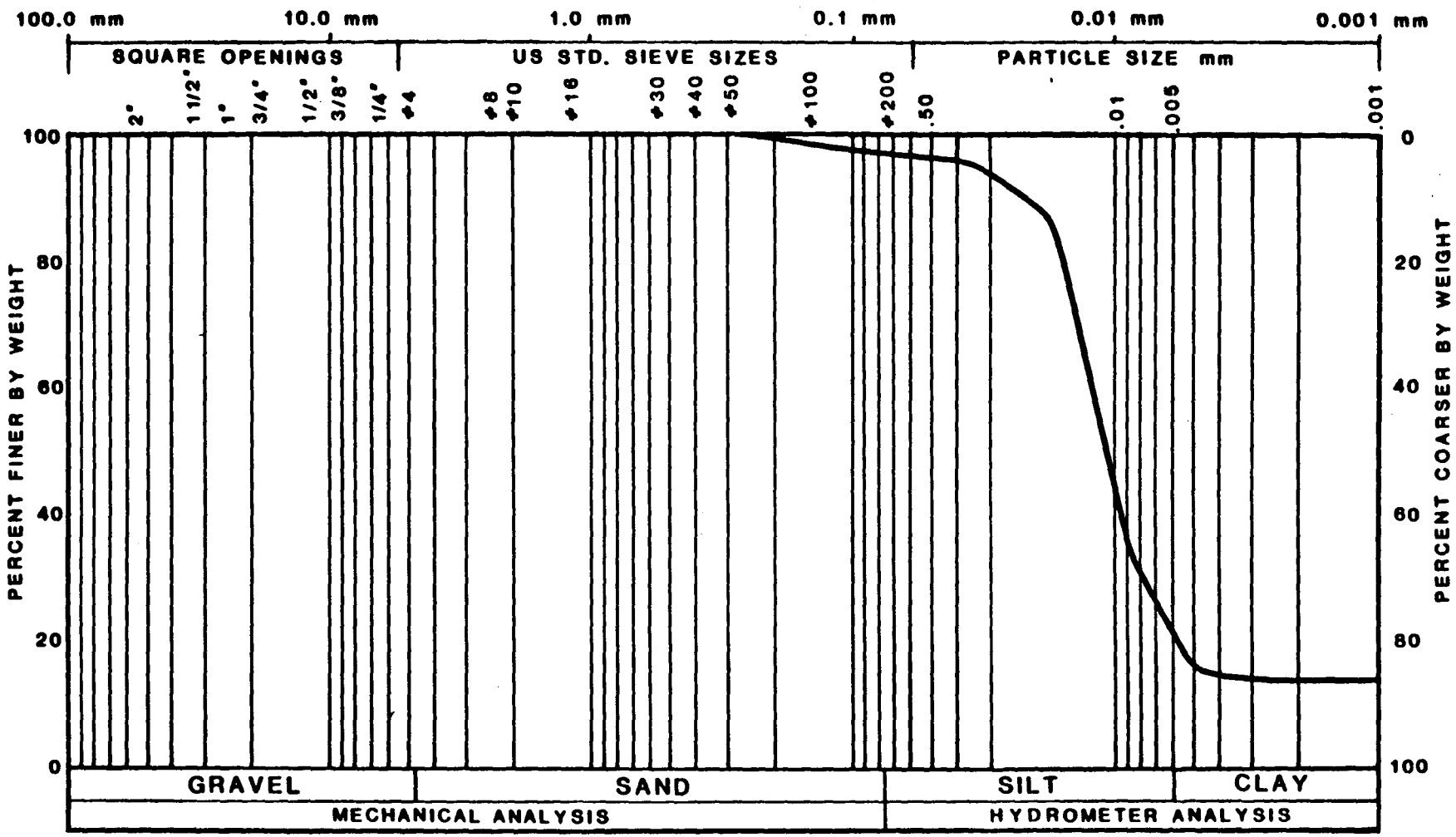
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	137	10.5-12.0	

FIGURE D5.40
PARTICLE SIZE DISTRIBUTION CURVE

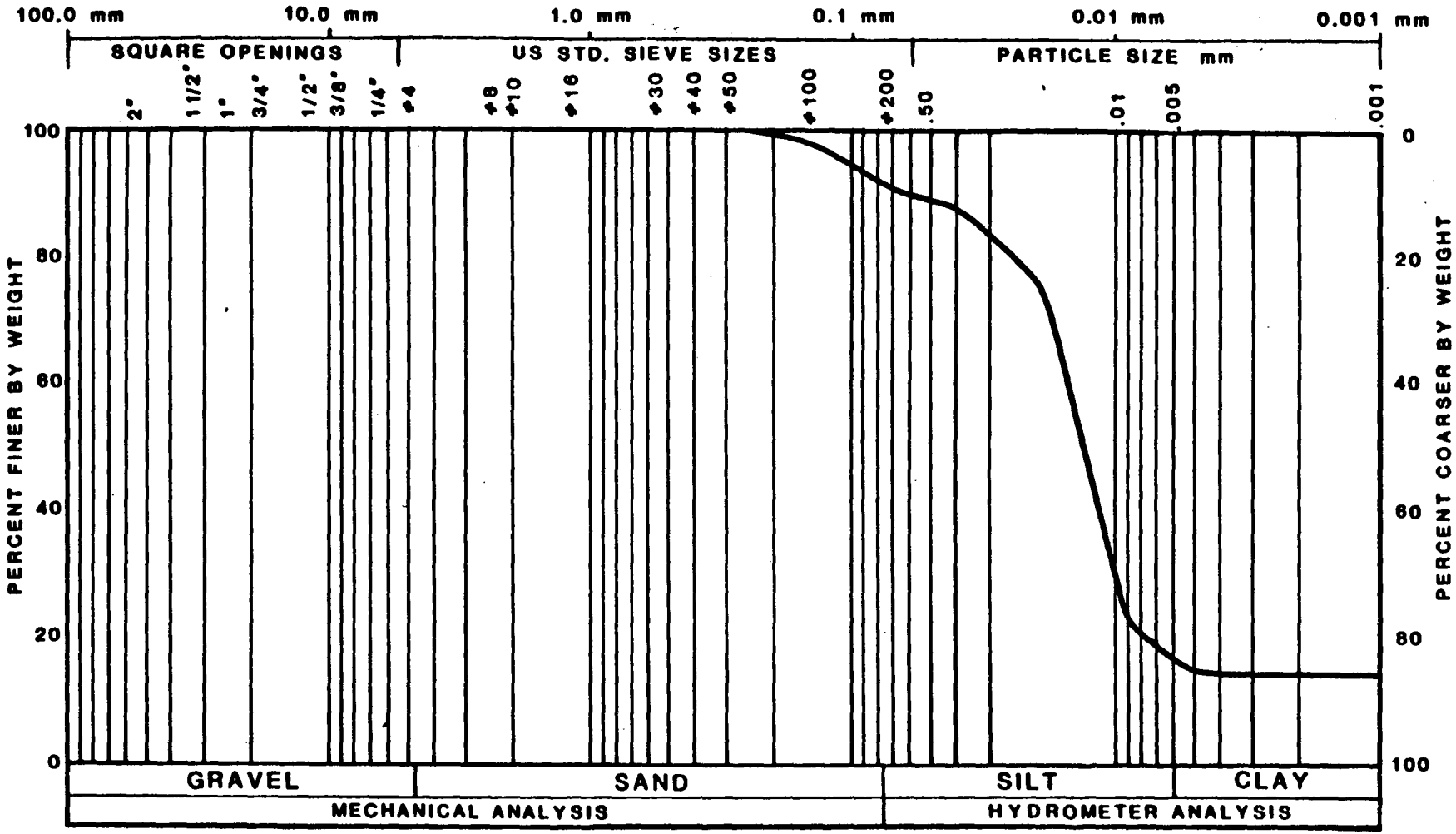
42



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
137	16.5-18.0	CL

FIGURE D5.41

PARTICLE SIZE DISTRIBUTION CURVE

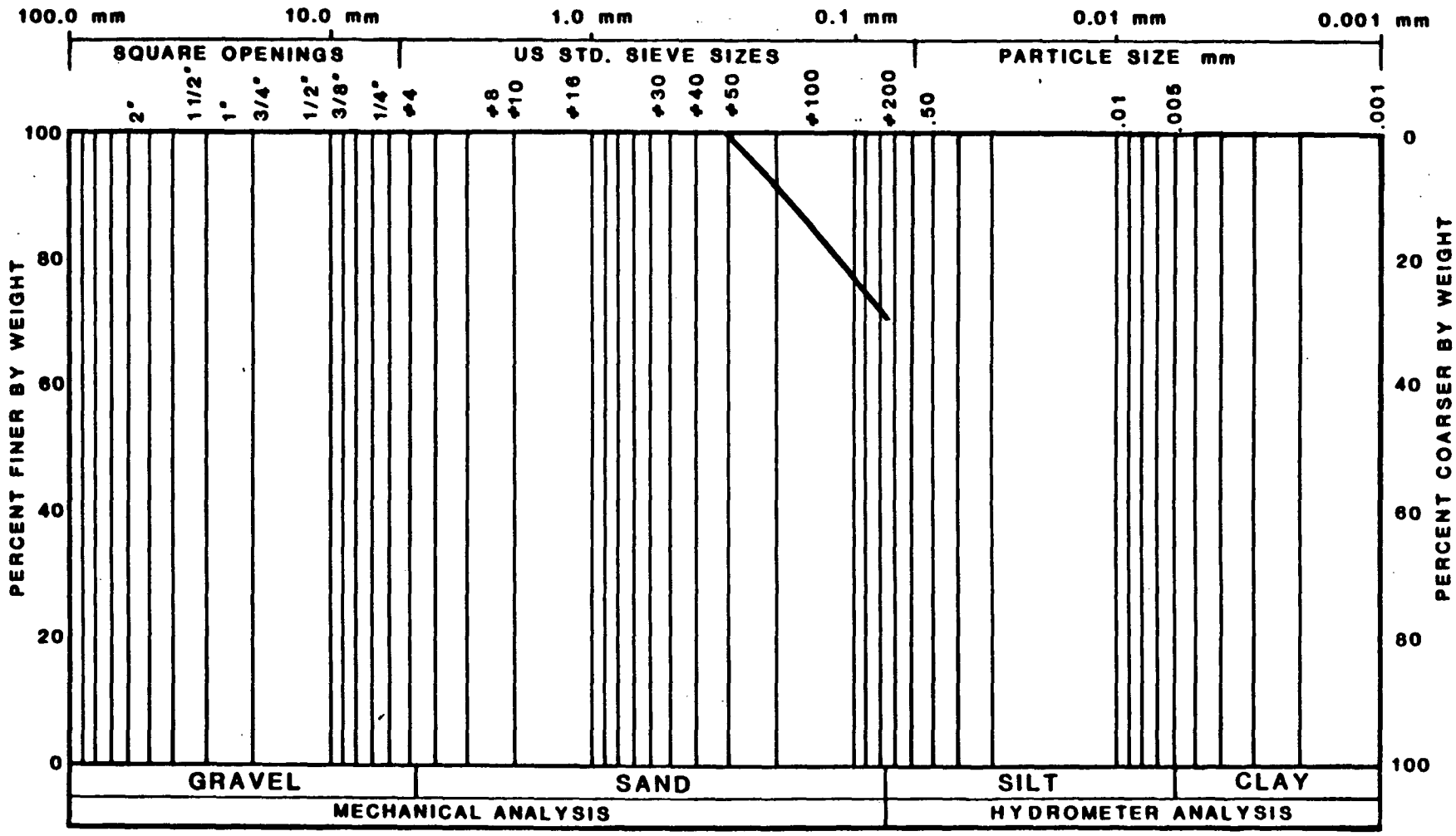


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
138	10.0–11.5	CL

FIGURE D5.42

PARTICLE SIZE DISTRIBUTION CURVE

hh

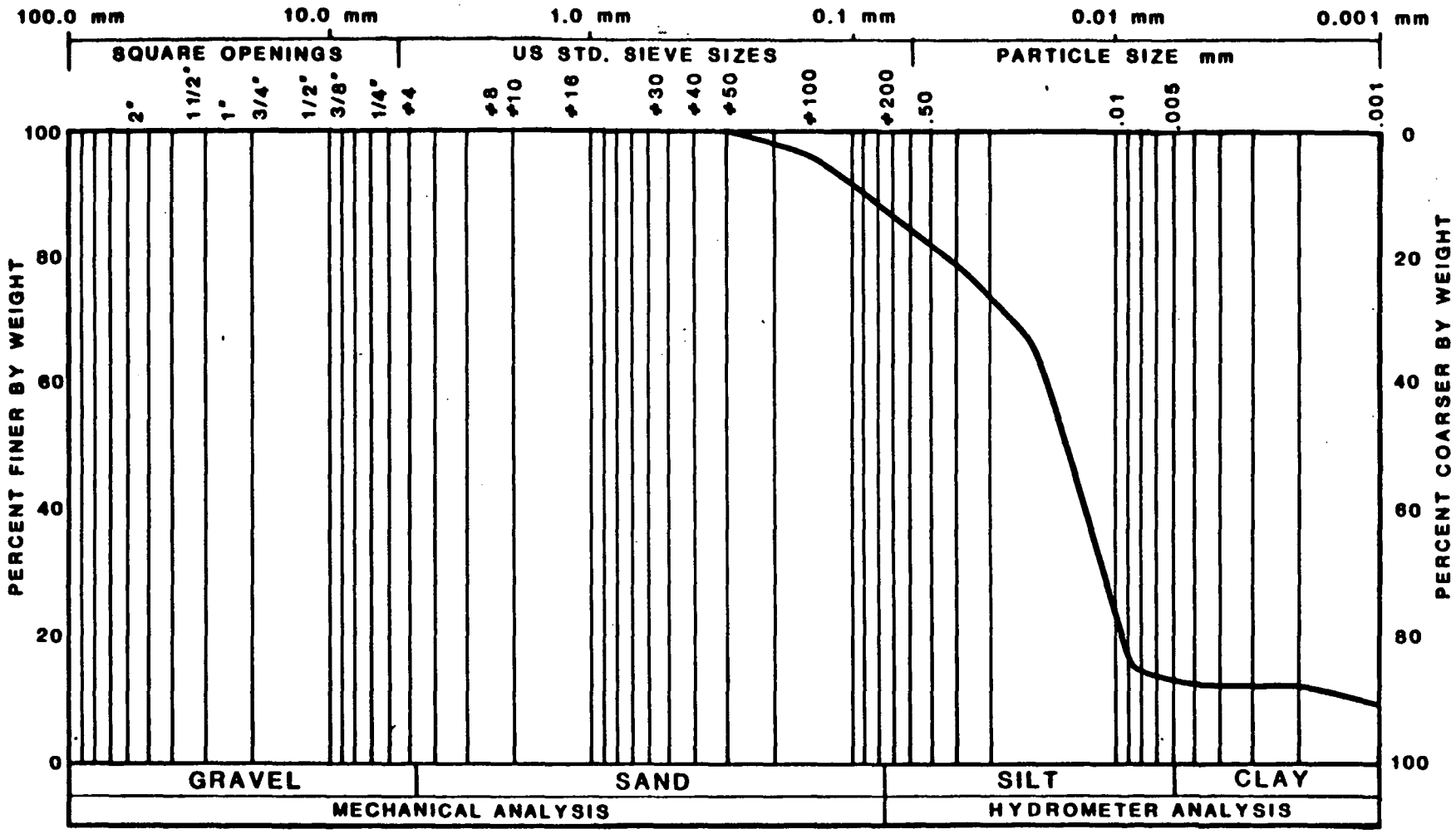


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
138	20-5-22.0	CL-ML

FIGURE D5.43

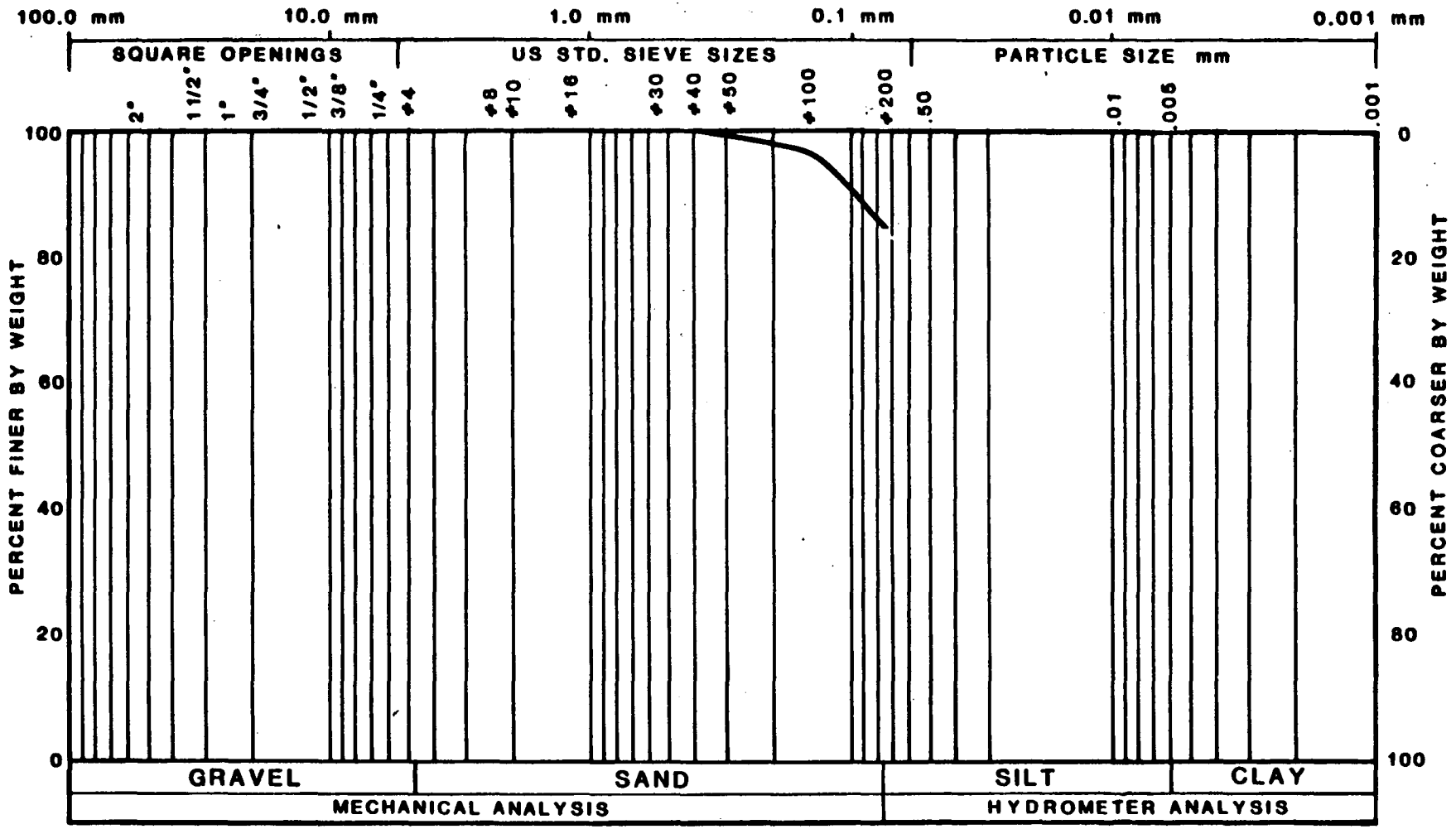
PARTICLE SIZE DISTRIBUTION CURVE

5h



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	138	35.0-37.5	CL

FIGURE D5.44
PARTICLE SIZE DISTRIBUTION CURVE

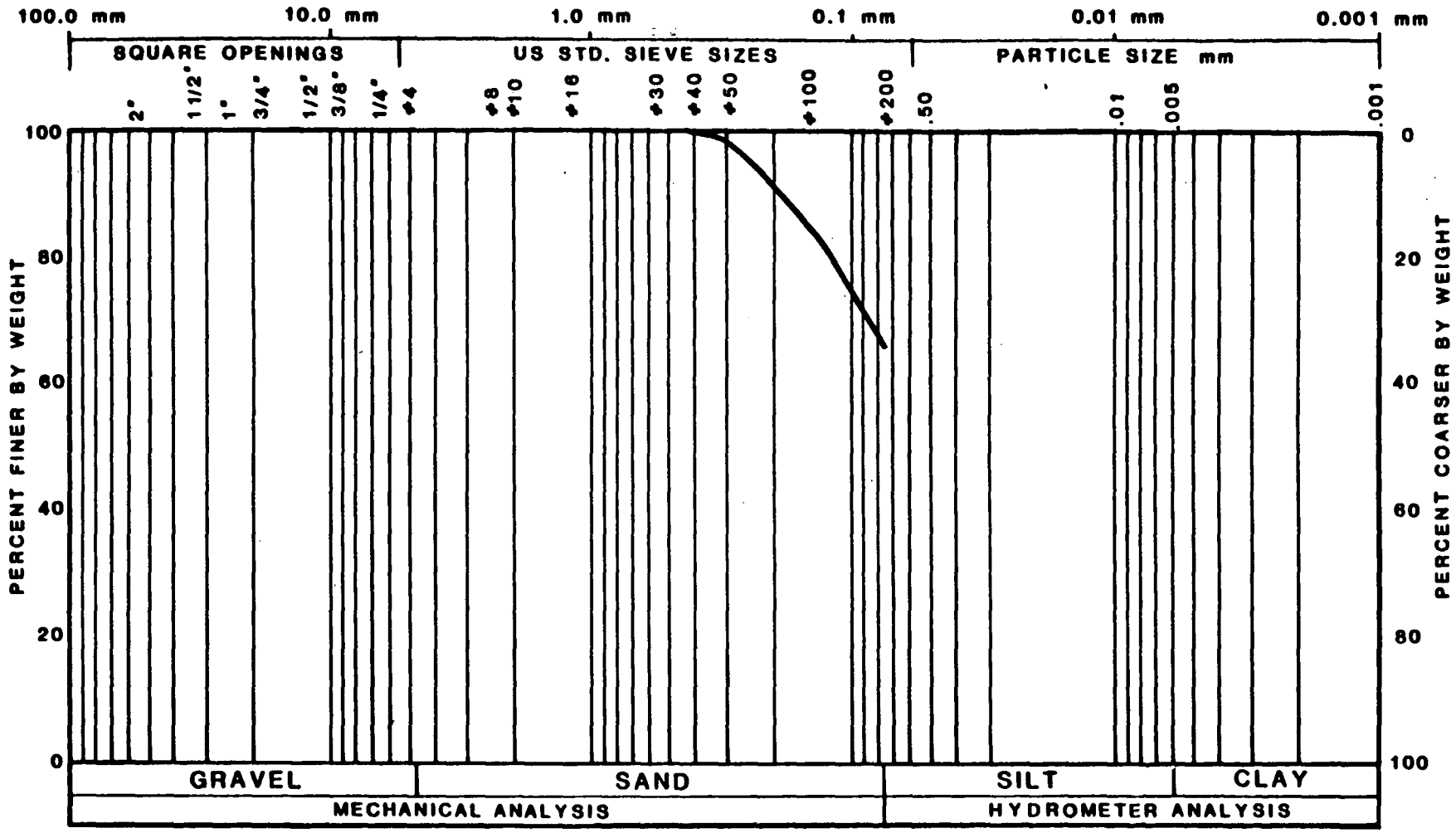


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
138	4.5-6.0	CL

FIGURE D5.45

PARTICLE SIZE DISTRIBUTION CURVE

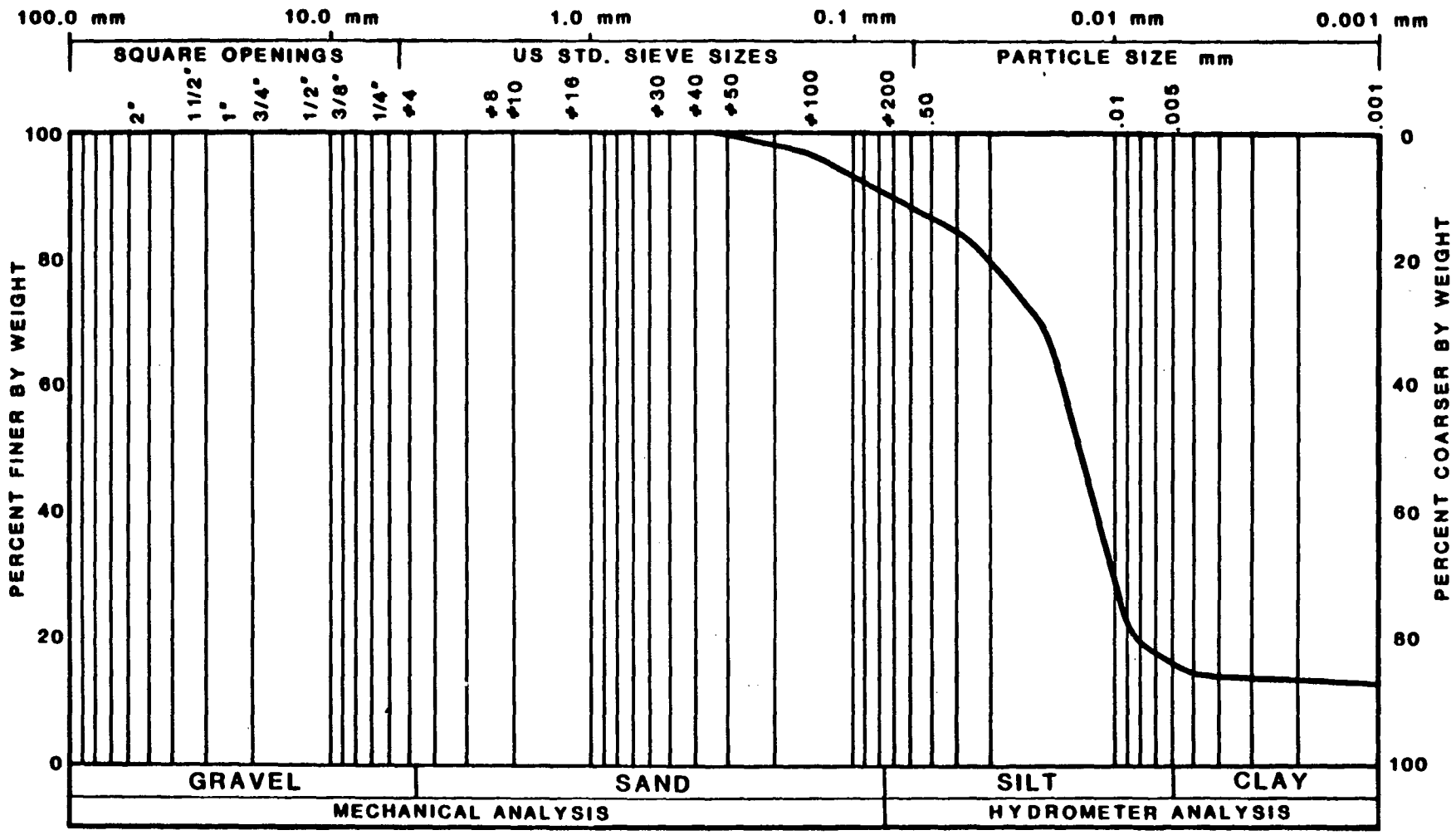
47



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
139	10.5-12.0	ML

FIGURE D5.46
PARTICLE SIZE DISTRIBUTION CURVE

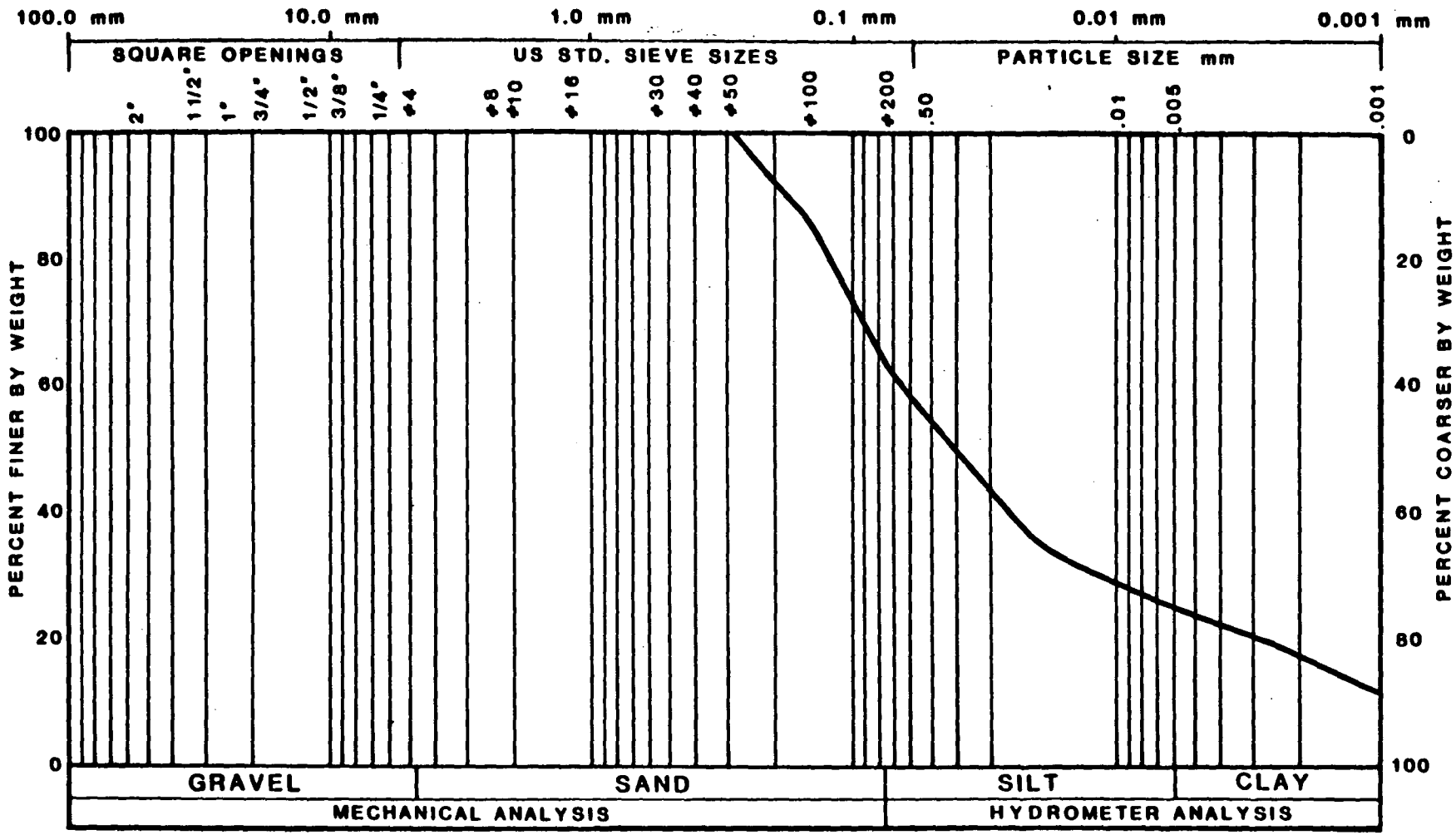
48



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
139	13.5-15.0	CL

FIGURE D5.47

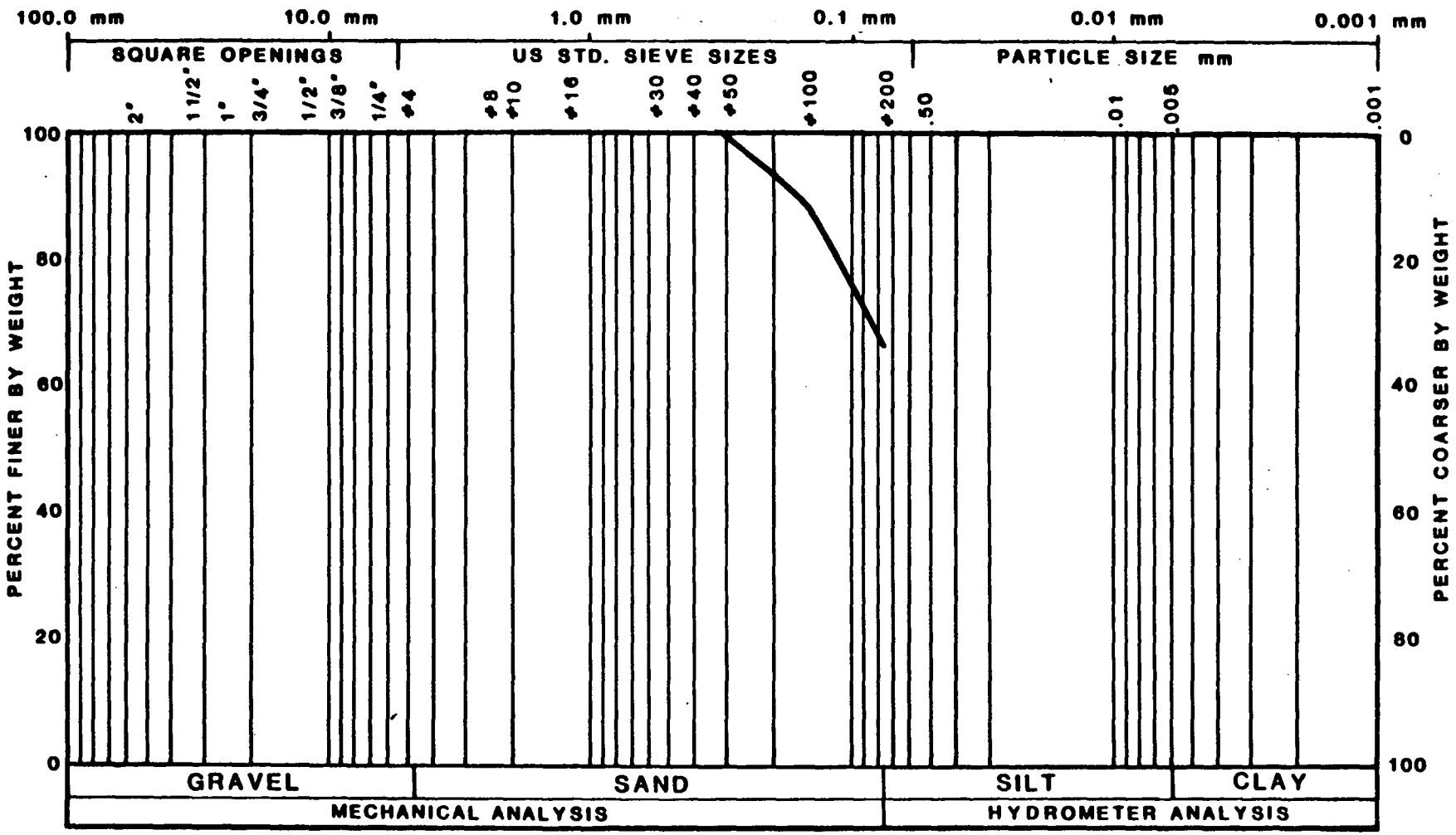
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	139	19.5-22.0	ML

FIGURE D5.48

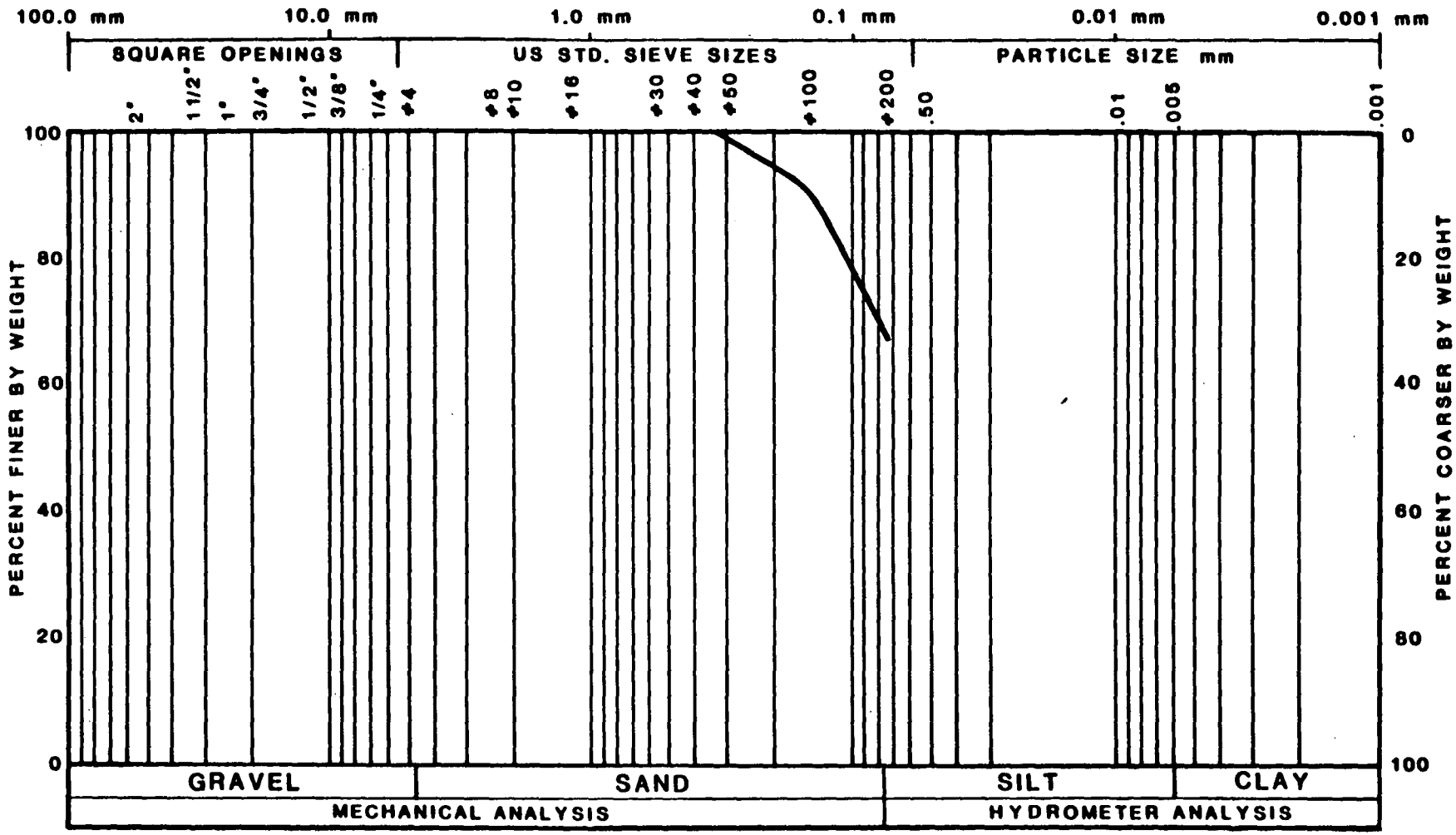
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
139	0.0-1.5	

FIGURE D5.49

PARTICLE SIZE DISTRIBUTION CURVE

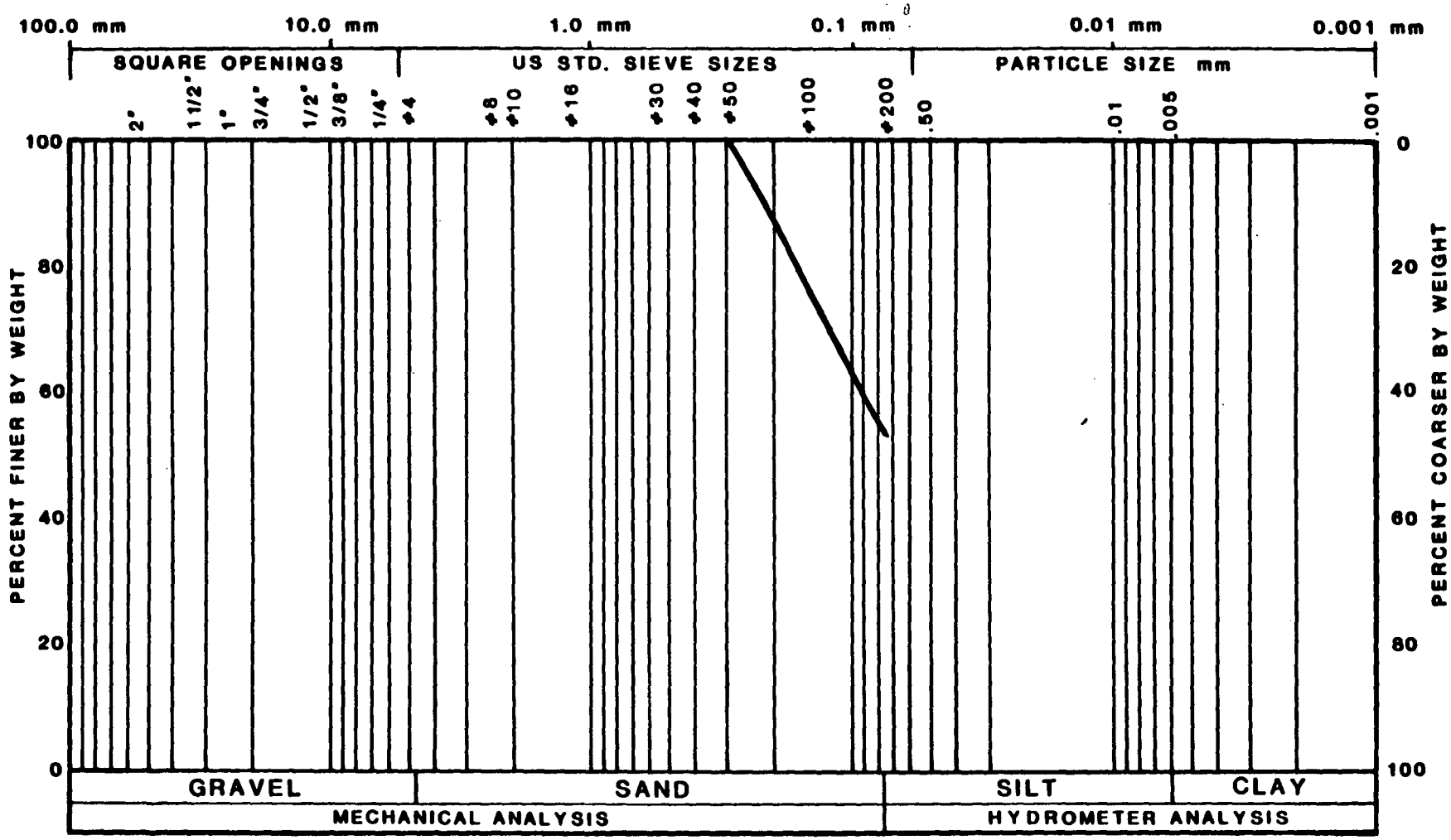


LEGEND		
SAMPLE HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
181	4.5-7.0	ML

FIGURE D5.50

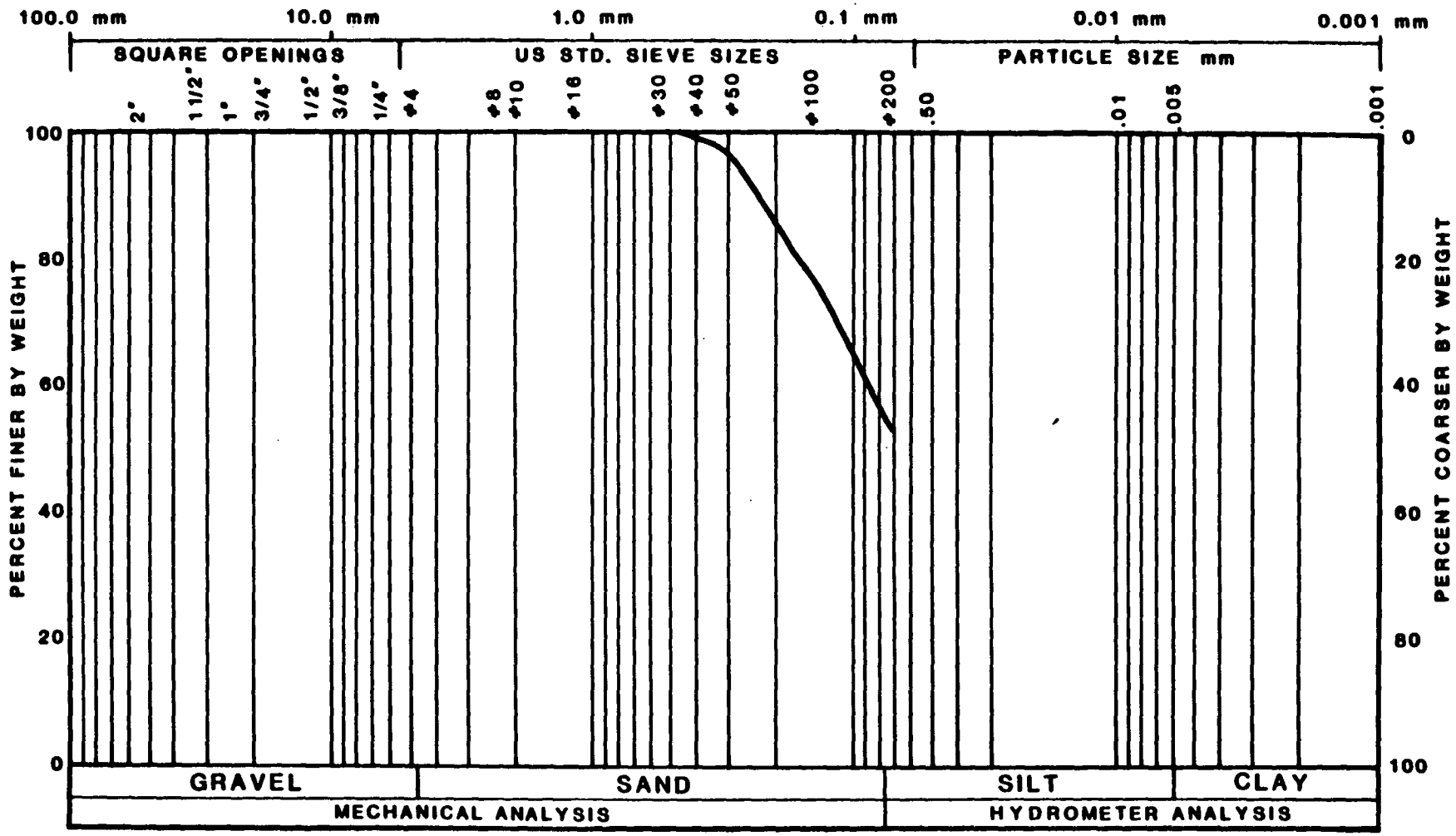
PARTICLE SIZE DISTRIBUTION CURVE

52



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	181	8.5–10.0	

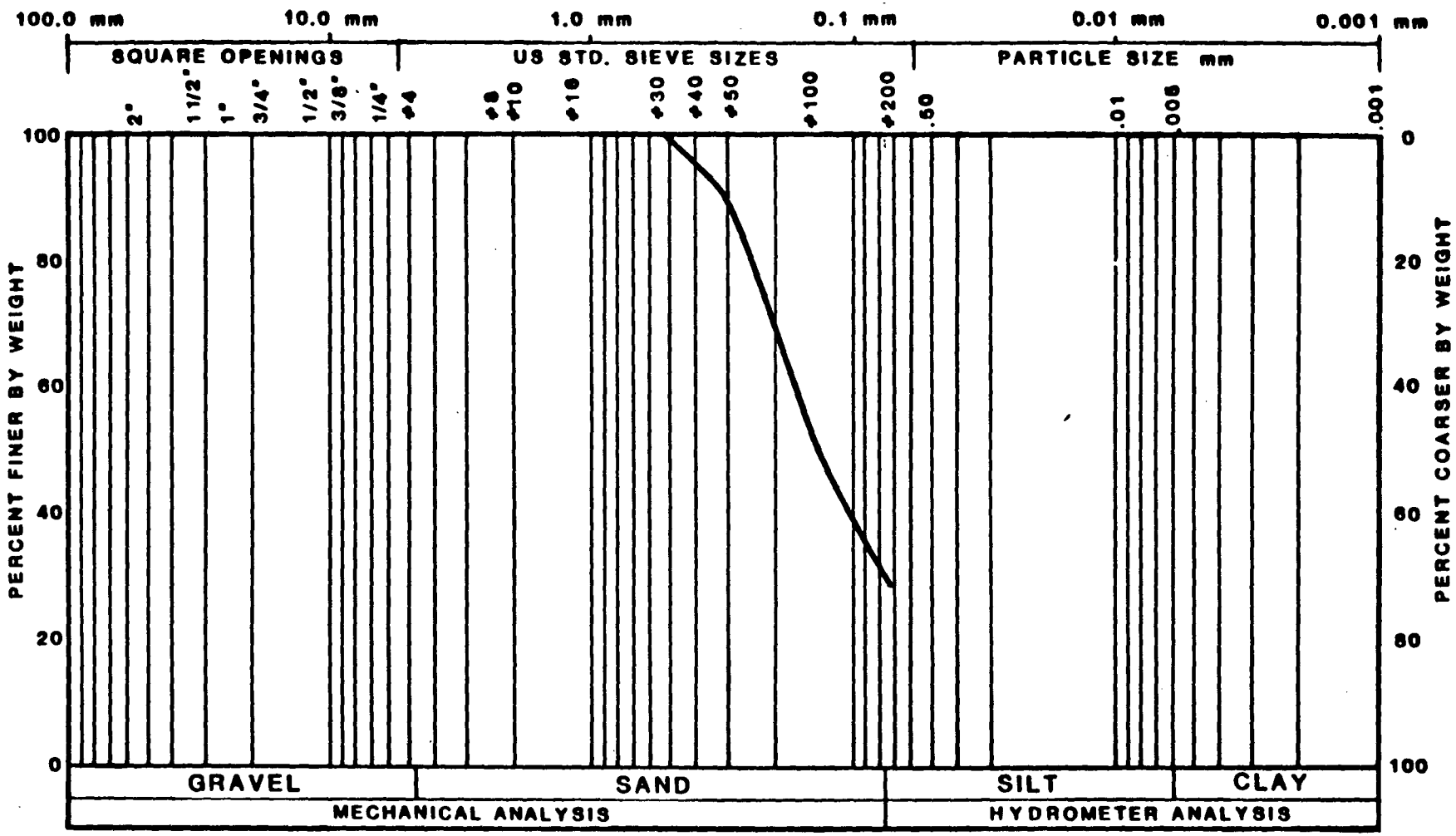
FIGURE D5.51
PARTICLE SIZE DISTRIBUTION CURVE



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	181	14.5-17.0	ML

FIGURE D5.52

PARTICLE SIZE DISTRIBUTION CURVE

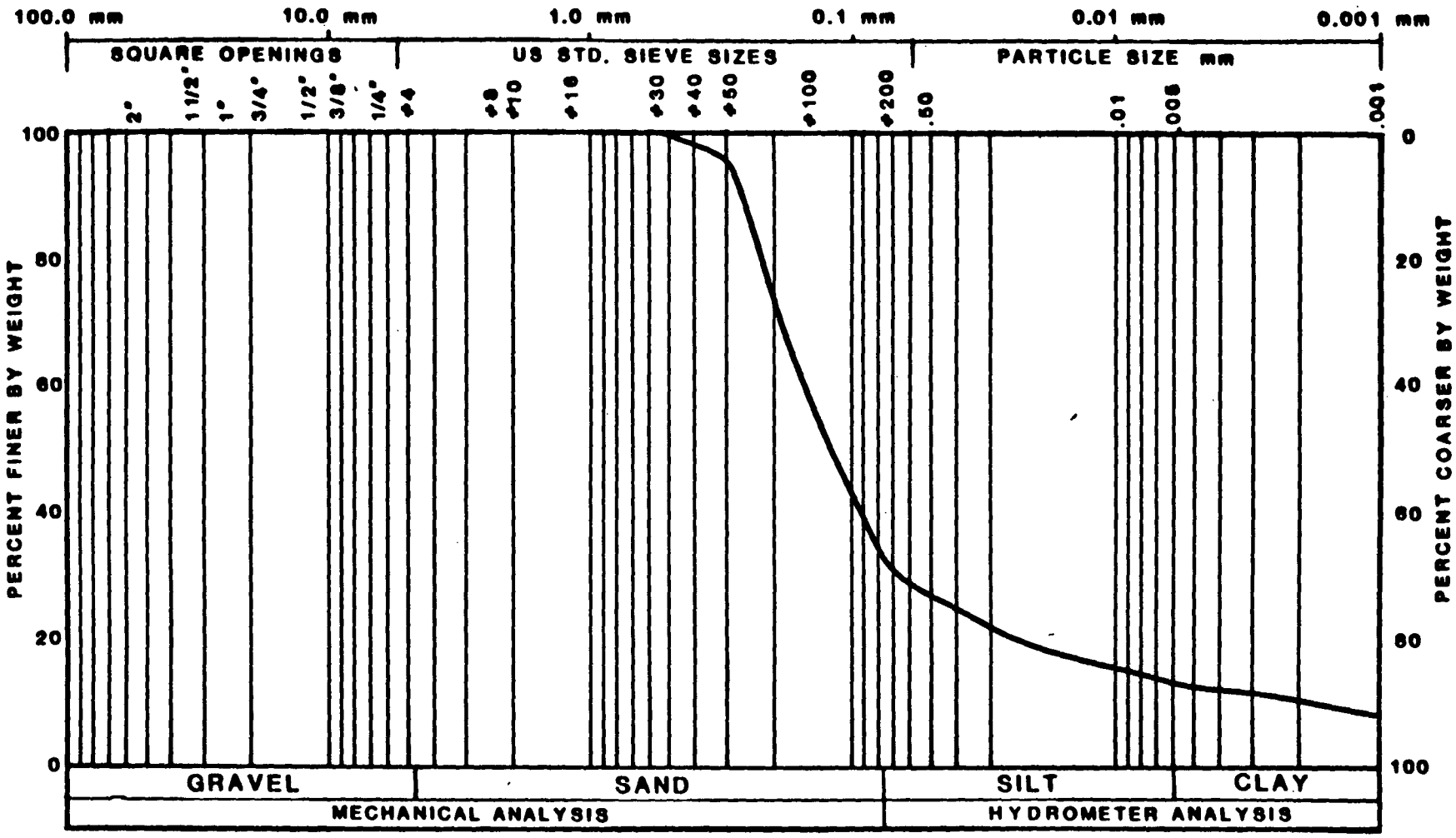


LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	181	20.0-21.5	SM

FIGURE D5.53

PARTICLE SIZE DISTRIBUTION CURVE

53



LEGEND			
SAMPLE	HAT 01	DEPTH INTERVAL (FT.)	UNIFIED SOIL CLASSIFICATION
	181	24.5-26.0	SM

FIGURE D5.54
PARTICLE SIZE DISTRIBUTION CURVE

ADDENDUM D6

PIEZOCONE SOUNDING LOGS

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This addendum contains piezocone sounding logs. When referring to the DOE boring and test pit ID numbers, please note that the numbers used in the text refer to the numbering system as used in the DOE computerized Database Management System (DBMS). The numbering system used on the piezocone logs does not match that used in the text. Therefore, when referring to the following piezocone logs in conjunction with the text of this document it may be necessary to convert the field and laboratory numbers via Table D4.1 in Addendum D4.

Results of piezocone testing

The following pages contain the results obtained by processing the raw field data from the piezocone soundings with a piezocone data analysis and plotting computer program developed by the TAC.

The program allows the engineer to pick the various soil layer boundaries on a high resolution graphics screen plot of the data. The engineer is aided by a bar-coded, computer-calculated soil classification plotted alongside the data plots. The tailings classification scheme, as developed through lab test correlations is presented as Figure D6.1.

The resulting graphics containing the data plots, bar-code classification, and designated layer boundaries are presented on the following pages. Following the graphic output are printouts containing various averaged piezocone readings and empirically correlated soil parameters for each layer and for the entire profile.

Bar code

White = sand
Gray = sand-slime
Charcoal gray = slimes

Layer numbers in graphics output correspond to those listed in printed output that follow graphics.

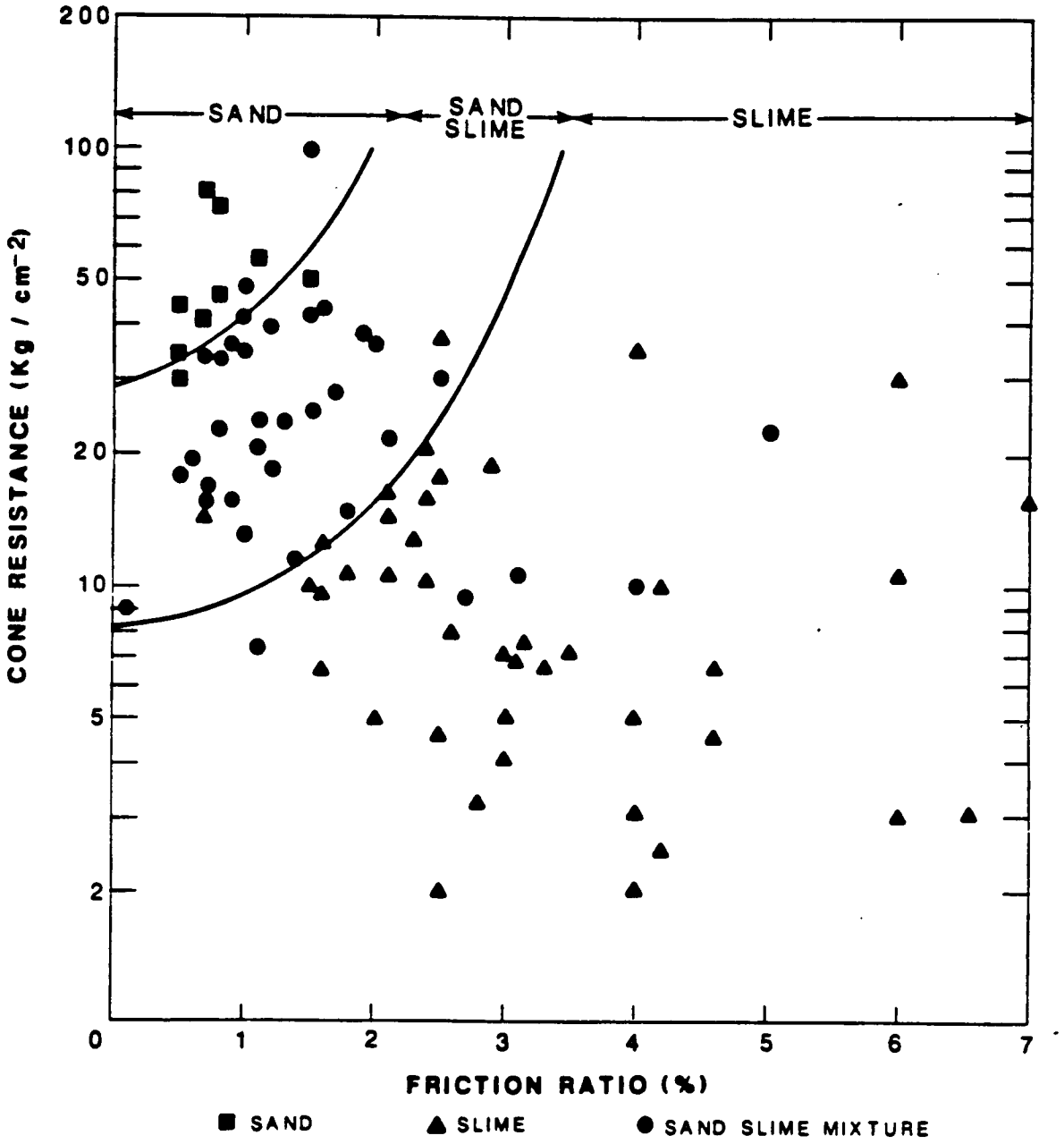

FIGURE D6.1
PIEZOCONE CLASSIFICATION CHART USED FOR TAILINGS

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 006
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	3.0	2.9	16.8	0.1	-0.0	0.5	S-SL*	5	40	30	59	2014	
2	3.0	5.1	2.1	6.5	0.2	-0.1	3.0	SLIM	4			23	778	6.5
3	5.1	9.1	4.0	21.0	0.2	-0.0	1.2	S-SL*	7	45	31	74	2520	
4	9.2	11.8	2.6	12.6	0.1	-0.0	1.1	S-SL*	4	27	29	44	1518	
5	11.8	19.2	7.3	7.1	0.2	0.5	3.1	SLIM	4			25	857	1.8
% THK:		50	9.5	17.4	0.1	0.0	1.0	S-SL	5	38	30	61	2091	
% THK:		49	9.4	7.0	0.2	0.4	3.1	SLIM	4			24	839	2.8

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 007
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	9.9	0.2	0.0	2.0	SLIM	6			34	1182	39.5
2	1.0	3.9	2.8	15.5	0.2	0.0	1.2	S-SL*	5	38	30	54	1864	
3	3.9	13.0	9.1	7.4	0.3	-0.0	4.2	SLIM	4			26	887	3.8
% THK:		21	2.8	15.5	0.2	0.0	1.2	S-SL	5	38	30	54	1863	
% THK:		78	10.1	7.6	0.3	0.0	4.0	SLIM	4			26	916	7.3

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 008
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	9.5	0.1	-0.0	1.4	SLIM	6			33	1144	32.2
2	1.3	3.9	2.6	22.4	0.2	-0.0	1.0	S-SL*	7	48	31	78	2690	
3	3.9	7.2	3.3	11.6	0.3	-0.0	2.8	SLIM	7			41	1393	7.8
4	7.3	16.3	9.1	5.1	0.2	-0.1	3.3	SLIM	3			18	608	2.0
% THK:		16	2.6	22.4	0.2	0.0	1.0	S-SL	7	48	31	78	2690	
% THK:		83	13.6	7.1	0.2	-0.1	3.0	SLIM	4			24	845	6.1

7

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 009
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	3.4	3.3	18.2	0.1	-0.0	0.7	S-SL*	6	42	30	64	2183	
2	3.4	4.8	1.4	9.9	0.3	0.0	2.8	SLIM	6			35	1194	8.8
3	4.9	6.0	1.2	33.2	0.2	0.1	0.7	S-SL*	11	60	33	116	3980	
4	6.1	6.5	0.4	12.9	0.3	0.1	2.1	SLIM	8			45	1553	7.8
% THK:		71	4.5	22.2	0.1	0.0	0.7	S-SL	7	46	31	77	2662	
% THK:		28	1.8	10.6	0.3	0.0	2.6	SLIM	6			37	1273	8.6

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 010
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.0	1.9	14.2	0.1	-0.1	0.5	S-SL*	4	35	29	50	1701	
2	2.0	3.6	1.6	7.0	0.1	-0.0	1.6	SLIM	4			25	842	9.0
% THK:		54	1.9	14.2	0.1	-0.1	0.5	S-SL	4	35	29	50	1701	
% THK:		45	1.6	7.0	0.1	0.0	1.6	SLIM	4			25	842	9.0

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 011
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	36.1	0.6	0.0	1.7	S-SL*	12	63	33	126	4326	
2	0.8	2.5	1.6	56.8	0.5	0.0	0.8	SAND*	11	78	36	199		
3	2.5	9.8	7.3	26.2	0.2	0.2	0.7	S-SL*	8	52	32	92	3147	
4	9.9	10.8	0.9	15.8	0.2	3.0	1.5	S-SL	5	32	29	55	1891	
5	10.8	12.2	1.4	21.5	0.3	1.5	1.5	S-SL*	7	39	30	75	2583	
6	12.3	16.3	4.0	7.0	0.0	1.4	0.7	SLIM*	4			24	839	1.9
% THK:		10	1.6	56.8	0.5	0.0	0.8	SAND	11	78	36	199		
% THK:		64	10.3	25.3	0.2	0.6	0.9	S-SL	7	49	32	88	3040	
% THK:		25	4.0	7.0	0.0	1.4	0.7	SLIM	4			24	839	1.9

10

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 012
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	17.4	0.2	-0.0	1.4	S-SL*	5	41	30	61	2086	
2	0.8	1.5	0.7	53.2	0.5	0.1	0.9	SAND*	10	76	35	186		
3	1.5	2.7	1.2	28.7	0.3	0.0	1.1	S-SL*	9	56	32	101	3448	
4	2.7	3.6	0.9	37.3	0.3	0.1	0.7	SAND*	7	64	34	131		
5	3.7	6.8	3.1	21.9	0.2	0.1	1.0	S-SL*	7	47	31	77	2631	
6	6.8	7.4	0.7	9.5	0.2	0.2	1.9	SLIM	6			33	1138	5.6
7	7.5	8.2	0.7	18.4	0.2	0.2	0.9	S-SL*	6	42	30	64	2207	
8	8.2	8.9	0.7	32.1	0.3	0.2	0.8	S-SL*	10	57	33	112	3852	
9	8.9	11.1	2.1	19.7	0.2	0.3	1.2	S-SL*	6	39	30	69	2360	
10	11.1	12.0	0.9	7.1	0.1	0.6	1.9	SLIM	4			25	855	2.6
% THK:		13	1.6	44.3	0.4	0.1	0.8	SAND	8	69	34	155		
% THK:		72	8.5	22.5	0.2	0.1	1.1	S-SL	7	46	31	78	2700	
% THK:		13	1.6	8.2	0.1	0.4	1.9	SLIM	4			28	978	3.9

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 013
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	13.2	0.1	-0.1	0.9	S-SL*	4	33	29	46	1579	
2	1.0	1.7	0.7	9.7	0.2	-0.1	1.8	SLIM	6			34	1167	19.3
3	1.8	5.5	3.8	16.6	0.2	-0.0	1.3	S-SL*	5	39	30	58	1989	
4	5.6	10.1	4.5	31.2	0.2	-0.1	0.8	S-SL*	10	56	32	109	3740	
% THK:		93	9.3	23.3	0.2	-0.1	1.0	S-SL	7	46	31	81	2792	
% THK:		6	0.7	9.7	0.2	-0.1	1.8	SLIM	6			34	1167	19.3

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 014
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	1.1	0.9	17.6	0.3	-0.2	1.7	S-SL	5	41	30	61	2107	
2	1.1	2.0	0.9	7.1	0.2	-0.2	2.4	SLIM	4			25	858	14.0
3	2.1	5.1	3.1	14.0	0.3	-0.2	1.9	SLIM	9			49	1682	12.5
4	5.1	8.0	2.9	17.3	0.3	-0.2	1.6	S-SL	5	40	30	61	2078	
5	8.0	9.7	1.6	45.5	0.3	-0.2	0.7	SAND*	9	67	34	159		
% THK:		17	1.6	45.5	0.3	-0.2	0.7	SAND	9	67	34	159		
% THK:		40	3.8	17.4	0.3	-0.2	1.6	S-SL	4	40	30	60	2084	
% THK:		42	4.0	12.4	0.3	-0.2	2.0	SLIM	7			43	1496	12.8

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 015
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	2.4	2.2	7.1	0.2	0.0	2.9	SLIM	4			25	846	16.2
2	2.4	3.1	0.7	25.2	0.4	0.1	1.6	S-SL*	8	52	32	88	3021	
3	3.1	5.7	2.6	8.9	0.2	0.1	2.3	SLIM	5			31	1071	7.6
4	5.8	7.2	1.4	27.5	0.3	0.2	1.3	S-SL*	9	54	32	96	3294	
5	7.2	9.1	1.9	14.1	0.3	0.2	2.1	SLIM	9			49	1697	6.6
6	9.1	10.6	1.4	28.8	0.2	0.3	0.8	S-SL*	9	50	32	101	3456	
7	10.6	11.7	1.1	16.8	0.3	0.3	1.9	SLIM	11			59	2015	5.0
8	11.8	16.5	4.8	27.3	0.4	0.3	1.3	S-SL*	9	41	30	95	3270	
9	16.6	18.4	1.9	49.0	0.5	0.3	1.0	SAND*	9	54	32	172		
10	18.5	19.9	1.4	28.0	0.4	0.3	1.5	S-SL*	9	36	29	98	3355	
11	19.9	22.0	2.1	42.6	0.5	0.4	1.1	S-SL*	14	46	31	149	5109	
12	22.0	22.7	0.7	17.5	0.3	0.3	1.9	S-SL	5	23	28	61	2101	
13	22.8	25.1	2.4	16.9	0.2	0.4	0.9	S-SL*	5	21	28	59	2024	
% THK:		7	1.9	49.0	0.5	0.3	1.0	SAND	9	54	32	172		
% THK:		60	14.9	27.4	0.3	0.3	1.2	S-SL	8	39	30	95	3289	
% THK:		31	7.8	10.8	0.2	0.1	2.4	SLIM	6			37	1293	9.4

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 016
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	4.4	4.4	8.2	0.2	0.1	2.3	SLIM	5			29	988	12.1
2	4.4	5.1	0.7	22.4	0.3	0.3	1.4	S-SL*	7	48	31	79	2694	
3	5.1	7.3	2.1	10.8	0.3	0.2	2.4	SLIM	7			38	1292	6.8
4	7.3	9.2	1.9	28.0	0.4	0.8	1.5	S-SL*	9	53	32	98	3365	
5	9.2	10.6	1.4	17.2	0.4	0.8	2.2	SLIM	11			60	2066	6.0
6	10.6	15.6	5.0	29.2	0.4	0.7	1.3	S-SL*	9	45	31	102	3506	
7	15.6	16.1	0.5	14.6	0.5	0.6	3.2	SLIM	9			51	1756	2.9
% THK:		47	7.6	28.3	0.4	0.7	1.4	S-SL	8	47	31	98	3395	
% THK:		52	8.4	10.7	0.3	0.3	2.4	SLIM	6			37	1289	9.2

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 017
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	5.5	5.4	8.2	0.3	-0.0	3.1	SLIM	5			29	989	10.1
2	5.6	7.0	1.4	26.2	0.3	0.1	1.3	S-SL*	8	53	32	92	3139	
3	7.0	9.3	2.4	13.1	0.4	0.1	2.7	SLIM	8			46	1575	6.2
4	9.4	11.5	2.1	40.7	0.4	0.1	0.9	SAND*	8	60	33	143		
5	11.5	12.5	0.9	36.5	0.6	0.1	1.6	S-SL*	12	53	32	128	4376	
6	12.5	13.0	0.5	13.8	0.5	0.1	3.3	SLIM	9			48	1660	3.7
7	13.0	17.3	4.3	31.8	0.4	0.1	1.1	S-SL*	10	44	31	111	3812	
8	17.3	19.4	2.1	17.5	0.4	0.1	2.5	SLIM	11			61	2094	2.8
9	19.4	20.1	0.7	35.6	0.5	0.2	1.4	S-SL*	11	42	30	124	4268	
10	20.1	21.8	1.6	12.8	0.5	0.2	4.0	SLIM	8			45	1536	1.9
11	21.8	23.2	1.4	24.4	0.5	0.2	2.0	SLIM	16			85	2923	2.7
12	23.3	30.4	7.1	8.4	0.2	2.5	2.9	SLIM	5			29	1006	1.0
13	30.4	31.3	0.9	28.6	0.4	1.8	1.3	S-SL*	9	29	29	100	3426	
14	31.4	31.8	0.5	15.0	0.1	1.6	1.0	S-SL*	4	16	26	52	1797	
% THK:		6	2.1	40.7	0.4	0.1	0.9	SAND	8	60	33	143		
% THK:		27	8.7	30.4	0.4	0.4	1.2	S-SL	9	43	31	106	3643	
% THK:		65	20.5	11.4	0.3	0.9	2.9	SLIM	7			39	1367	4.4

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 018
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	3.6	3.6	13.4	0.1	-0.0	1.0	S-SL*	4	34	29	47	1609	
2	3.7	4.8	1.1	13.1	0.3	0.0	2.0	SLIM	8			46	1572	10.5
3	4.9	8.4	3.5	21.5	0.2	0.1	1.1	S-SL*	7	47	31	75	2584	
4	8.4	11.7	3.3	32.4	0.3	0.1	0.9	S-SL*	10	53	32	113	3890	
5	11.8	13.4	1.6	13.7	0.3	0.1	2.2	SLIM	9			48	1644	3.7
6	13.4	15.6	2.1	25.5	0.3	0.2	1.2	S-SL*	8	39	30	89	3056	
7	15.6	16.8	1.1	40.8	0.3	0.2	0.6	SAND*	8	50	32	143		
8	16.8	18.4	1.6	40.6	0.5	0.2	1.1	S-SL*	13	48	31	142	4867	
% THK:		6	1.1	40.8	0.3	0.2	0.6	SAND	8	50	32	143		
% THK:		78	14.1	24.7	0.2	0.1	1.0	S-SL	7	44	31	86	2970	
% THK:		15	2.7	13.5	0.3	0.1	2.1	SLIM	8			47	1614	6.5

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 019
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	0.8	0.7	13.4	0.1	-0.1	0.8	S-SL*	4	34	29	47	1613	
% THK:		100	0.7	13.4	0.1	-0.1	0.8	S-SL	4	34	29	46	1613	

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 020
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	1.0	1.0	15.2	0.1	-0.2	0.8	S-SL*	5	37	30	53	1827	
2	1.0	2.0	1.0	6.7	0.1	-0.1	1.8	SLIM	4			23	798	13.9
3	2.0	3.1	1.1	15.9	0.2	-0.1	1.4	S-SL*	5	38	30	56	1905	
4	3.2	6.5	3.3	10.1	0.2	-0.1	2.4	SLIM	6			35	1208	7.9
5	6.5	9.3	2.8	27.2	0.2	0.0	0.7	S-SL*	9	53	32	95	3265	
6	9.4	10.3	0.9	13.3	0.2	0.0	1.4	S-SL	4	29	29	47	1599	
7	10.3	11.3	1.0	31.7	0.2	0.0	0.6	S-SL*	10	51	32	111	3800	
% THK:		61	6.8	22.4	0.2	-0.0	0.9	S-SL	7	44	31	78	2691	
% THK:		38	4.3	9.3	0.2	-0.1	2.3	SLIM	5			32	1112	9.3

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 021
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	1.2	1.2	7.2	0.1	-0.2	2.0	SLIM	4			25	869	27.7
2	1.3	2.5	1.2	14.8	0.3	-0.1	1.7	S-SL	4	36	29	52	1777	
3	2.5	4.9	2.4	8.2	0.2	0.0	2.6	SLIM	5			29	978	8.2
4	4.9	8.2	3.3	26.4	0.3	0.1	1.1	S-SL*	8	53	32	92	3163	
5	8.2	9.2	0.9	51.8	0.4	0.2	0.8	SAND*	10	72	35	181		
6	9.2	9.9	0.7	15.4	0.3	0.2	2.1	SLIM	10			54	1847	5.8
7	9.9	10.6	0.7	26.5	0.3	0.2	1.2	S-SL*	8	47	31	93	3183	
8	10.6	12.3	1.6	38.8	0.4	0.2	1.0	S-SL*	12	56	32	136	4657	
9	12.3	13.0	0.7	19.0	0.6	0.2	3.0	SLIM	12			67	2283	4.7
10	13.0	16.6	3.5	28.9	0.4	0.3	1.6	S-SL*	9	42	30	101	3465	
11	16.6	18.2	1.6	40.6	0.5	0.4	1.1	S-SL*	13	48	31	142	4872	
12	18.3	19.2	0.9	19.6	0.5	0.3	2.5	SLIM	13			69	2352	2.9
% THK:		4	0.9	51.8	0.4	0.2	0.8	SAND	10	72	35	181		
% THK:		63	11.9	29.5	0.4	0.2	1.3	S-SL	9	47	31	103	3543	
% THK:		31	5.9	11.9	0.3	0.1	2.5	SLIM	7			41	1423	10.7

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 022
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.5	2.4	16.5	0.1	0.0	0.8	S-SL*	5	39	30	58	1986	
2	2.5	5.4	2.9	4.5	0.1	0.1	1.7	SLIM	2			16	538	5.0
3	5.4	7.5	2.1	20.0	0.2	0.3	1.0	S-SL*	6	45	31	70	2405	
4	7.5	8.4	0.9	8.9	0.2	0.5	1.8	SLIM	5			31	1064	4.8
5	8.5	11.8	3.3	26.9	0.2	0.5	0.6	S-SL*	8	47	31	94	3233	
6	11.8	13.2	1.4	43.6	0.2	0.6	0.6	SAND*	8	58	33	153		
7	13.3	15.1	1.9	27.9	0.2	0.5	0.7	S-SL*	9	42	30	98	3352	
8	15.2	16.1	0.9	45.0	0.2	0.5	0.5	SAND*	9	54	32	158		
9	16.1	17.2	1.1	30.2	0.3	0.6	1.0	S-SL*	10	41	30	106	3626	
10	17.3	18.7	1.4	44.7	0.4	0.7	0.8	SAND*	8	51	32	156		
% THK:		20	3.7	44.4	0.3	0.6	0.7	SAND	8	54	32	155		
% THK:		59	10.8	23.8	0.2	0.4	0.8	S-SL	7	43	31	83	2855	
% THK:		20	3.8	5.5	0.1	0.2	1.7	SLIM	2			19	662	5.0

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 023
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	7.2	7.2	6.4	0.2	0.3	3.1	SLIM	4			22	769	7.0
2	7.2	8.2	1.0	16.6	0.3	0.5	1.6	S-SL	5	39	30	58	1987	
3	8.2	14.1	5.8	6.6	0.2	0.7	2.5	SLIM	4			23	792	2.6
4	14.1	16.0	1.9	27.7	0.3	1.0	1.2	S-SL*	9	41	30	97	3330	
5	16.0	23.6	7.6	4.5	0.2	2.1	3.5	SLIM	2			16	537	0.9
% THK:		12	2.9	23.9	0.3	0.8	1.3	S-SL	7	40	30	83	2866	
% THK:		87	20.6	5.8	0.2	1.1	3.1	SLIM	3			20	689	3.5

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 024
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.2	2.1	11.3	0.2	0.0	1.6	SLIM	7			40	1359	24.8
2	2.3	24.7	22.4	4.5	0.2	0.5	4.3	SLIM	2			16	536	1.5
% THK:		100	24.5	5.1	0.2	0.5	4.1	SLIM	2			18	606	3.5

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 025
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	18.7	0.2	-0.2	1.1	S-SL*	6	43	30	65	2245	
2	1.3	3.0	1.6	7.7	0.2	-0.1	2.1	SLIM	5			27	922	11.8
3	3.0	4.1	1.1	20.4	0.3	-0.1	1.6	S-SL*	6	45	31	72	2454	
4	4.2	5.3	1.2	13.9	0.4	-0.1	2.8	SLIM	9			49	1666	10.1
5	5.4	6.8	1.4	9.5	0.1	-0.1	1.4	SLIM	6			33	1137	6.3
6	6.8	10.6	3.8	8.9	0.3	-0.0	3.0	SLIM	5			31	1069	4.3
7	10.6	12.0	1.4	13.8	0.2	0.0	1.6	SLIM	9			48	1652	4.3
8	12.1	15.1	3.1	10.2	0.2	0.1	2.3	SLIM	6			36	1223	2.7
% THK:		15	2.3	19.5	0.2	-0.2	1.3	S-SL	5	43	31	68	2344	
% THK:		84	12.5	10.2	0.2	-0.0	2.4	SLIM	6			35	1218	5.6

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 026
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	5.1	5.0	14.2	0.1	-0.0	0.9	S-SL*	4	35	29	50	1703	
2	5.1	6.1	0.9	8.2	0.2	0.0	2.3	SLIM	5			29	989	6.1
3	6.1	9.0	2.9	22.9	0.3	0.2	1.1	S-SL*	7	48	31	80	2753	
4	9.0	9.7	0.7	13.2	0.2	0.2	1.6	SLIM	8			46	1588	5.3
% THK:		83	7.9	17.4	0.2	0.1	1.0	S-SL	5	39	30	61	2088	
% THK:		16	1.6	10.4	0.2	0.1	2.0	SLIM	6			36	1251	5.8

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 027
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.8	1.7	12.8	0.2	-0.1	1.3	S-SL	4	33	29	45	1533	
2	1.8	6.5	4.7	7.1	0.2	0.0	2.8	SLIM	4			25	856	6.8
3	6.6	9.4	2.9	21.5	0.4	-0.0	1.8	S-SL	7	46	31	75	2579	
4	9.4	13.2	3.8	22.3	0.3	-0.0	1.3	S-SL*	7	40	30	78	2680	
5	13.2	13.9	0.7	8.4	0.0	-0.0	0.5	SLIM*	5			29	1007	2.3
6	14.0	16.1	2.1	30.8	0.4	0.0	1.2	S-SL*	10	43	31	108	3700	
7	16.1	16.8	0.7	14.0	0.5	0.2	3.6	SLIM	9			49	1680	2.7
8	16.8	17.3	0.5	26.3	0.5	0.3	1.8	S-SL	8	37	29	92	3162	
% THK:		64	11.0	22.4	0.3	-0.0	1.4	S-SL	7	40	31	78	2692	
% THK:		35	6.1	8.0	0.2	0.0	2.6	SLIM	4			28	967	5.8

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 028
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	3.0	2.9	13.4	0.1	-0.2	0.6	S-SL*	4	34	29	47	1609	
2	3.0	3.7	0.7	8.8	0.1	-0.2	1.0	SLIM*	5			31	1052	9.4
3	3.7	5.6	1.9	17.6	0.1	-0.2	0.5	S-SL*	5	41	30	62	2115	
4	5.6	10.6	5.0	4.9	0.0	-0.1	0.2	SLIM*	3			17	593	3.0
% THK:		45	4.8	15.1	0.1	-0.2	0.6	S-SL	4	36	30	52	1809	
% THK:		54	5.7	5.4	0.0	-0.1	0.3	SLIM	3			18	649	3.8

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 029
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	7.0	6.9	11.2	0.3	-0.1	2.6	SLIM	7			39	1342	10.7
2	7.1	10.1	3.1	3.2	0.3	0.3	8.2	SLIM	2			11	383	2.0
% THK:		100	10.0	8.7	0.3	0.0	4.3	SLIM	5			30	1044	8.0

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 030
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	11.1	0.2	-0.1	1.4	SLIM	7			39	1329	41.3
2	1.1	6.5	5.4	6.1	0.1	-0.0	2.1	SLIM	4			21	734	6.5
3	6.6	8.5	1.9	18.6	0.3	-0.0	1.7	S-SL	6	42	30	65	2229	
4	8.5	12.8	4.3	6.9	0.2	0.2	2.9	SLIM	4			24	828	2.8
% THK:		15	1.9	18.6	0.3	0.0	1.7	S-SL	6	42	30	65	2229	
% THK:		84	10.7	6.9	0.1	0.1	2.4	SLIM	4			23	827	8.3

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 031
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.5	2.4	6.5	0.2	0.0	3.1	SLIM	4			23	775	15.2
2	2.5	4.1	1.6	18.9	0.3	-0.0	1.7	S-SL	6	43	30	66	2269	
3	4.2	7.2	3.1	5.8	0.2	0.0	3.9	SLIM	3			20	701	4.6
4	7.3	8.5	1.2	18.8	0.4	0.1	2.0	SLIM	12			66	2252	8.5
5	8.5	11.5	3.1	8.6	0.2	0.1	2.9	SLIM	5			30	1033	3.6
6	11.6	12.8	1.2	15.1	0.3	0.2	1.9	SLIM	10			53	1811	4.2
7	12.8	13.9	1.1	6.7	0.3	0.2	3.8	SLIM	4			23	799	2.0
8	14.0	14.7	0.7	16.3	0.4	0.4	2.7	SLIM	10			57	1953	3.6
9	14.7	15.8	1.1	12.2	0.4	0.4	3.6	SLIM	8			43	1469	2.7
10	15.9	17.5	1.6	32.7	0.7	0.4	2.3	S-SL	10	43	30	115	3926	
11	17.5	19.9	2.4	16.0	0.5	0.4	2.8	SLIM	10			56	1924	2.5
12	19.9	21.6	1.6	9.2	0.2	0.5	1.8	SLIM	6			32	1107	1.5
13	21.6	25.4	3.8	11.3	0.4	0.8	3.6	SLIM	7			39	1354	1.5
14	25.4	26.8	1.4	12.1	0.3	1.4	2.8	SLIM	8			42	1451	1.3
15	26.9	27.8	0.9	15.5	0.3	1.7	1.8	S-SL	5	18	27	54	1856	
16	27.8	28.7	0.9	9.1	0.3	2.0	2.9	SLIM	6			32	1094	1.0
17	28.8	30.4	1.6	16.5	0.4	1.4	2.6	SLIM	10			58	1978	1.4
18	30.4	32.1	1.6	10.7	0.1	0.8	1.3	SLIM	7			37	1282	1.0
% THK:		13	4.1	23.5	0.5	0.5	2.0	S-SL	7	37	30	82	2824	
% THK:		86	27.2	10.9	0.3	0.5	2.9	SLIM	6			38	1313	3.9

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 032
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	2.1	1.9	8.6	0.3	0.0	3.4	SLIM	5			30	1031	20.4
2	2.1	3.5	1.4	16.0	0.3	0.0	2.0	SLIM	10			56	1918	16.5
3	3.6	6.9	3.3	10.2	0.4	-0.0	3.5	SLIM	6			36	1224	7.5
4	6.9	12.1	5.2	23.1	0.4	0.0	1.8	S-SL	7	44	31	81	2771	
5	12.2	14.5	2.4	22.1	0.6	0.0	2.7	SLIM	14			77	2647	4.9
6	14.6	16.4	1.9	14.4	0.3	0.2	2.2	SLIM	9			50	1725	3.0
7	16.5	23.1	6.7	36.6	0.7	0.2	2.0	S-SL*	12	43	30	128	4394	
8	23.2	25.0	1.9	60.3	0.9	0.2	1.5	SAND*	12	54	32	211		
9	25.1	30.3	5.2	22.1	0.6	0.2	2.6	SLIM	14			77	2654	2.0
10	30.3	40.3	10.0	11.9	0.3	0.8	2.1	SLIM	7			42	1427	0.9
% THK:		4	1.9	60.3	0.9	0.2	1.5	SAND	12	54	32	211		
% THK:		29	11.9	30.7	0.6	0.1	1.9	S-SL	9	43	31	107	3684	
% THK:		65	26.1	14.8	0.4	0.4	2.5	SLIM	9			51	1777	4.7

SITE ID: HAT01 LOCATION ID: 033
GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.1	1.0	10.5	0.2	-0.0	1.9	SLIM	7			37	1262	38.9
2	1.1	2.0	0.9	13.3	0.2	-0.1	1.3	S-SL	4	34	29	47	1601	
3	2.1	4.2	2.1	19.1	0.3	-0.1	1.5	S-SL*	6	43	31	67	2296	
4	4.2	6.1	1.9	10.4	0.3	-0.1	2.4	SLIM	6			36	1245	7.7
5	6.1	11.1	5.0	25.9	0.3	-0.1	1.3	S-SL*	8	49	31	91	3105	
6	11.2	12.1	1.0	48.7	0.5	-0.1	1.1	SAND*	9	63	33	171		
7	12.1	12.6	0.5	41.2	0.7	-0.1	1.8	S-SL*	13	56	32	144	4944	
8	12.6	15.0	2.4	19.0	0.5	-0.1	2.6	SLIM	12			67	2283	4.2
9	15.0	17.6	2.6	37.8	0.5	-0.0	1.4	S-SL*	12	48	31	132	4536	
10	17.6	19.3	1.6	56.9	0.6	-0.1	1.1	SAND*	11	58	33	199		
11	19.3	21.4	2.1	44.9	0.7	-0.0	1.6	S-SL*	14	48	31	157	5385	
12	21.5	25.3	3.8	20.6	0.5	-0.0	2.6	SLIM	13			72	2469	2.3
13	25.3	26.2	0.9	46.0	0.7	0.1	1.5	S-SL*	15	44	31	161	5519	
14	26.2	27.9	1.6	22.6	0.5	0.0	2.2	S-SL	7	25	28	79	2714	
% THK:		9	2.6	53.7	0.6	-0.1	1.1	SAND	10	59	33	188		
% THK:		57	15.7	30.1	0.4	-0.0	1.5	S-SL	9	44	31	105	3609	
% THK:		33	9.1	16.9	0.4	-0.0	2.5	SLIM	10			59	2031	8.0

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 034
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.6	0.5	11.2	0.3	-0.0	2.6	SLIM	7			39	1343	63.1
2	0.6	5.8	5.2	19.9	0.3	-0.0	1.4	S-SL*	6	44	31	69	2383	
3	5.9	7.1	1.2	16.4	0.4	-0.1	2.5	SLIM	10			57	1969	9.1
4	7.1	9.4	2.4	26.3	0.3	-0.1	1.2	S-SL*	8	51	32	92	3161	
5	9.5	10.7	1.2	36.5	0.3	-0.1	0.9	S-SL*	12	57	33	128	4385	
6	10.8	12.9	2.1	34.4	0.4	-0.1	1.0	S-SL*	11	52	32	121	4133	
7	12.9	15.3	2.3	42.9	0.4	-0.1	1.0	SAND*	8	55	32	150		
8	15.3	15.5	0.2	40.1	0.3	-0.1	0.8	SAND*	8	51	32	141		
9	15.5	22.9	7.3	52.8	0.5	-0.1	1.0	SAND*	10	55	32	185		
10	22.9	24.1	1.2	22.3	0.7	-0.1	3.3	SLIM	14			78	2679	2.4
11	24.1	25.6	1.4	60.0	0.7	-0.0	1.2	SAND*	11	53	32	210		
% THK:		44	11.2	51.4	0.5	-0.1	1.0	SAND	9	54	32	180		
% THK:		43	10.9	25.9	0.3	-0.1	1.2	S-SL	8	48	32	90	3111	
% THK:		11	2.9	17.9	0.5	-0.1	2.8	SLIM	11			62	2154	15.6

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 035
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	5.6	5.5	16.5	0.3	-0.1	1.7	S-SL	5	39	30	58	1985	
2	5.6	9.9	4.3	27.0	0.4	-0.1	1.5	S-SL*	8	52	32	94	3237	
3	9.9	17.3	7.4	38.6	0.4	-0.1	1.1	S-SL*	12	52	32	135	4628	
4	17.4	23.7	6.4	55.4	0.6	-0.1	1.1	SAND*	11	55	32	194		
5	23.8	25.6	1.8	23.2	0.6	-0.1	2.4	S-SL	7	27	29	81	2778	
6	25.6	26.6	1.0	39.1	0.4	-0.0	1.1	S-SL*	13	39	30	137	4693	
7	26.7	27.4	0.7	18.9	0.5	-0.1	2.6	SLIM	12			66	2263	1.8
8	27.4	28.5	1.1	16.4	0.3	-0.0	2.1	SLIM	10			57	1971	1.6
% THK:		22	6.4	55.4	0.6	-0.1	1.1	SAND	11	55	32	194		
% THK:		70	20.0	28.7	0.4	-0.1	1.5	S-SL	8	45	31	100	3438	
% THK:		6	1.8	17.4	0.4	-0.0	2.3	SLIM	10			60	2084	1.7

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 036
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.3	2.1	12.3	0.1	-0.1	0.8	S-SL*	4	32	29	43	1477	
2	2.3	3.0	0.7	22.6	0.2	-0.1	0.7	S-SL*	7	48	31	79	2709	
3	3.0	3.7	0.7	10.1	0.2	-0.1	2.1	SLIM	6			35	1211	10.3
4	3.7	4.7	0.9	17.2	0.1	-0.1	0.8	S-SL*	5	40	30	60	2064	
5	4.7	5.4	0.7	7.4	0.1	-0.1	1.9	SLIM	4			26	887	6.1
6	5.4	6.8	1.4	30.7	0.3	-0.1	1.0	S-SL*	10	58	33	107	3685	
7	6.9	7.4	0.6	14.8	0.3	-0.2	2.3	SLIM	9			52	1773	7.8
8	7.4	8.6	1.2	21.7	0.2	-0.1	0.8	S-SL*	7	46	31	76	2598	
9	8.7	12.2	3.5	35.3	0.4	-0.1	1.1	S-SL*	11	55	32	124	4241	
10	12.2	13.1	0.9	41.7	0.3	-0.1	0.7	SAND*	8	56	32	146		
11	13.2	14.6	1.4	37.2	0.4	-0.2	1.0	S-SL*	12	51	32	130	4459	
12	14.6	18.1	3.5	14.2	0.5	0.1	3.5	SLIM	9			50	1705	2.7
% THK:		5	0.9	41.7	0.3	-0.1	0.7	SAND	8	56	32	146		
% THK:		63	11.2	26.9	0.3	-0.1	0.9	S-SL	8	47	31	94	3233	
% THK:		31	5.5	12.9	0.4	0.0	3.0	SLIM	7			45	1545	4.7

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 037
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.0	1.9	9.9	0.2	-0.0	1.9	SLIM	6			35	1183	24.1
2	2.0	5.1	3.1	24.5	0.2	-0.1	1.0	S-SL*	8	51	32	86	2940	
3	5.1	9.2	4.0	17.3	0.4	-0.1	2.4	SLIM	11			60	2073	8.6
4	9.2	10.4	1.1	24.5	0.3	-0.1	1.2	S-SL*	8	45	31	86	2946	
5	10.4	11.6	1.2	12.7	0.3	-0.0	2.6	SLIM	8			44	1519	4.2
6	11.6	13.0	1.4	18.1	0.4	-0.0	2.0	S-SL	6	33	29	63	2177	
7	13.0	19.6	6.6	13.0	0.4	0.1	2.7	SLIM	8			46	1565	2.6
% THK:		29	5.6	22.9	0.3	-0.1	1.3	S-SL	7	45	31	80	2750	
% THK:		70	13.7	13.8	0.4	0.0	2.5	SLIM	8			48	1656	7.5

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 038
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	11.9	0.2	-0.0	1.7	SLIM	7			42	1430	43.6
2	1.1	3.0	1.9	17.7	0.2	-0.0	1.2	S-SL*	5	41	30	62	2120	
3	3.1	5.6	2.6	13.8	0.4	-0.1	2.5	SLIM	9			48	1659	10.8
4	5.7	7.6	1.9	19.2	0.3	-0.1	1.5	S-SL*	6	43	31	67	2302	
5	7.6	9.9	2.3	6.2	0.2	-0.0	3.2	SLIM	4			22	744	3.2
% THK:		39	3.8	18.5	0.2	-0.1	1.4	S-SL	5	42	31	64	2211	
% THK:		60	5.9	10.5	0.3	-0.0	2.6	SLIM	6			36	1263	13.4

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 039
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	2.8	2.6	16.4	0.2	-0.0	1.3	S-SL*	5	39	30	57	1967	
2	2.8	4.2	1.4	9.2	0.3	-0.1	3.1	SLIM	6			32	1103	9.3
3	4.3	5.0	0.7	22.7	0.4	-0.1	1.6	S-SL*	7	48	31	79	2725	
4	5.0	5.9	0.9	8.5	0.2	-0.1	2.9	SLIM	5			30	1015	6.3
5	5.9	6.4	0.4	26.1	0.4	-0.0	1.4	S-SL*	8	53	32	92	3138	
6	6.4	8.0	1.6	9.9	0.3	-0.1	2.6	SLIM	6			35	1183	5.7
7	8.1	16.4	8.3	3.7	0.1	0.0	3.5	SLIM	2			13	442	1.5
% THK:		23	3.7	18.6	0.3	-0.0	1.4	S-SL	5	42	31	64	2236	
% THK:		76	12.2	5.5	0.2	-0.0	3.3	SLIM	3			19	657	3.3

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

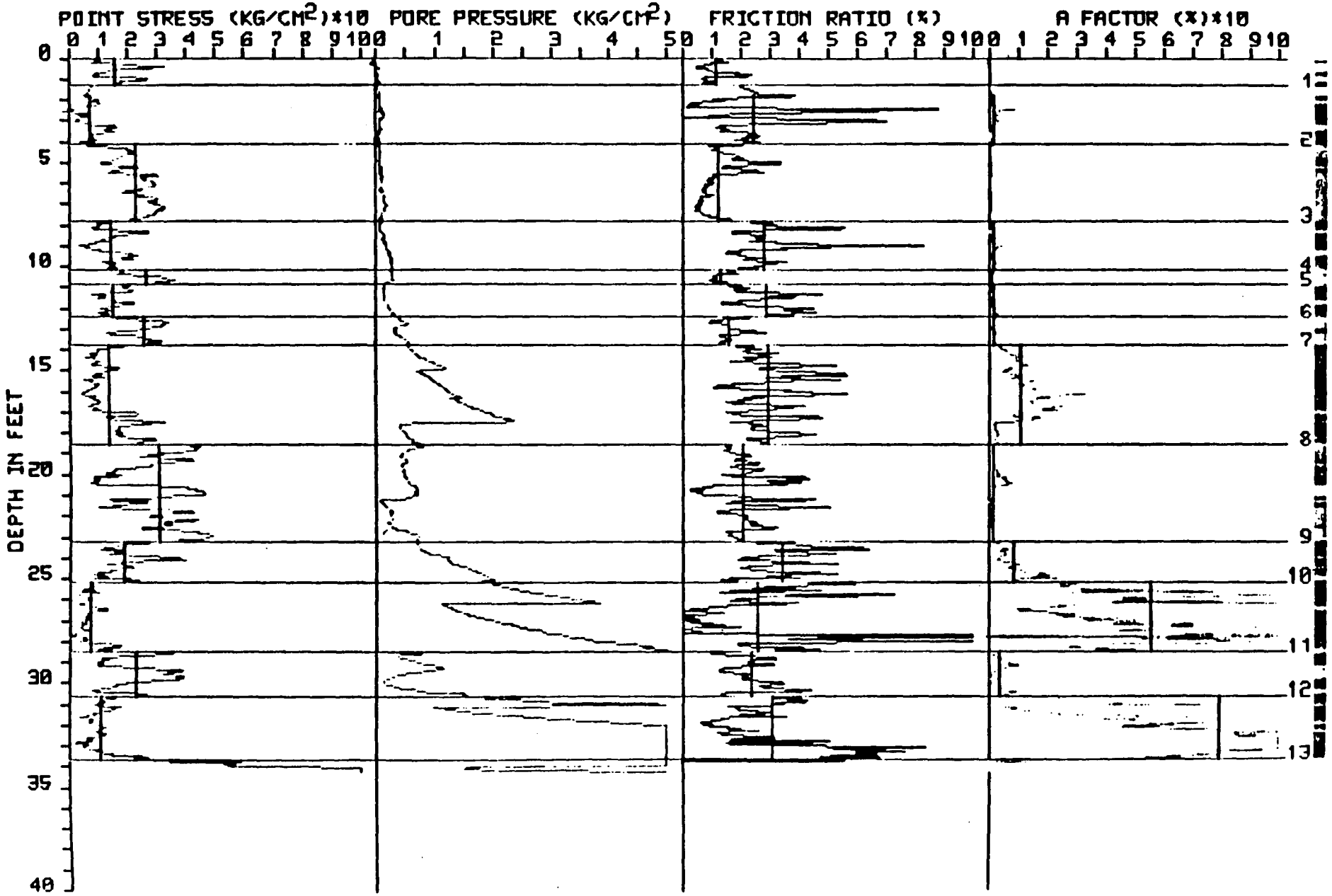
LOCATION ID: 040
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	15.0	0.1	-0.1	0.6	S-SL*	4	37	29	52	1797	
2	1.3	2.5	1.1	14.1	0.2	-0.2	1.4	S-SL	4	35	29	49	1689	
3	2.5	3.4	0.9	45.4	0.4	-0.2	0.9	SAND*	9	71	35	159		
4	3.5	4.2	0.7	15.1	0.3	-0.2	2.2	SLIM	10			53	1816	12.7
5	4.2	5.1	0.9	27.2	0.4	-0.2	1.5	S-SL*	9	54	32	95	3264	
6	5.1	8.2	3.1	9.1	0.2	-0.1	2.6	SLIM	6			32	1093	5.7
7	8.3	9.9	1.6	18.8	0.5	-0.1	2.6	SLIM	12			66	2252	7.1
8	9.9	11.3	1.4	10.1	0.2	-0.1	1.6	SLIM	6			35	1217	3.7
9	11.3	13.3	1.9	12.6	0.3	-0.1	2.4	SLIM	8			44	1507	3.6
10	13.3	13.7	0.4	27.2	0.3	-0.0	1.1	S-SL*	9	42	30	95	3261	
11	13.7	14.7	0.9	10.5	0.2	-0.0	1.7	SLIM	6			37	1260	2.6
% THK:		6	0.9	45.4	0.4	-0.2	0.9	SAND	9	71	35	159		
% THK:		25	3.6	19.1	0.2	-0.1	1.1	S-SL	5	41	30	66	2293	
% THK:		68	9.6	12.1	0.3	-0.1	2.3	SLIM	7			42	1454	5.4

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

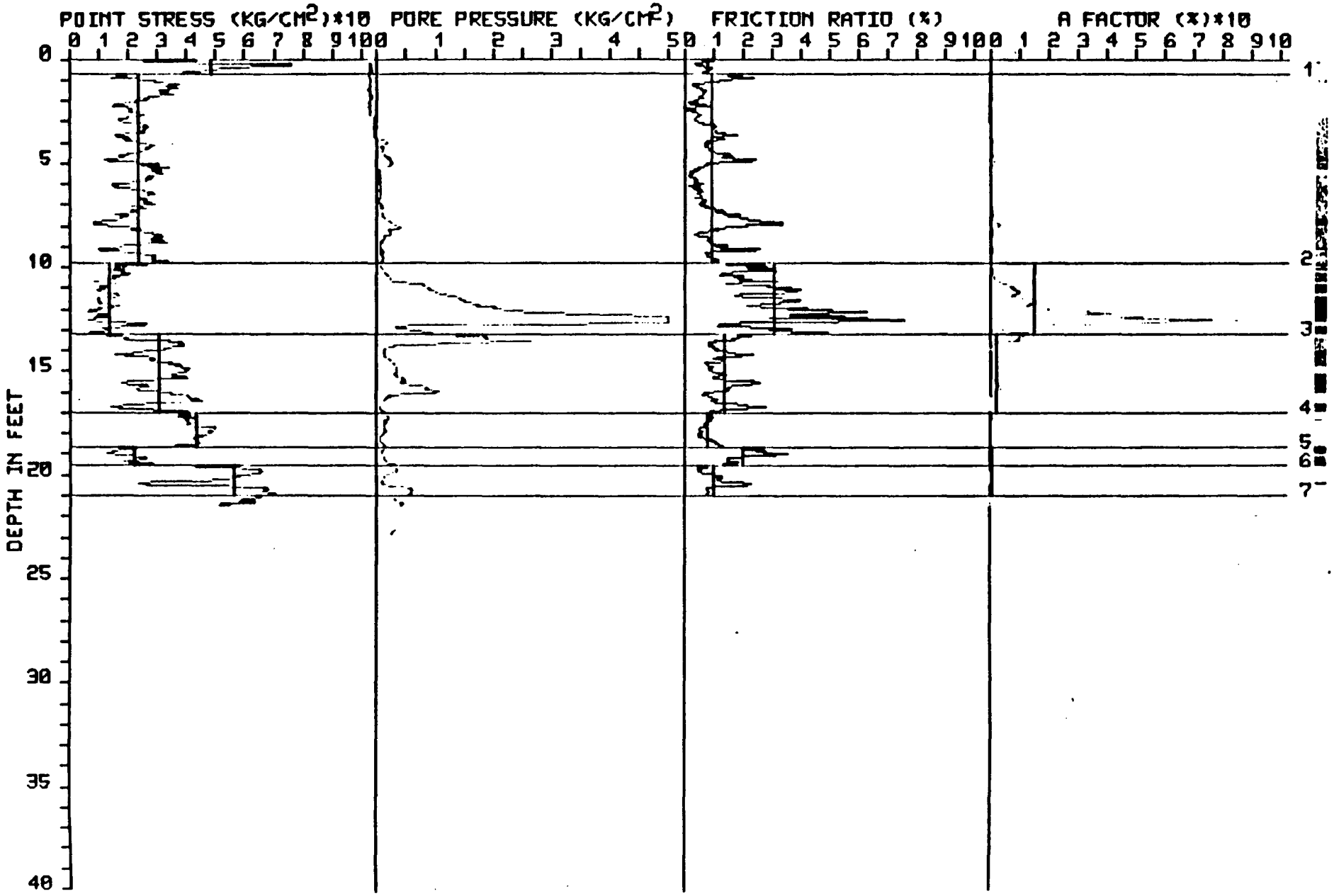
LOCATION ID: 001



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

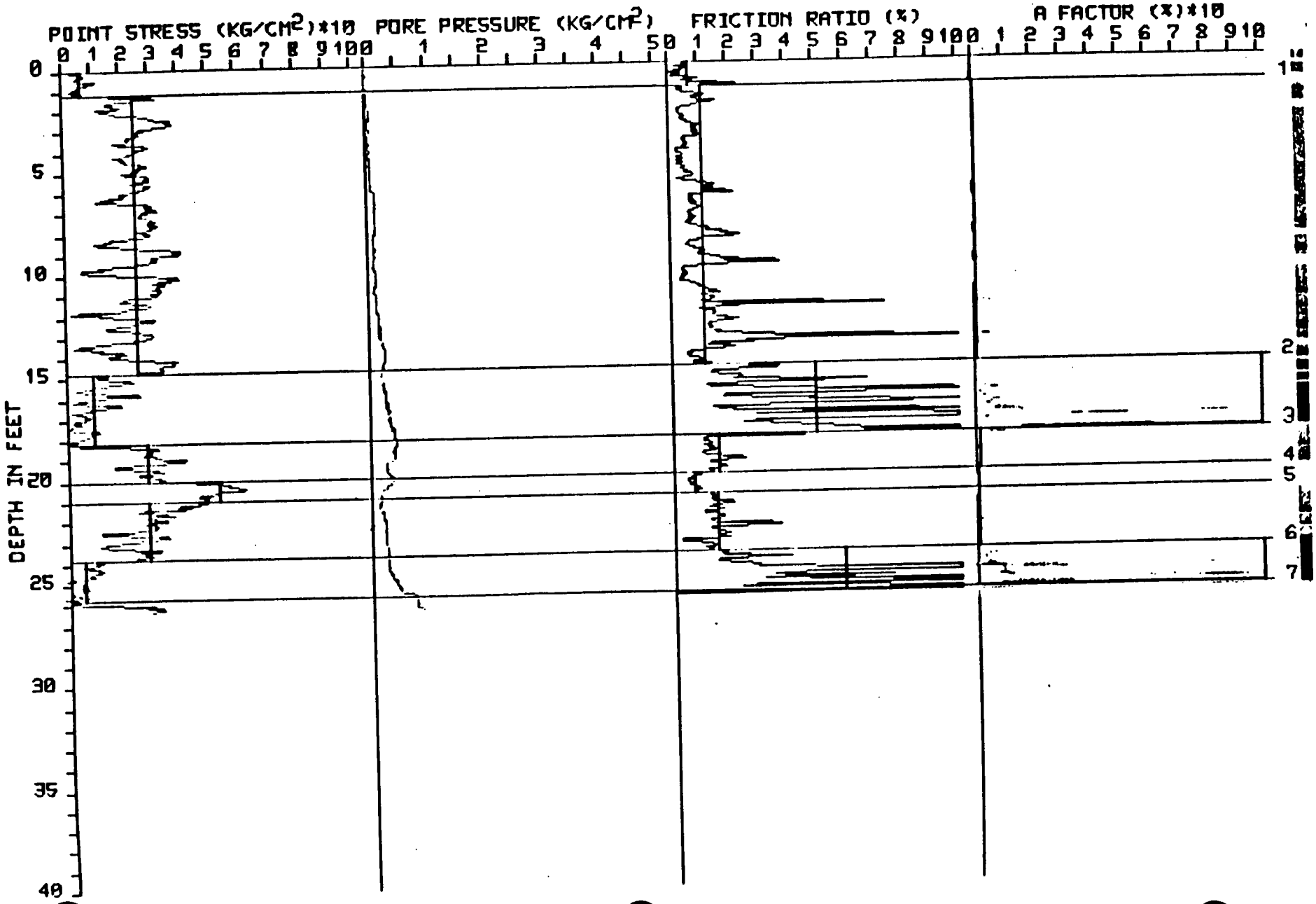
LOCATION ID: 002



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 003

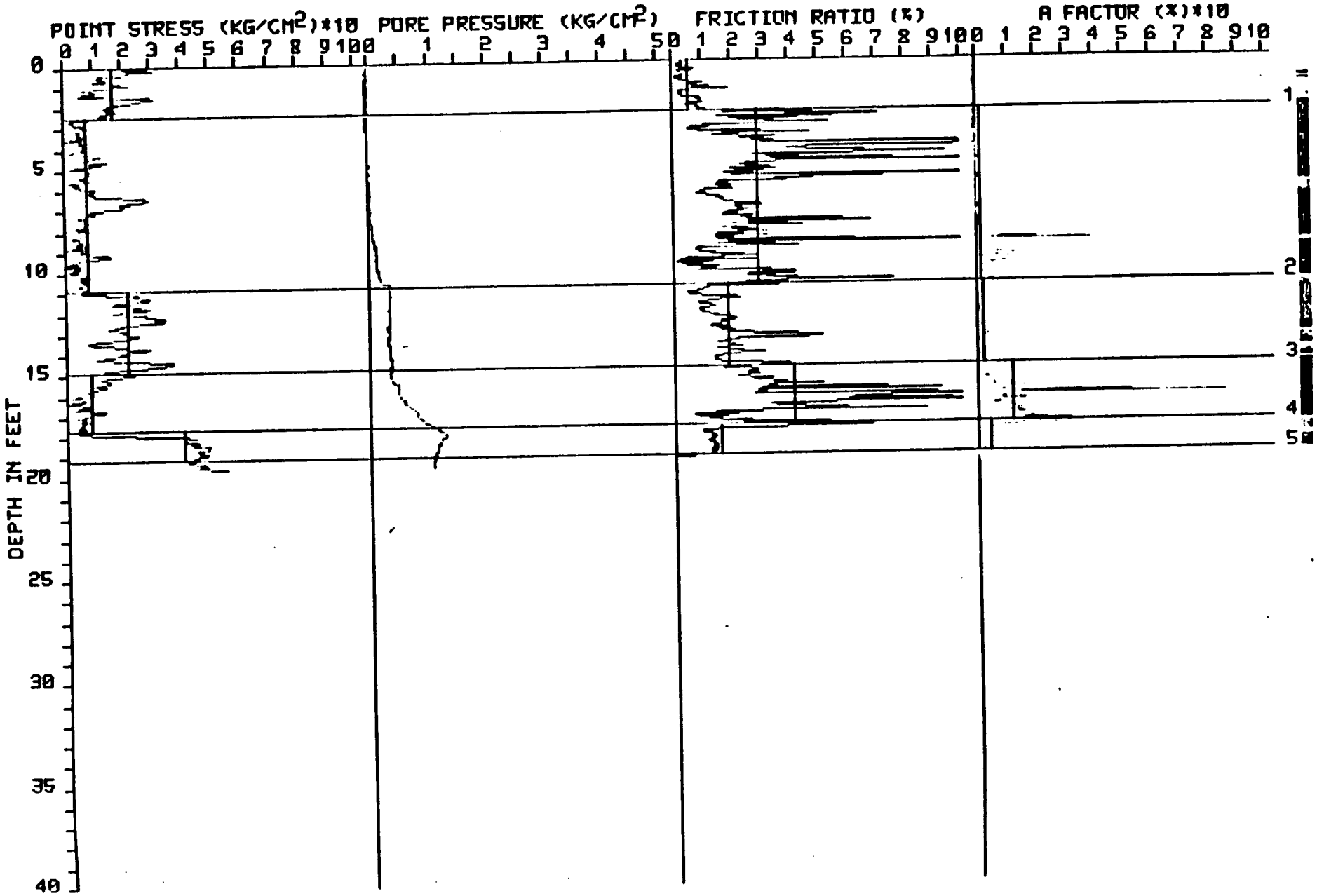


4h

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

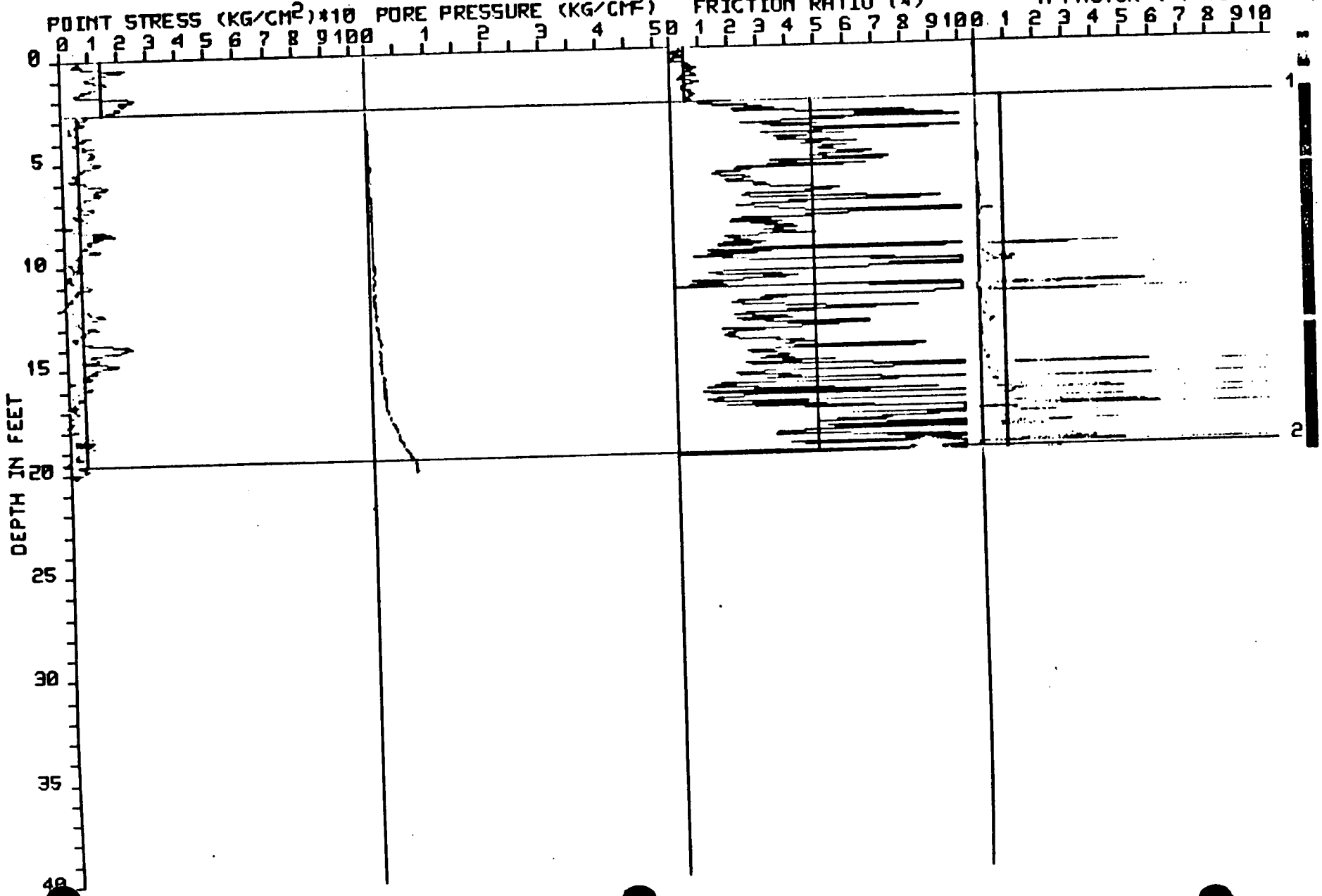
LOCATION ID: 004



PIEZOCONE SOUNDING TEST

LOCATION ID: 005

SITE ID: HAT01



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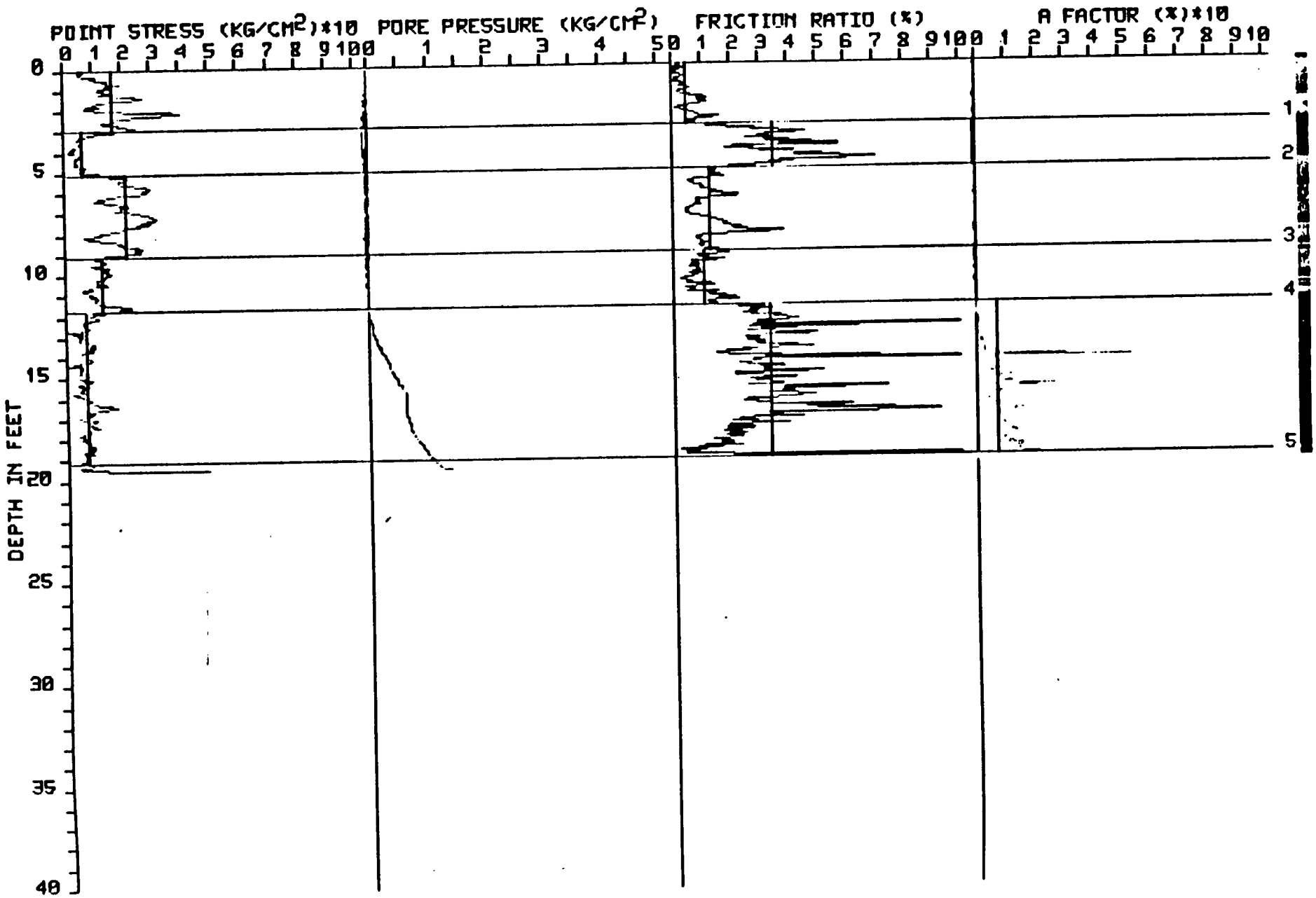

45

PIEZOCONE SOUNDING TEST

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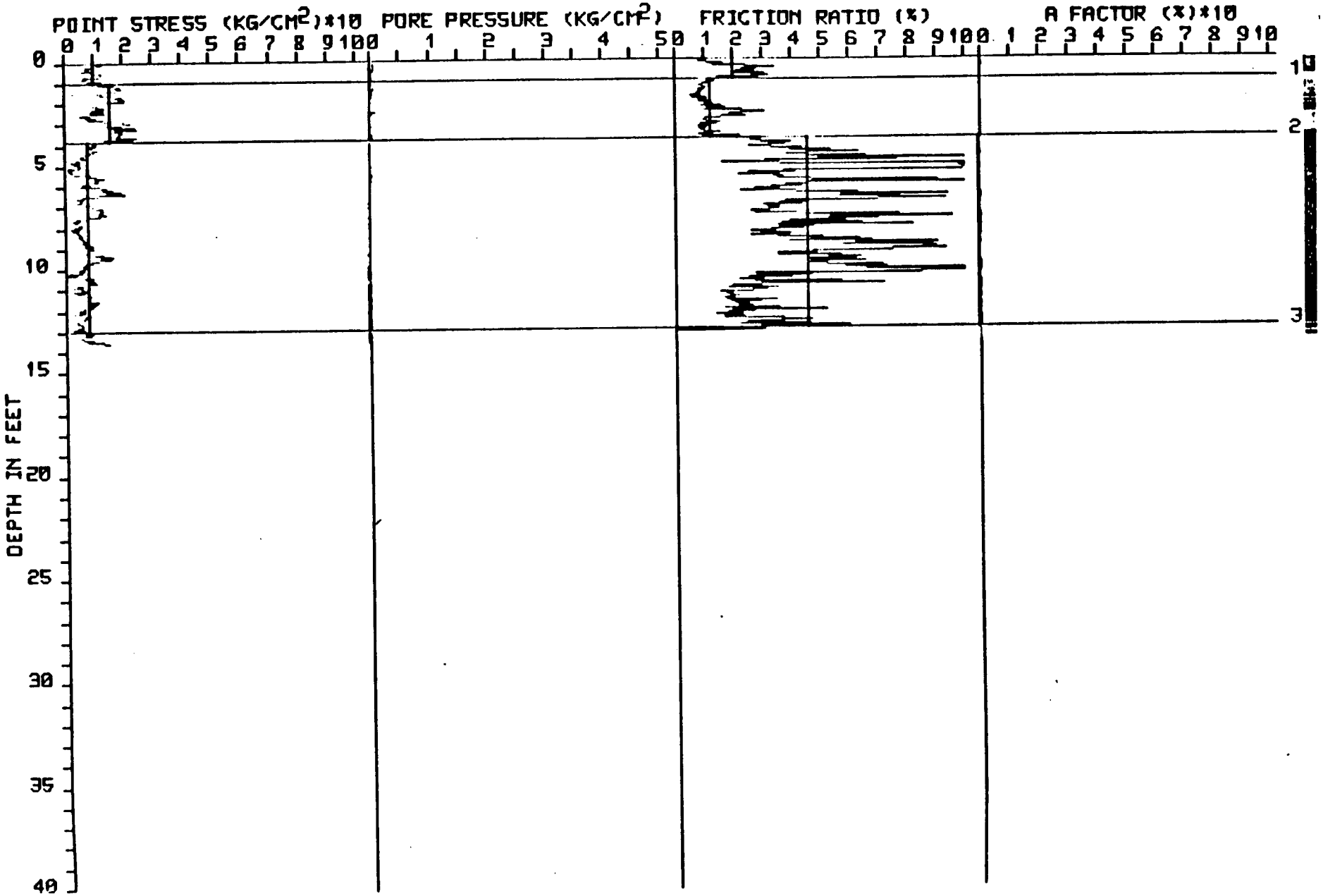
LOCATION ID: 007

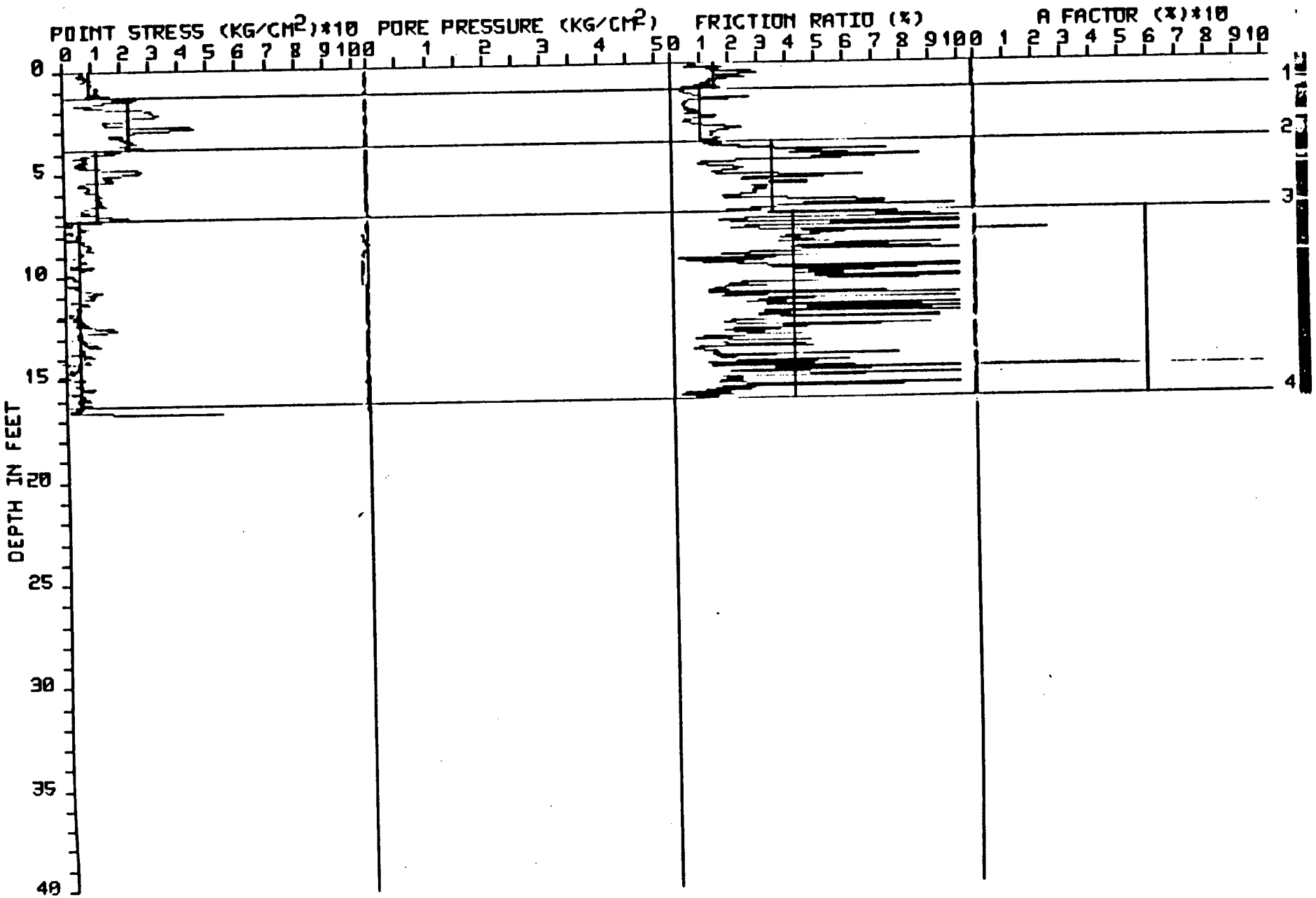


44

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

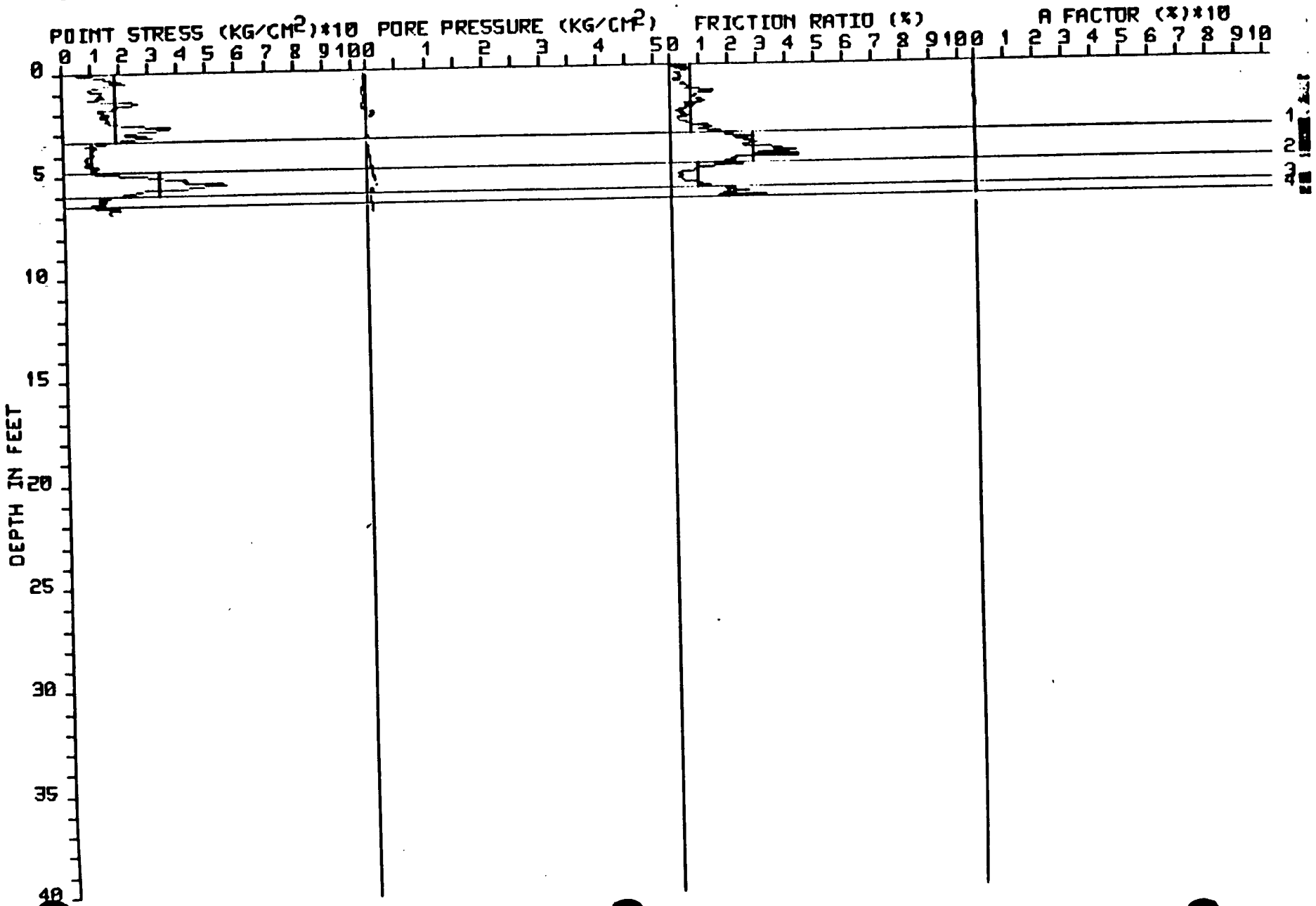
LOCATION ID: 008



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 009

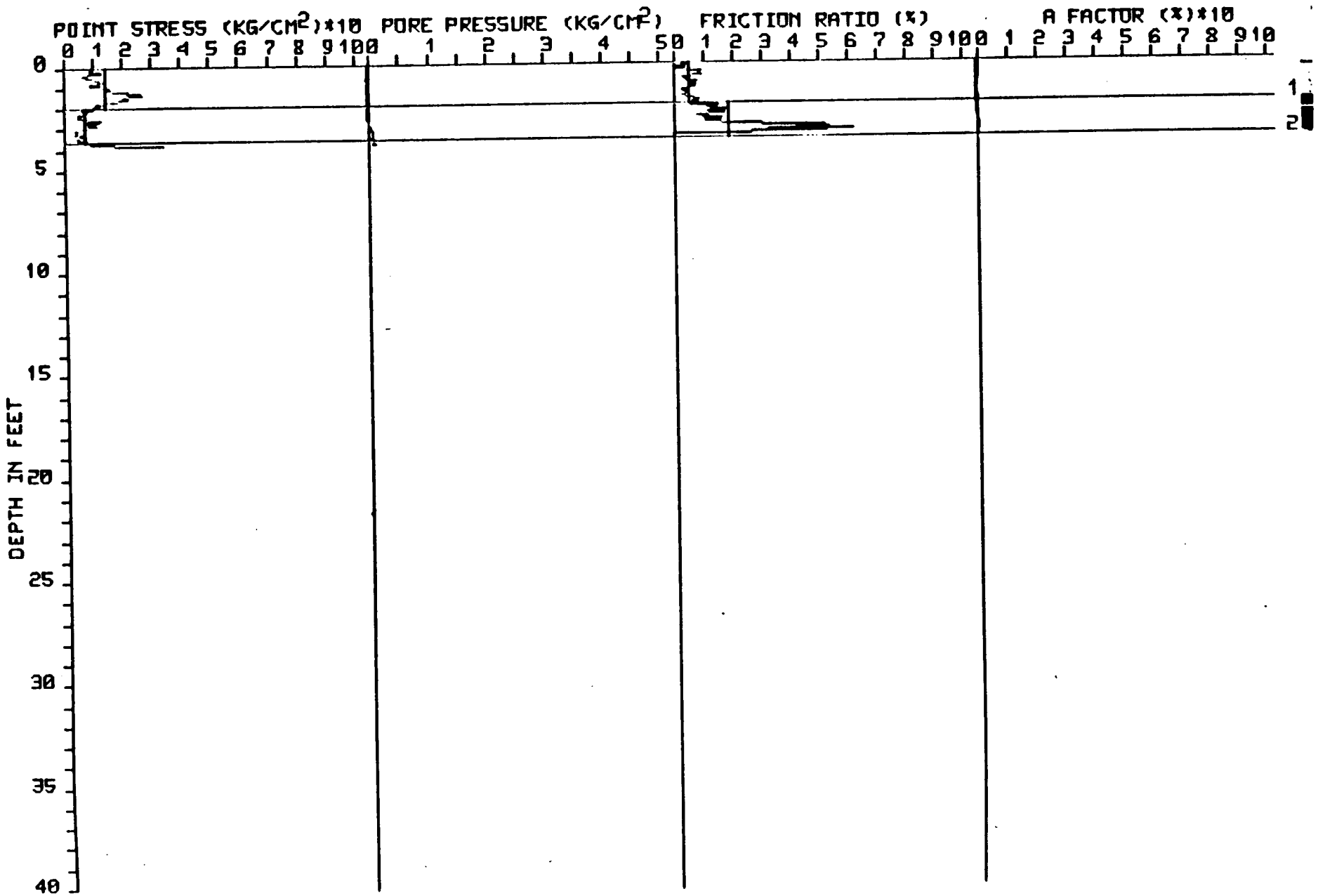


48

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

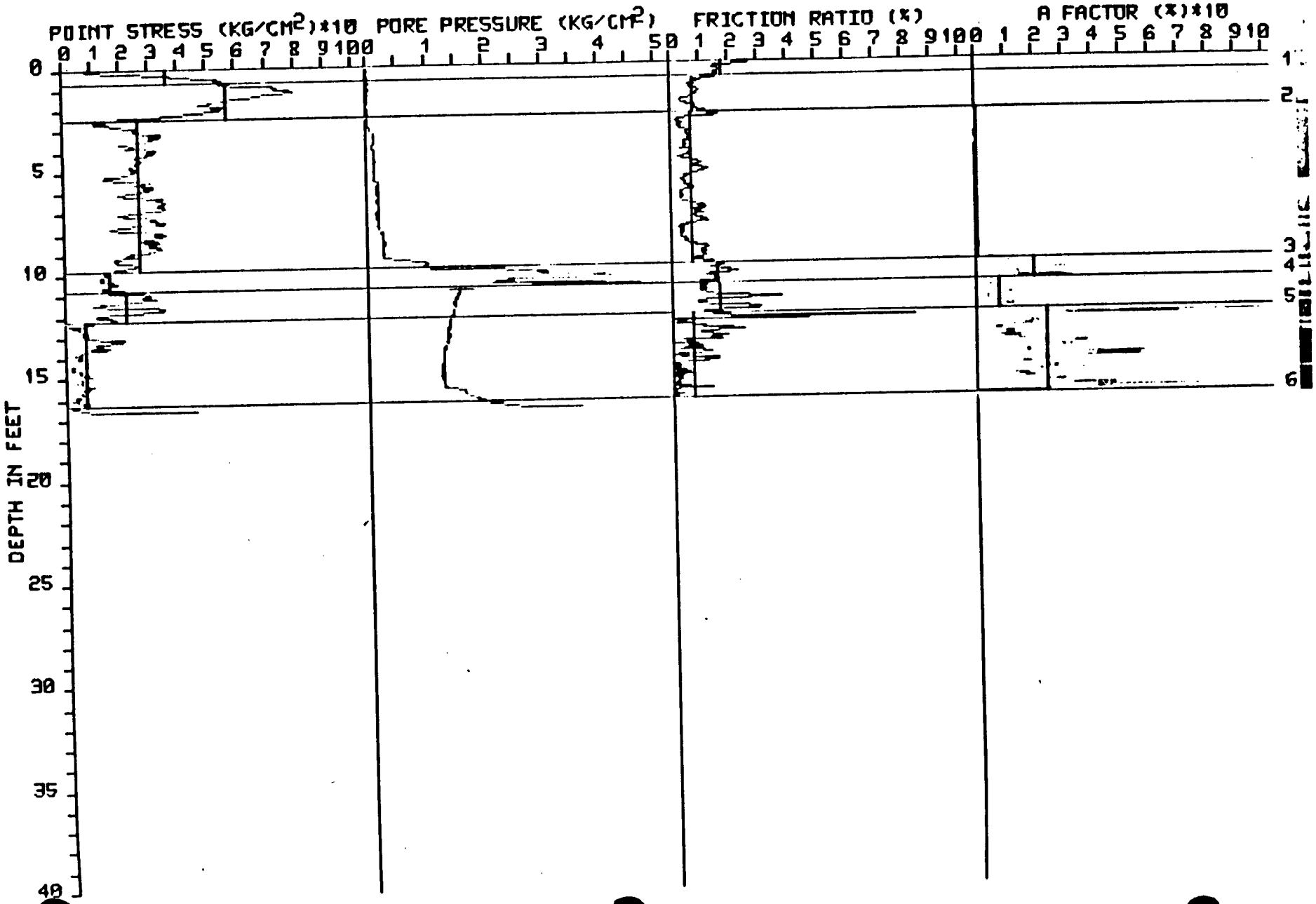
LOCATION ID: 010



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

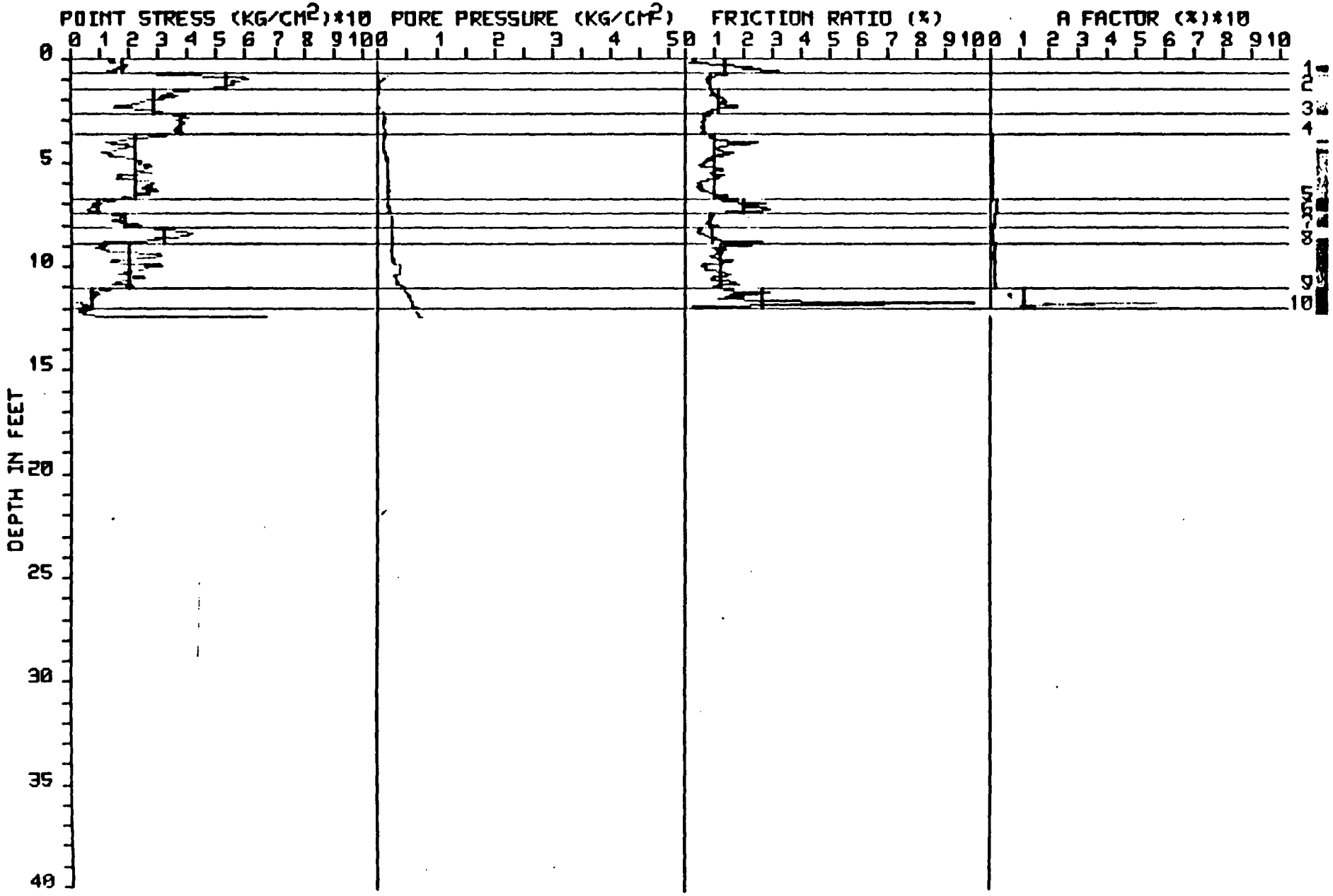
LOCATION ID: 011



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

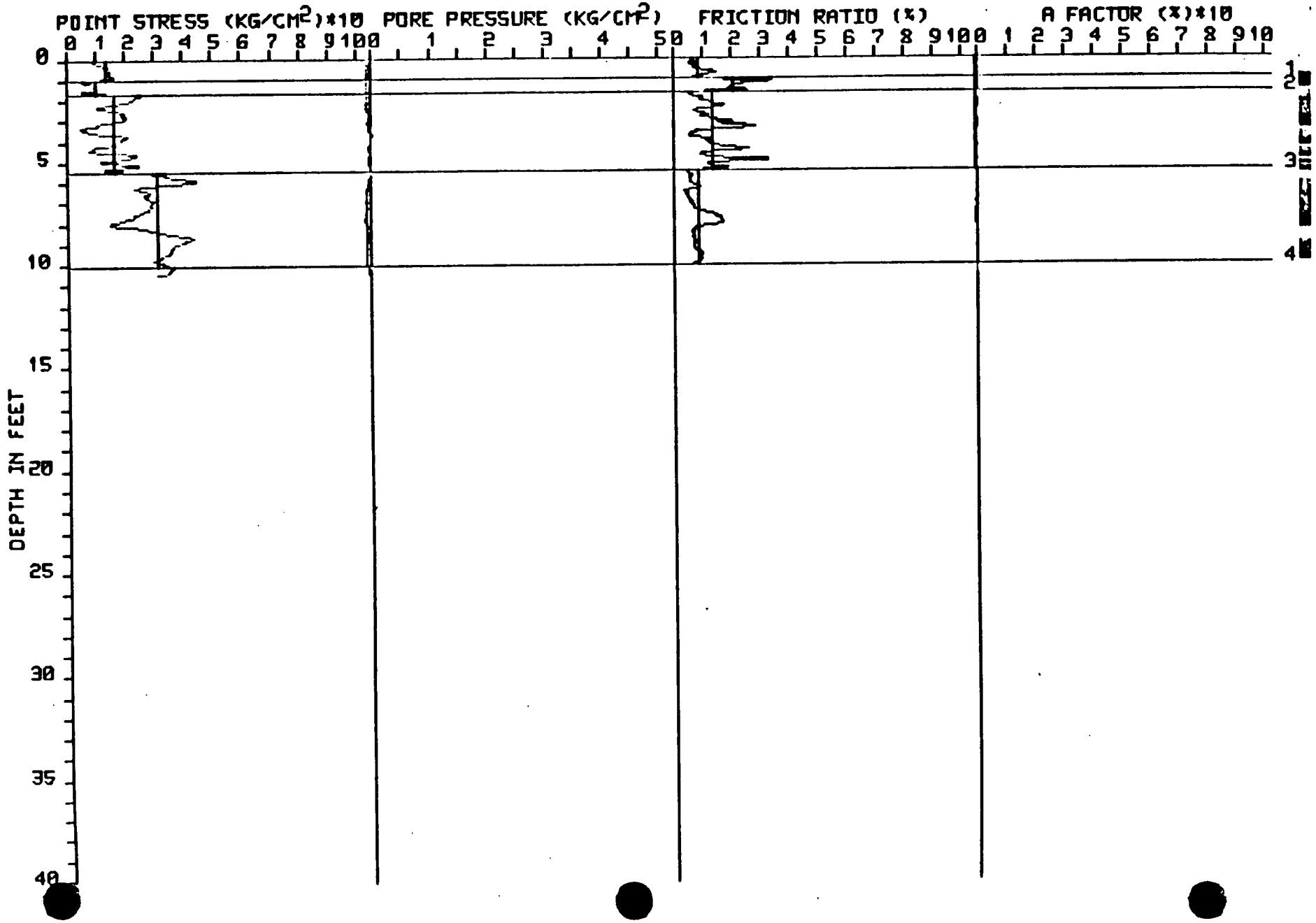
LOCATION ID: 012



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

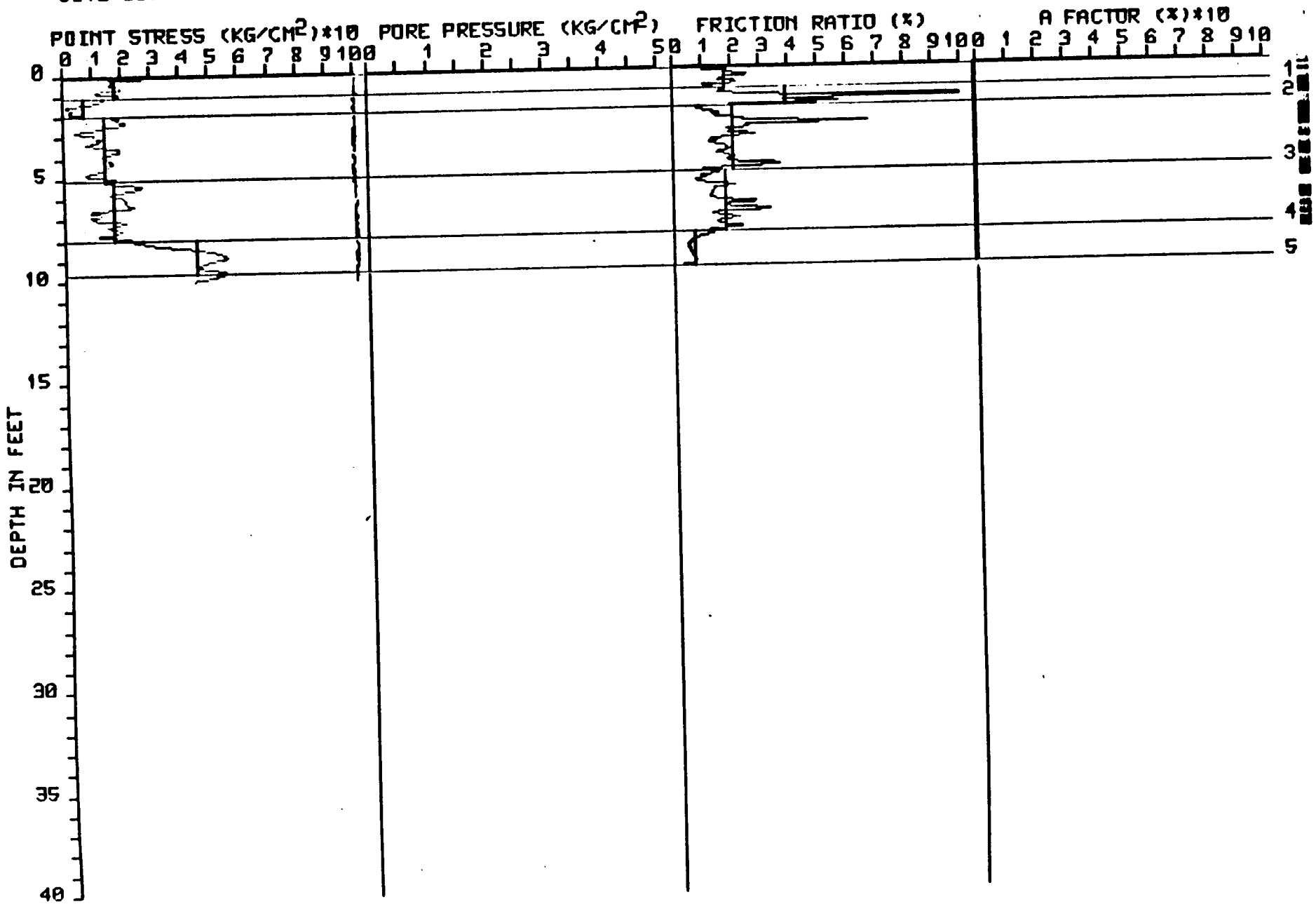
LOCATION ID: 013



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

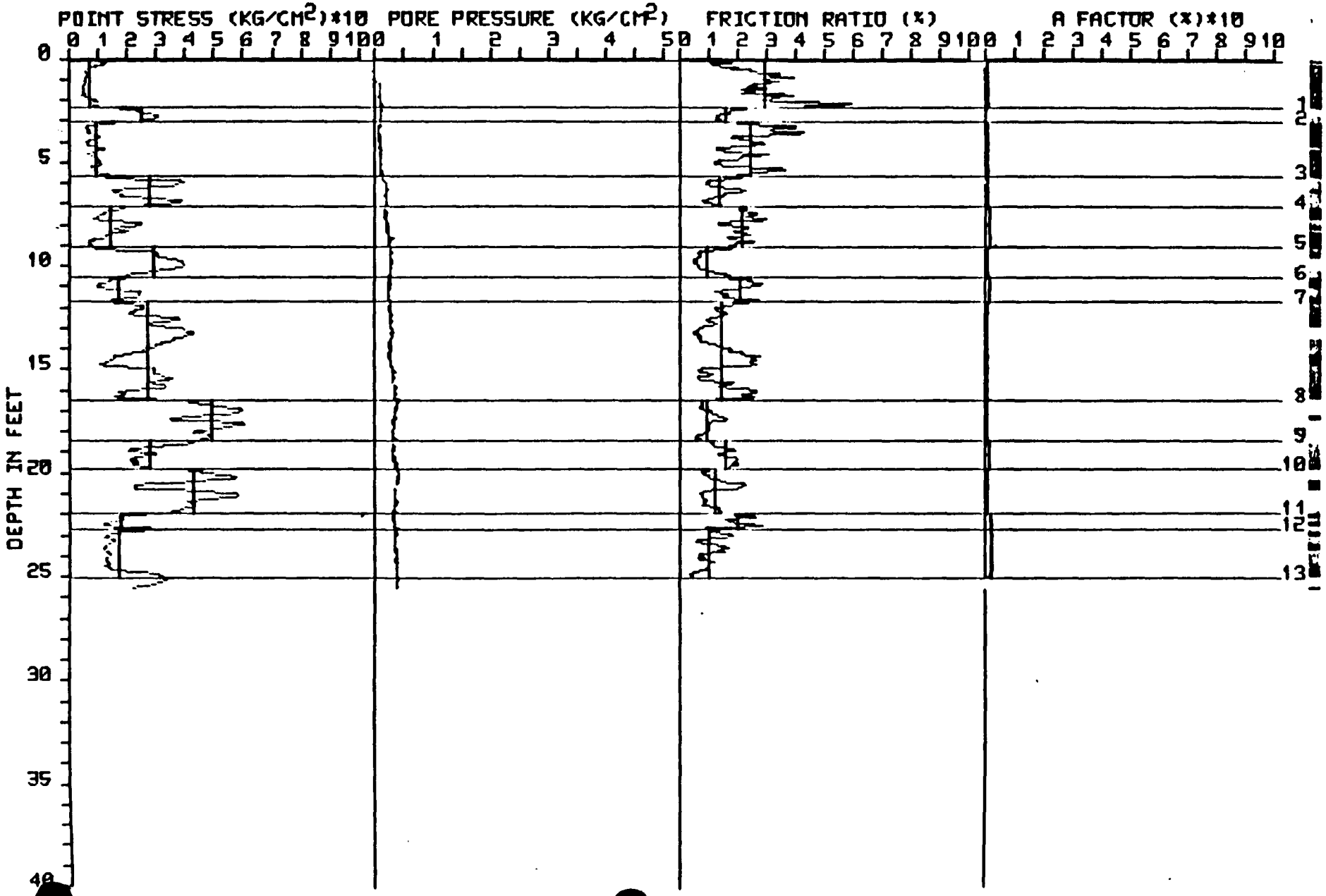
LOCATION ID: 014



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 015

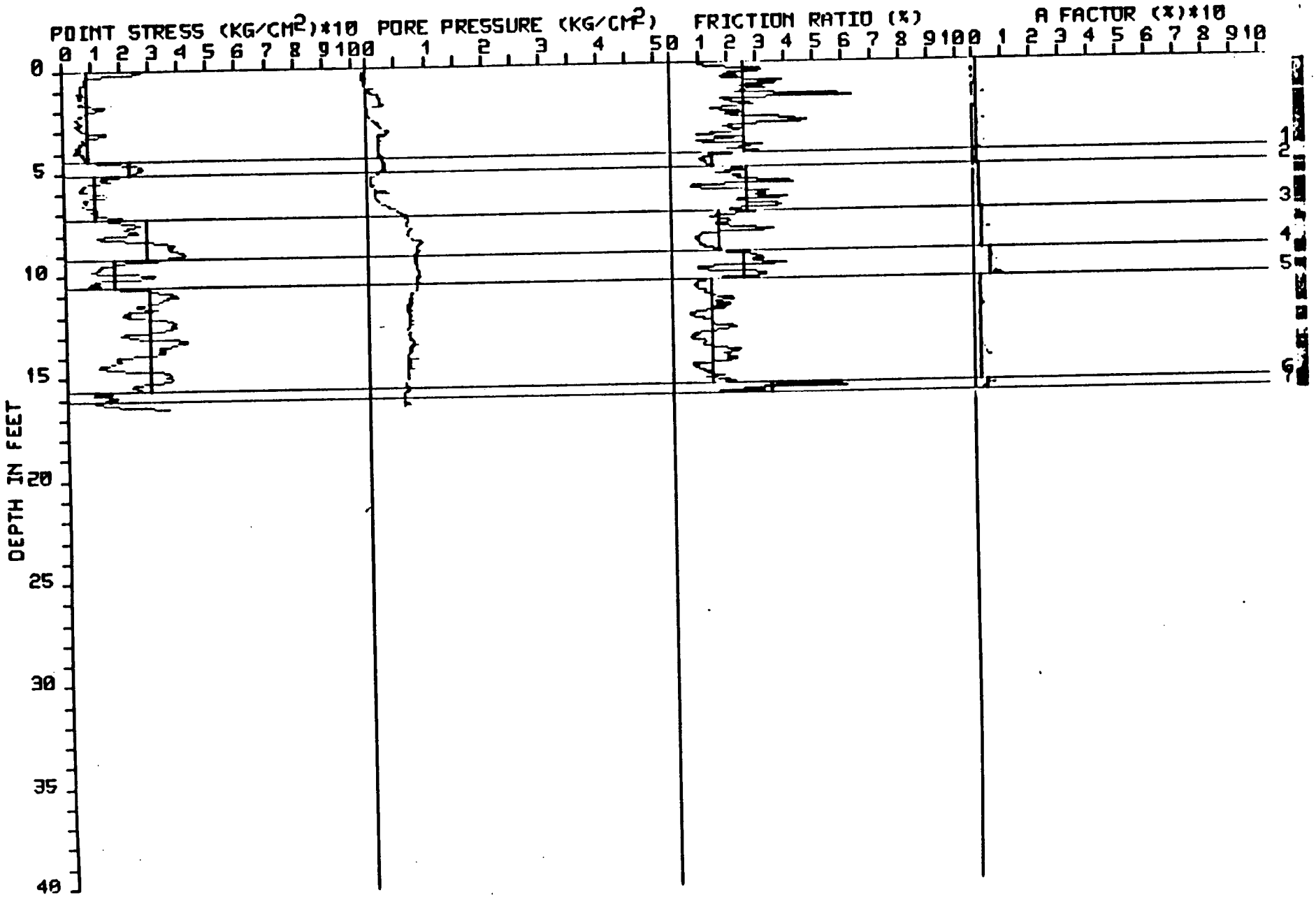


54

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 016

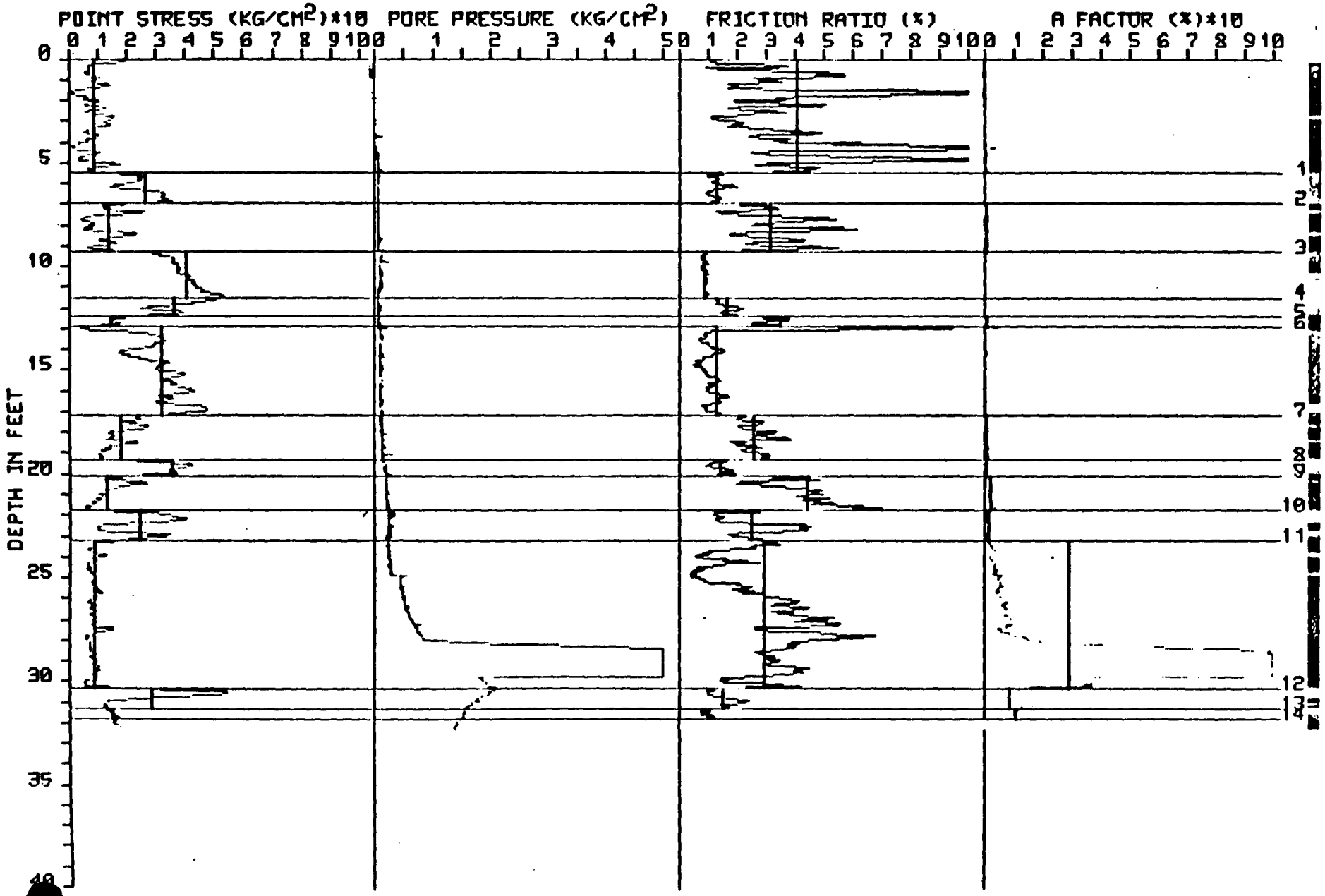


55

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 017

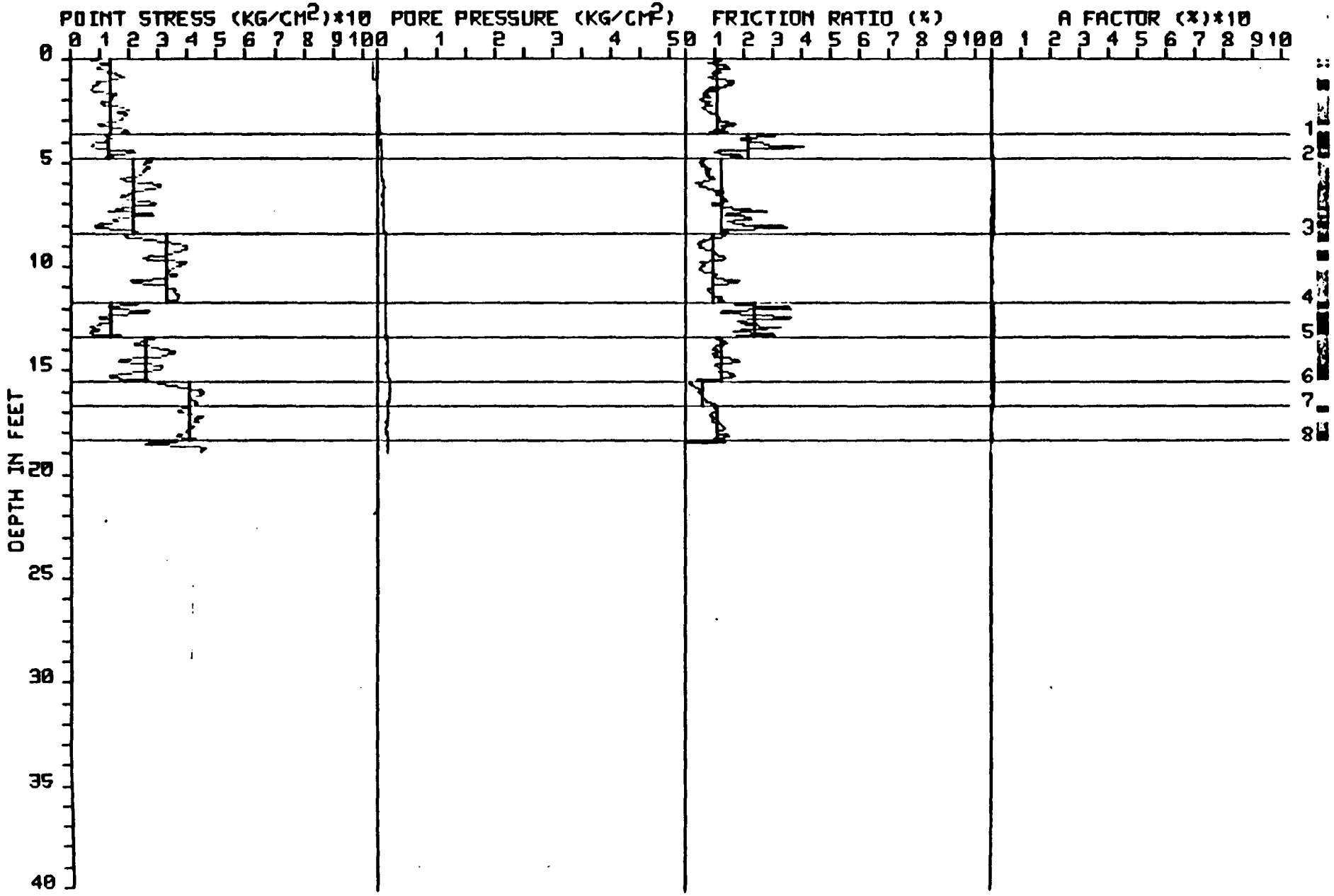


56

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

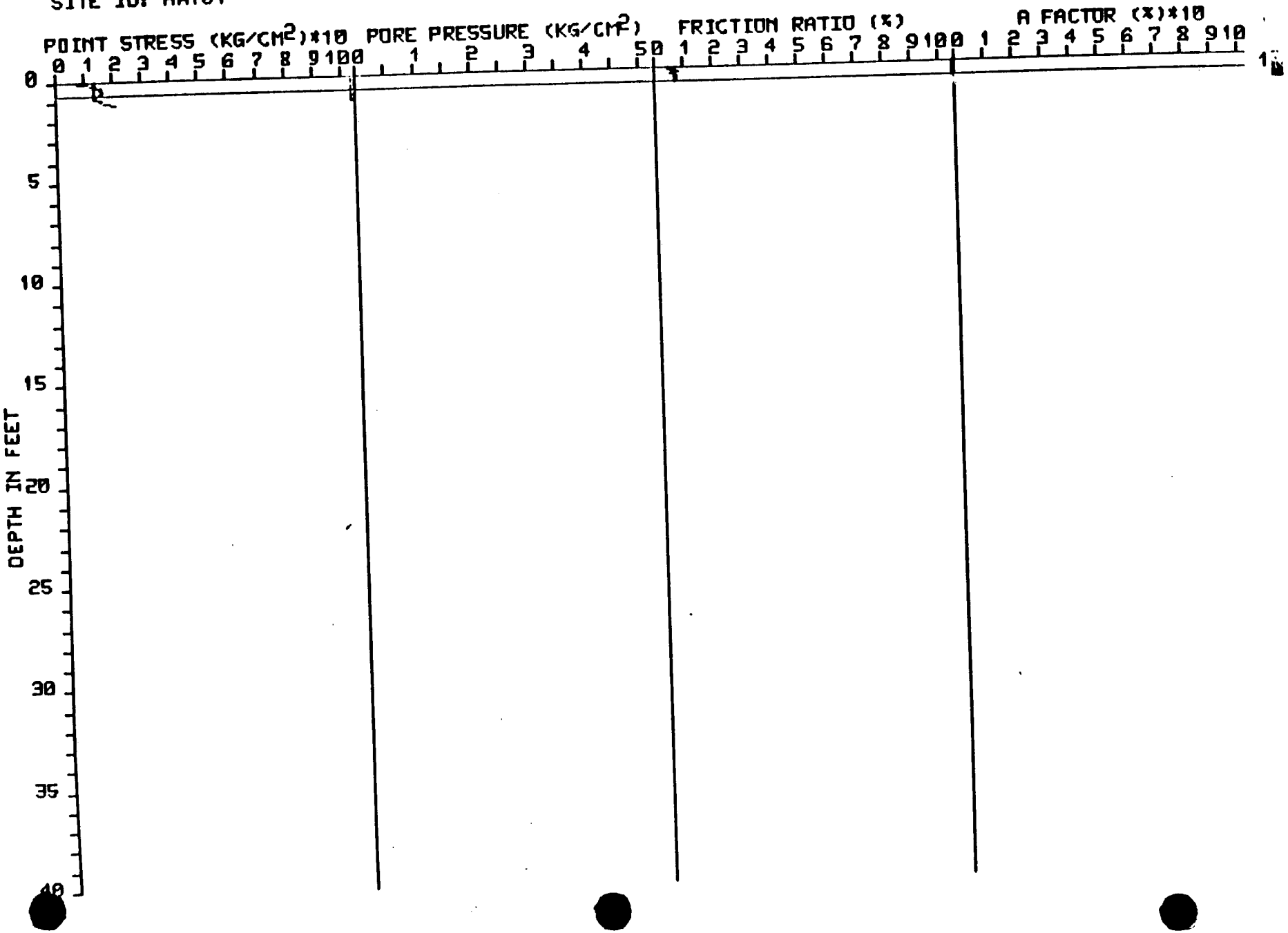
LOCATION ID: 018



PIEZOCONE SOUNDING TEST

LOCATION ID: 019

SITE ID: HAT01

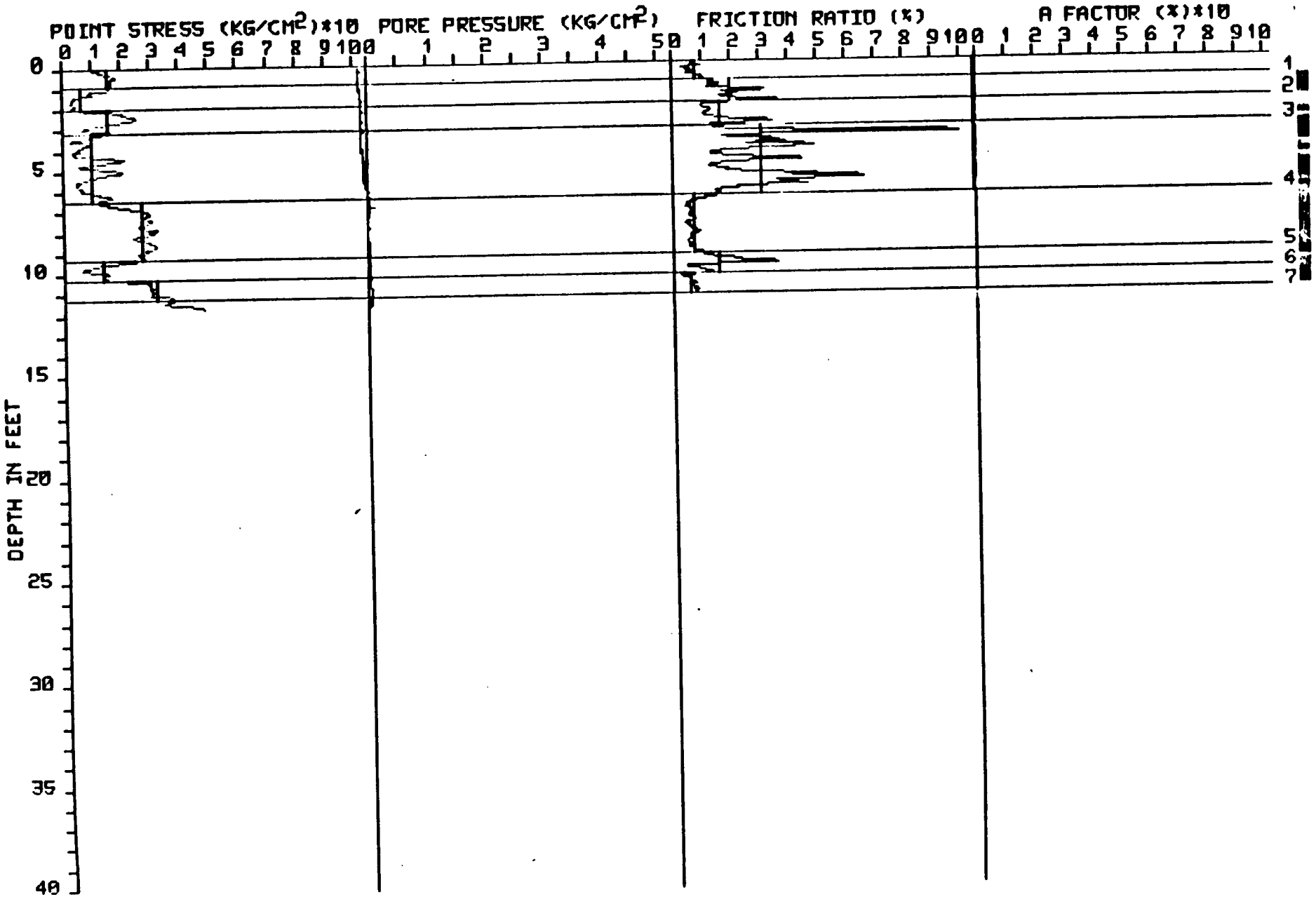


68

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

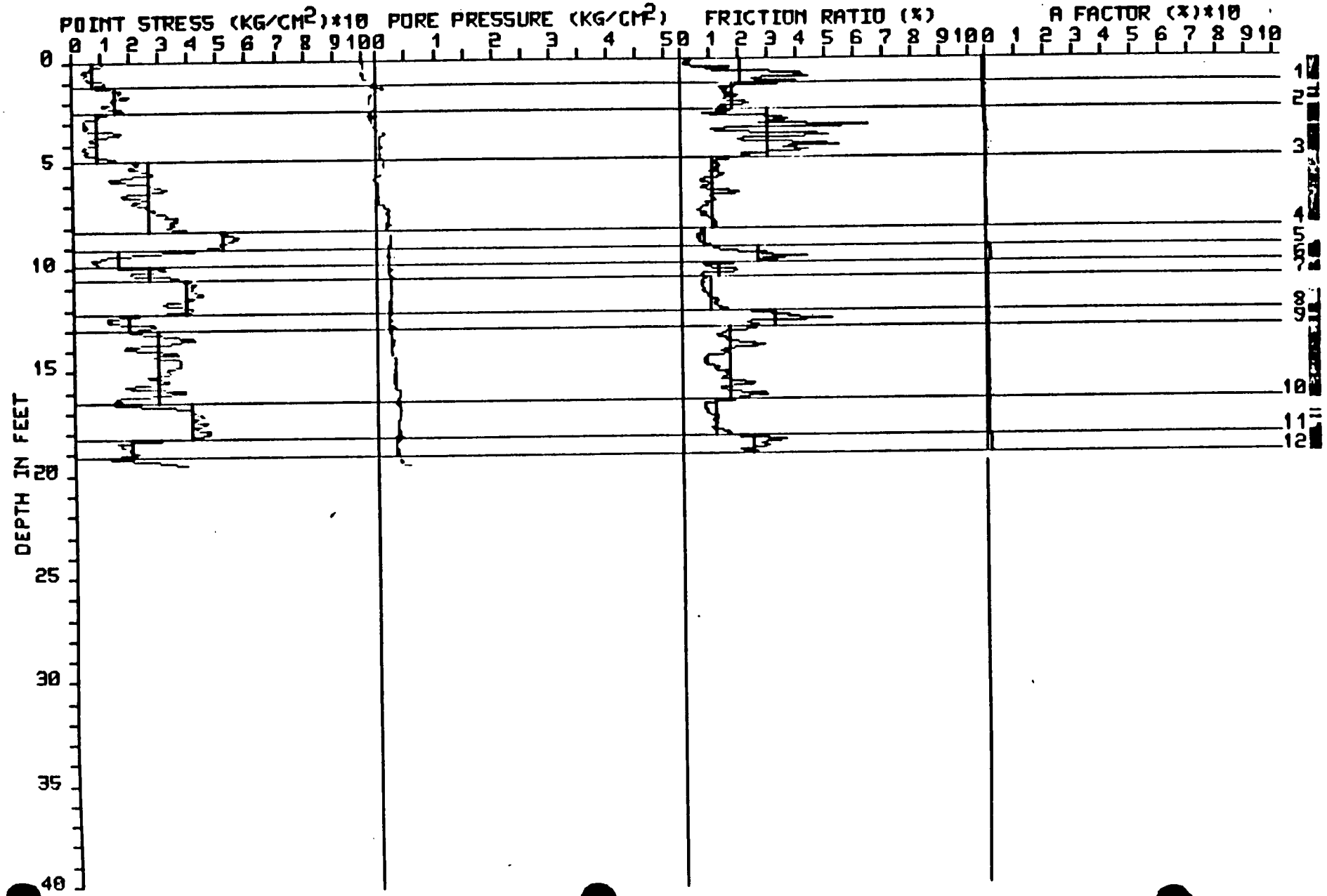
LOCATION ID: 020



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 021



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PIEZOCONE SOUNDING TEST

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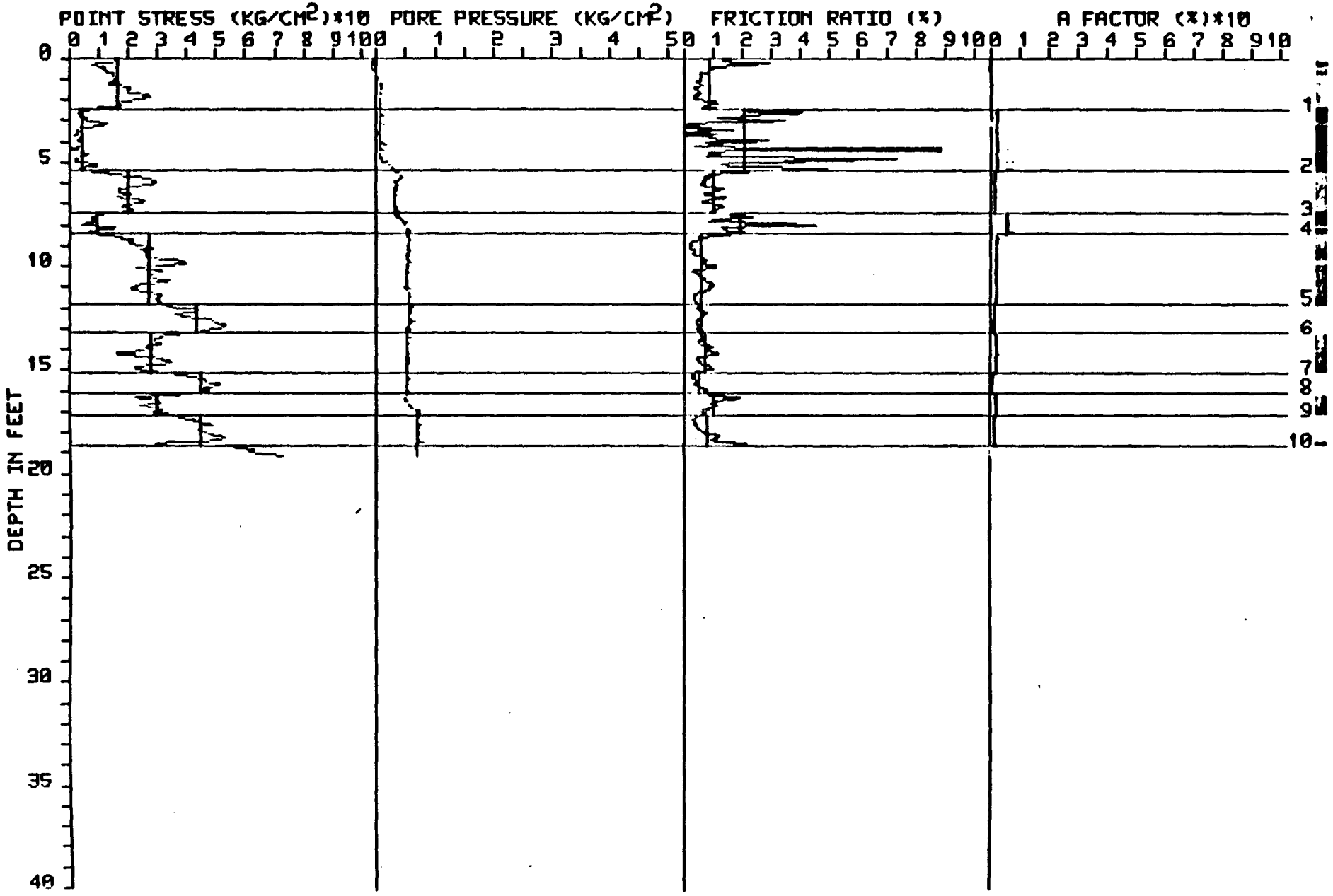
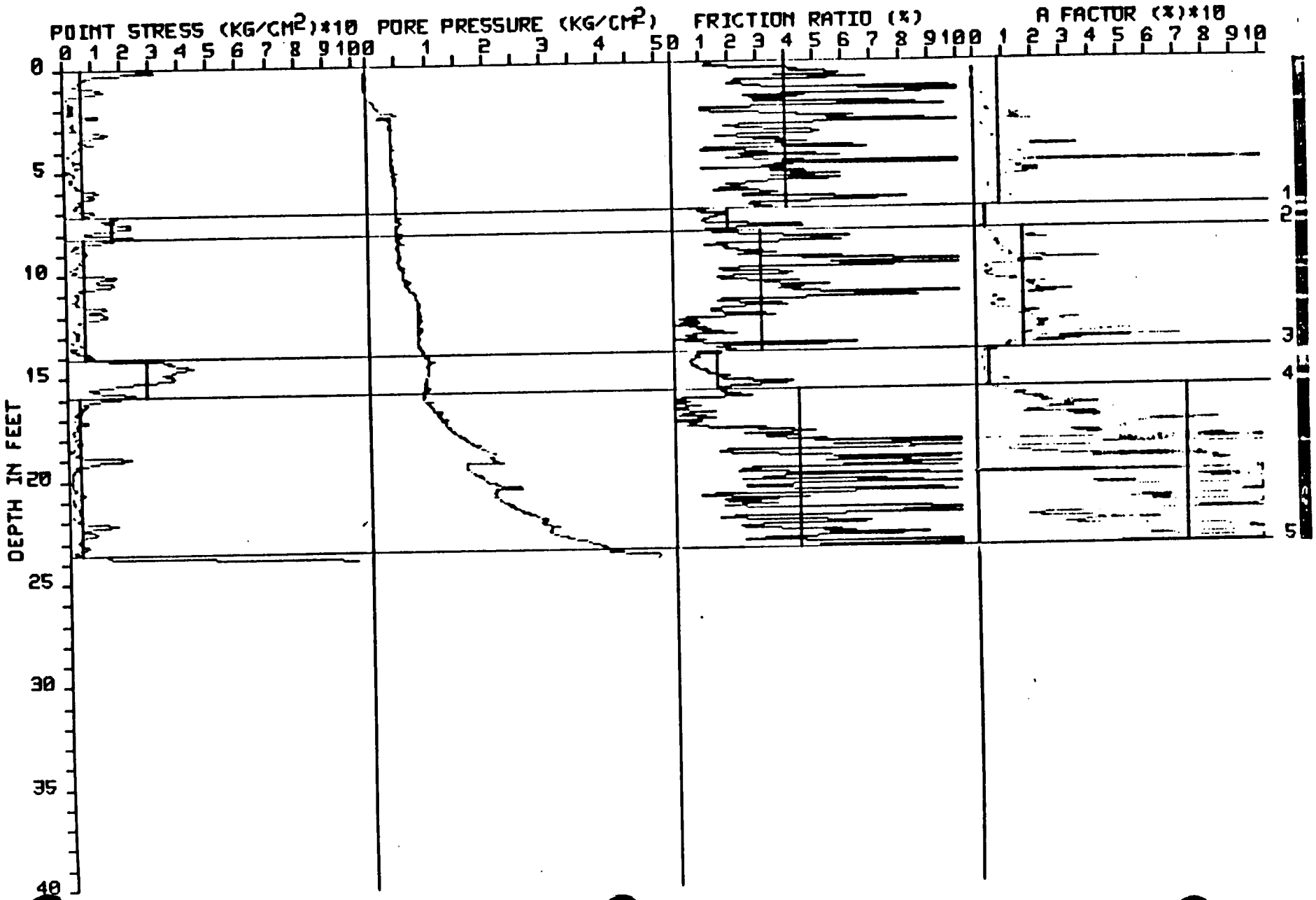
LOCATION ID: 022



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 023



PIEZOCONE SOUNDING TEST

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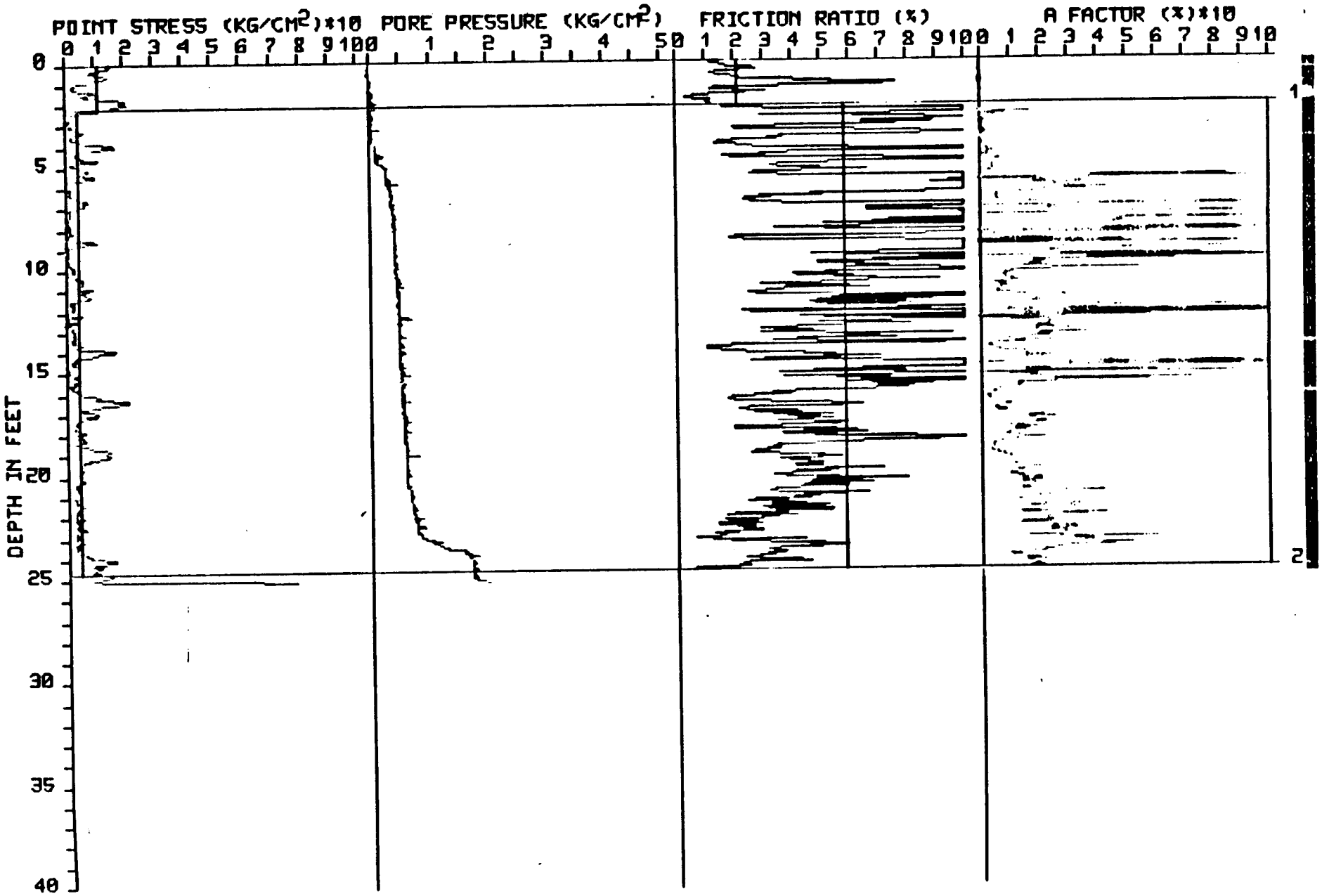

PIEZOCONE SOUNDING TEST

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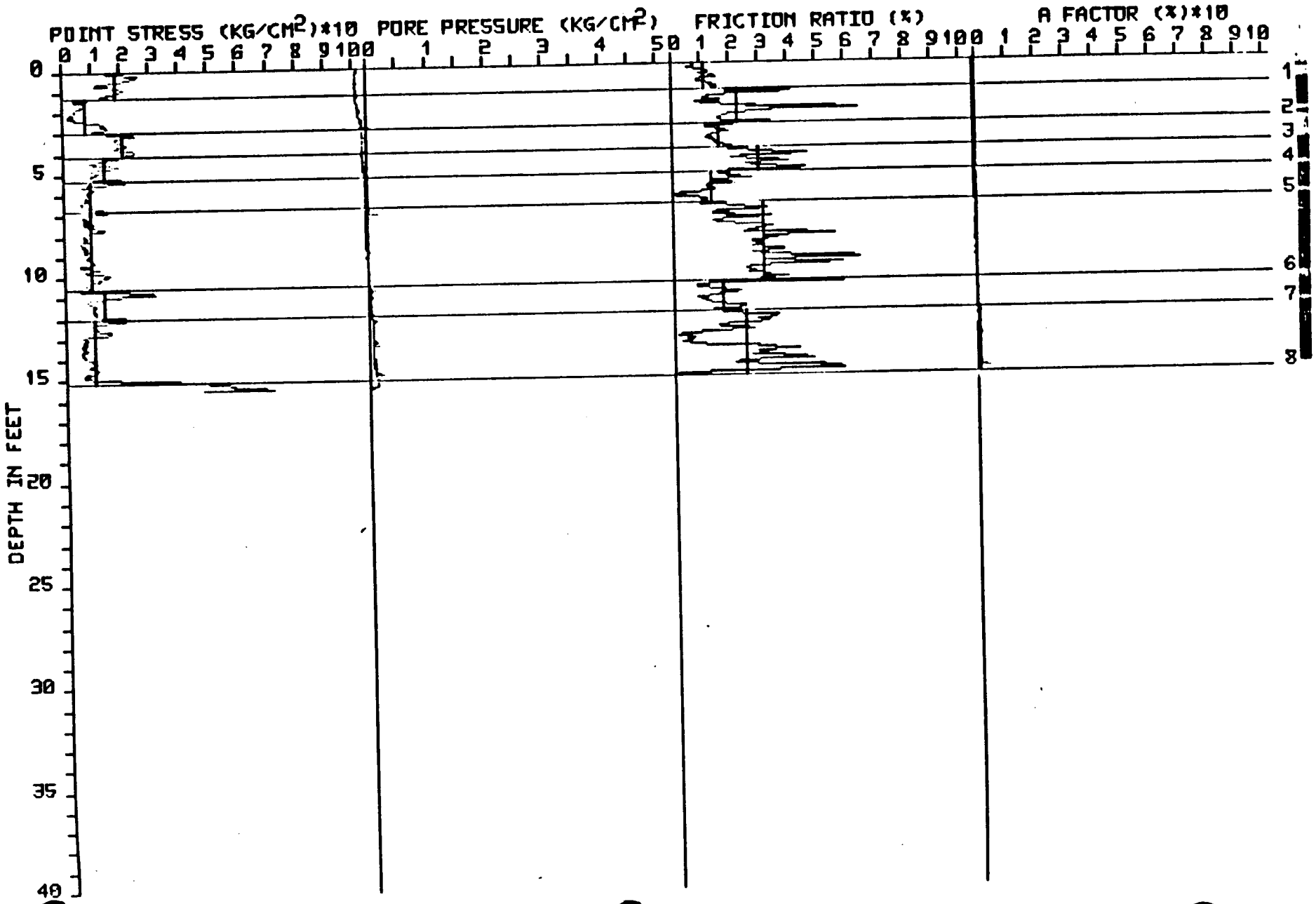
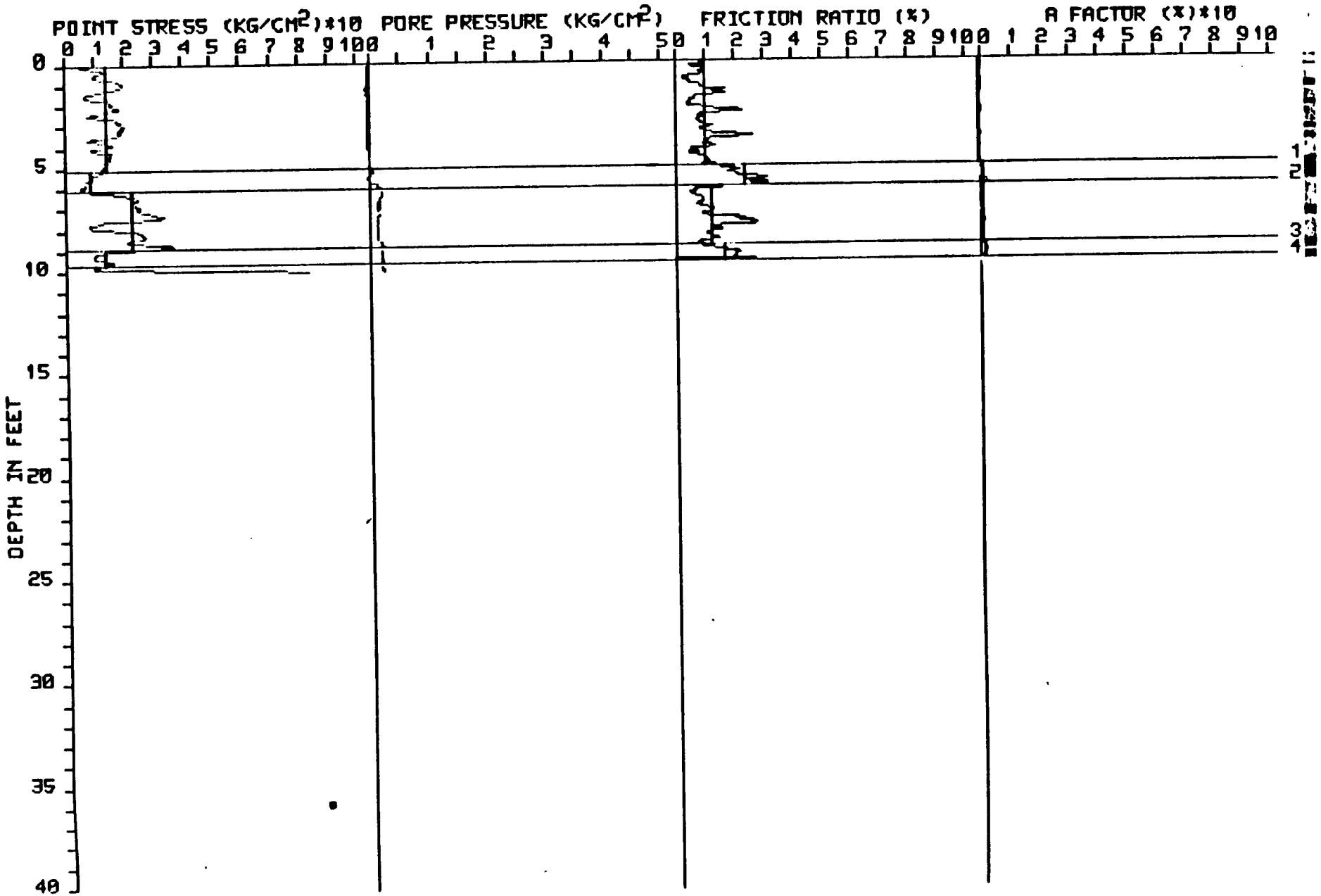
LOCATION ID: 025



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 026



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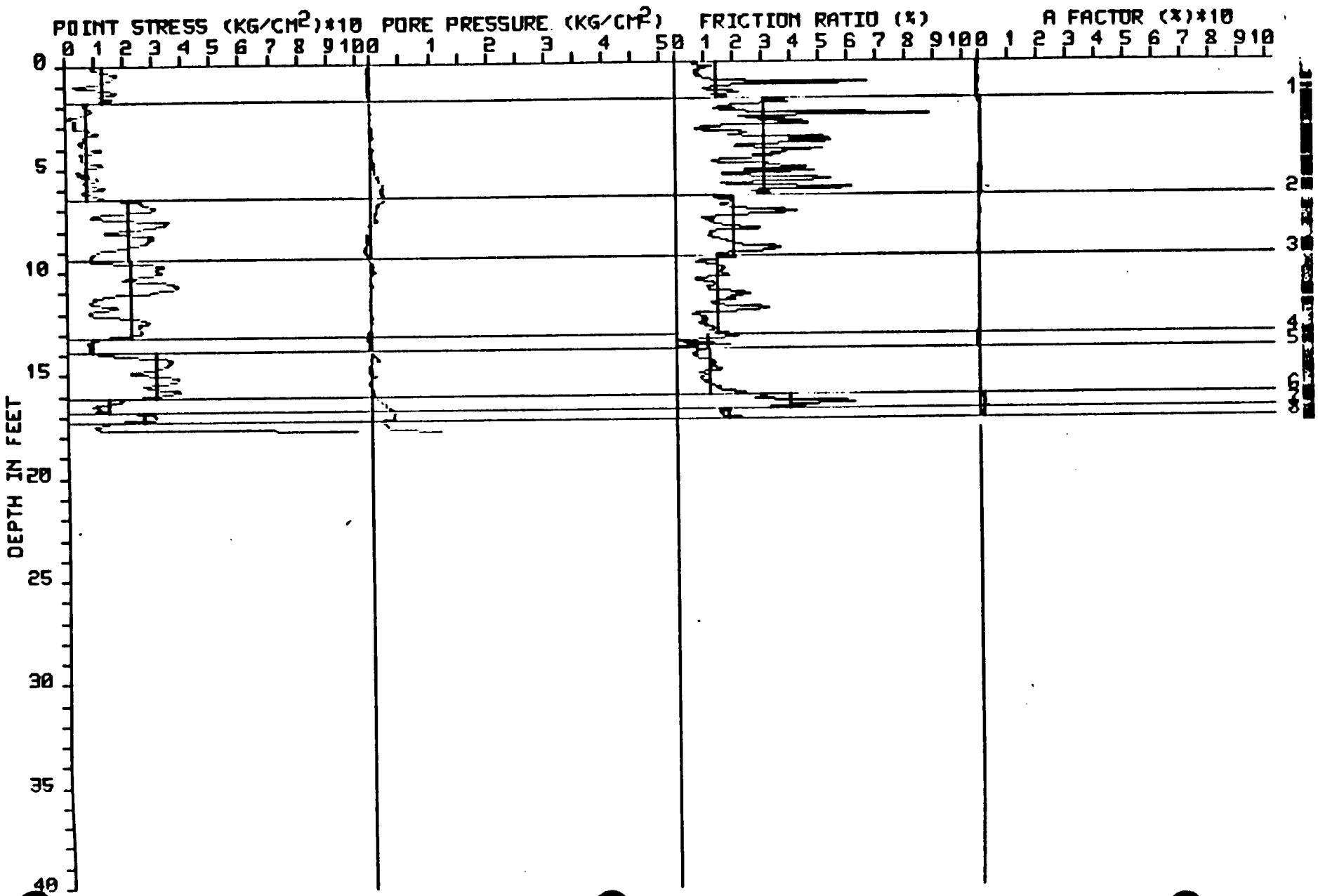
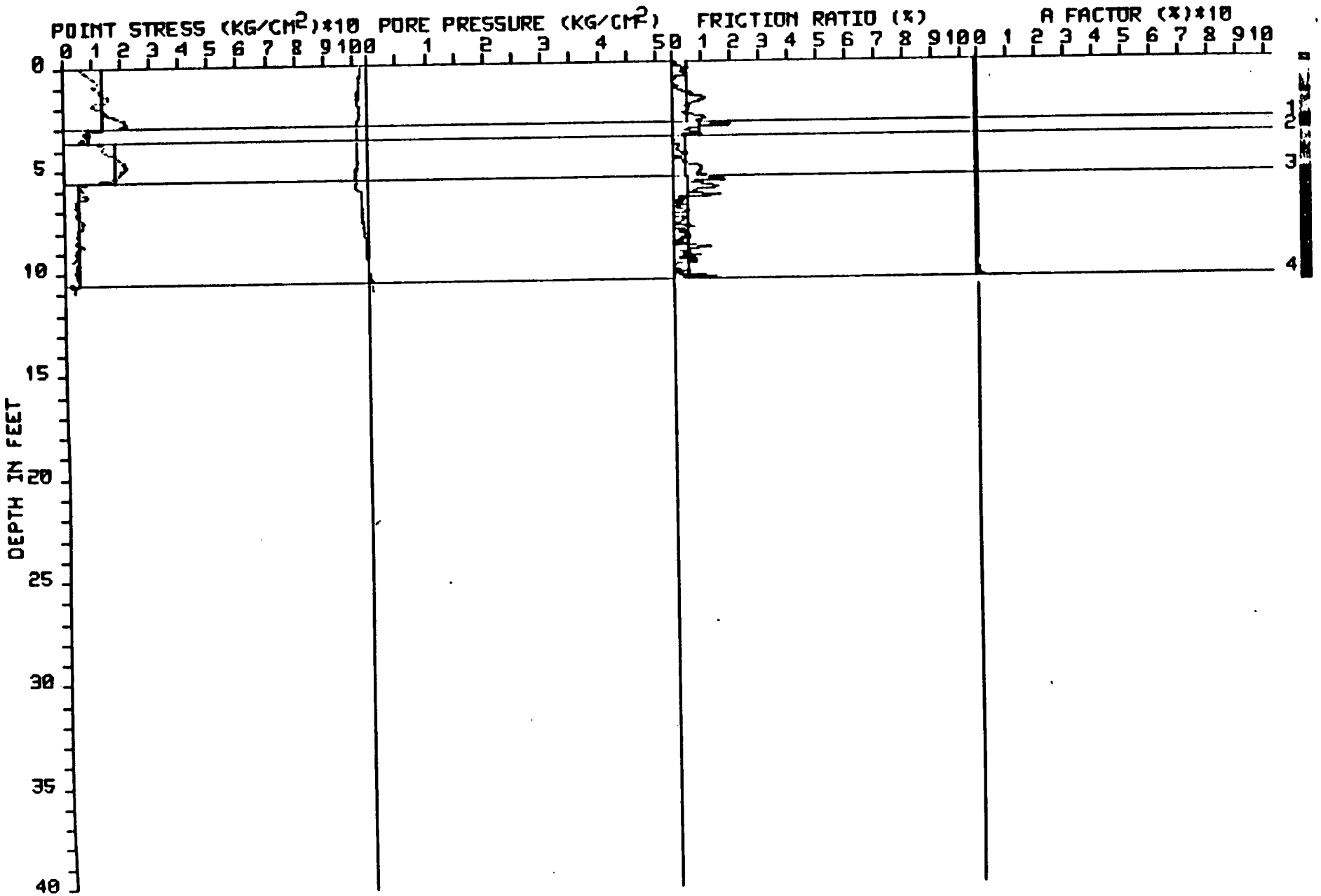


PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 028



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SITE ID: HAT01

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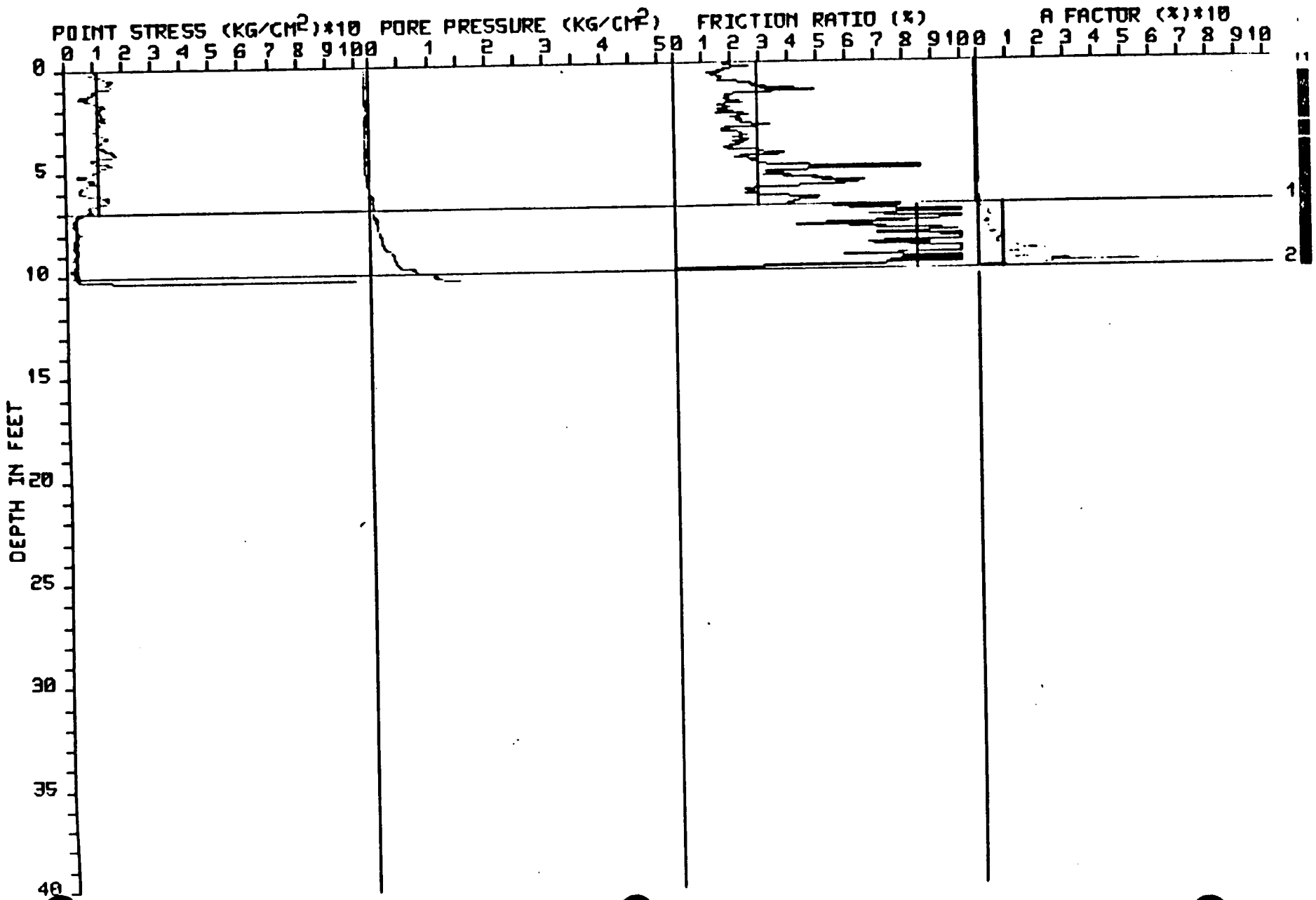

PIEZOCONE SOUNDING TEST

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LOCATION ID: 030

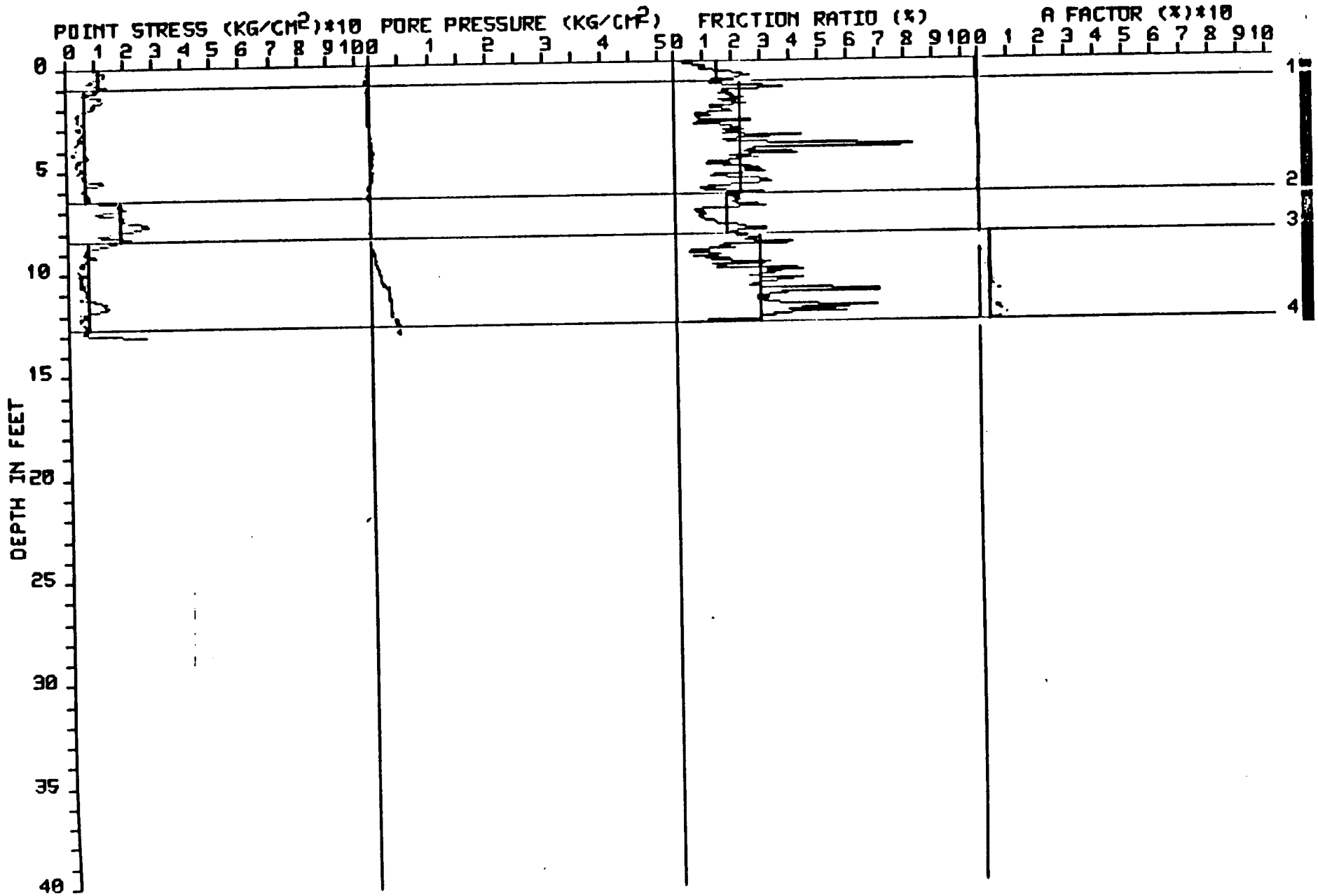

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Table D6.1 Geochemical analyses of Colorado State University borings

Boring Number[a]	Sample depth (feet)	pH	Electrical conductivity (mhos/centimeter)	Constituent[b] SO_4	Fe	Ca	Mg	Na	Cl	Al	Mn	As	Se	$CaCO_3$ equivalent (percent)
MH-200	2.5	8.1	1.8	3650	158	2660	782	323	130	812	252	4	3	10.4
MH-200	3.0	8.0	1.8	3140	130	2500	507	118	60	778	224	4	2	21.8
MH-200	3.5	8.1	2.0	4240	128	4260	473	161	60	675	183	4	4	19.3
MH-200	4.0	8.0	1.9	3870	110	3380	378	69	<20	781	159	4	4	21.8
MH-200	4.8	8.2	0.2	200	118	222	29	30	272	288	390	3	5	36.0
MH-200	6.0	8.6	0.1	111	84	131	21	16	<20	363	296	2	4	17.5
MH-200	10.0	8.6	0.2	270	115	217	53	41	<20	336	191	3	4	36.0
MH-200	15.0	8.6	0.1	67	106	114	30	49	<20	348	138	3	4	49.8
MH-200	19.0	8.5	0.1	134	82	155	35	29	<20	248	224	2	3	18.7
MH-205	5.5	8.5	0.2	173	112	167	65	35	<20	278	222	3	5	41.0
MH-205	6.0	8.3	0.8	160	215	1460	186	50	<20	325	610	2	3	29.6
MH-205	7.0	8.5	0.2	190	144	149	55	81	<20	306	228	3	2	36.4
MH-205	10.0	7.9	1.7	3050	96	2110	541	268	<20	931	194	2	<1	18.0
MH-205	12.5	8.1	0.2	300	78	105	60	29	30	609	89	1	1	11.5
MH-205	17.0	8.4	0.1	150	67	131	44	35	20	276	237	1	<1	12.8
MH-205	22.0	8.3	0.2	170	38	53	23	300	30	671	45	1	3	6.1
MH-205	25.5	8.6	0.1	155	87	130	37	36	20	277	193	13	<1	18.4
MH-208	27.0	6.4	2.0	5070	430	5470	177	96	<20	549	72	13	<1	0.84
MH-208	27.5	8.0	0.2	348	304	340	47	22	<20	253	271	4	6	34.4
MH-208	30.2	8.5	0.1	90	130	131	26	24	<20	263	231	4	6	32.0
MH-208	36.0	8.4	0.1	89	93	116	32	31	<20	260	208	2	3	31.4
MH-208	38.0	8.1	0.2	370	74	289	91	72	<20	845	128	2	<1	9.8
MH-208	43.0	8.6	0.1	67	119	111	32	35	<20	342	202	2	2	29.8
MH-208	49.0	8.1	0.2	120	52	124	47	98	<20	671	103	3	<1	18.0

[a]Boring numbers currently do not have DOE identification numbers; CSU boring numbers represent NX rock core samples.
[b]Analysis done by solute extraction; values are expressed in milligrams per gram of dry soil; SO_4 - sulfate; Fe - iron; Ca - calcium; Mg - magnesium; As - arsenic; Se - selenium.

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 001
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	16.4	0.2	0.0	1.0	S-SL*	5	39	30	57	1965	
2	1.3	4.1	2.8	7.3	0.1	0.1	1.4	SLIM	4			25	870	9.6
3	4.2	8.0	3.8	22.6	0.3	0.1	1.1	S-SL*	7	48	31	79	2709	
4	8.0	10.1	2.1	14.2	0.4	0.2	2.6	SLIM	9			50	1709	5.8
5	10.1	11.1	1.0	24.5	0.3	0.2	1.4	S-SL*	8	44	31	86	2937	
6	11.1	12.5	1.4	14.3	0.4	0.2	2.7	SLIM	9			50	1718	4.2
7	12.5	13.7	1.2	25.7	0.4	0.4	1.5	S-SL*	8	41	30	90	3086	
8	13.8	18.5	4.8	13.2	0.4	1.1	2.8	SLIM	8			46	1585	2.6
9	18.6	23.3	4.7	30.6	0.6	0.5	1.9	S-SL*	10	37	29	107	3671	
10	23.3	25.2	1.9	18.0	0.6	1.4	3.2	SLIM	12			63	2164	2.0
11	25.3	28.3	3.1	6.2	0.1	2.7	2.1	SLIM	4			22	742	0.8
12	28.3	30.7	2.3	21.8	0.5	1.0	2.2	SLIM	14			76	2615	1.8
13	30.7	33.8	3.1	11.8	0.4	6.6	3.3	SLIM	7			41	1414	1.0
% THK:		35	11.9	25.6	0.4	0.3	1.5	S-SL	8	41	30	89	3071	
% THK:		64	21.5	12.7	0.3	1.9	2.5	SLIM	7			44	1527	3.3

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 002
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	48.0	0.3	-0.1	0.7	SAND*	9	72	35	168		
2	0.8	9.8	9.1	23.7	0.2	0.0	0.8	S-SL*	7	49	31	83	2845	
3	9.9	13.2	3.3	13.4	0.4	1.6	2.7	SLIM	8			47	1611	4.1
4	13.2	17.0	3.8	30.4	0.4	0.5	1.2	S-SL*	10	43	30	106	3647	
5	17.1	18.6	1.6	43.1	0.3	0.1	0.8	SAND*	8	50	31	151		
6	18.7	19.6	0.9	22.2	0.4	0.2	1.9	S-SL	7	30	29	78	2662	
7	19.6	21.0	1.4	56.3	0.5	0.3	1.0	SAND*	11	55	32	197		
% THK:		17	3.7	49.0	0.4	0.1	0.9	SAND	9	56	32	171		
% THK:		66	13.8	25.4	0.3	0.2	1.0	S-SL	7	46	31	89	3053	
% THK:		15	3.3	13.4	0.4	1.6	2.7	SLIM	8			46	1611	4.1

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

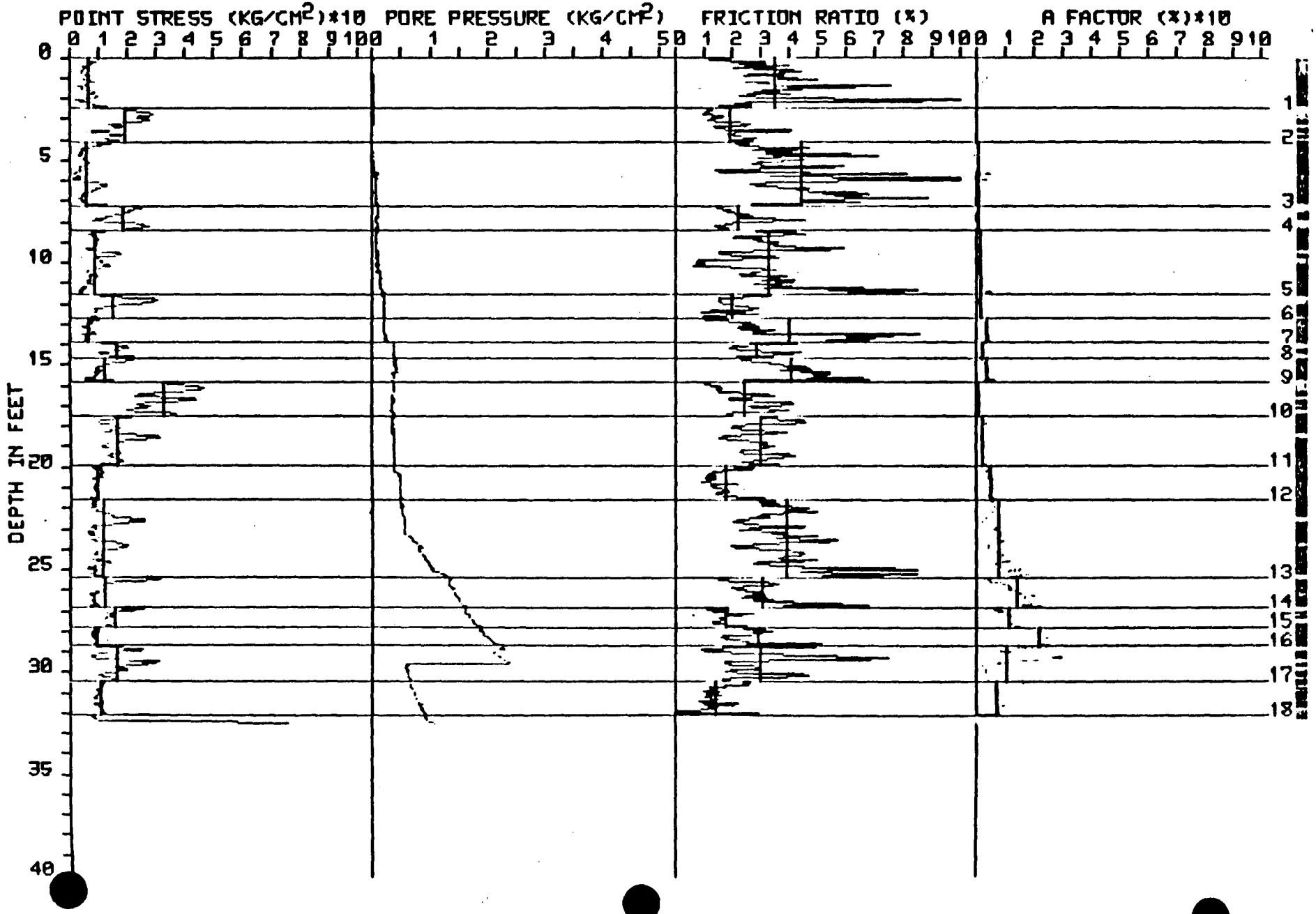
LOCATION ID: 003
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.2	1.1	6.7	0.0	-0.0	0.6	SLIM*	4			23	800	25.6
2	1.2	14.8	13.5	24.9	0.2	0.1	1.0	S-SL*	8	48	31	87	2985	
3	14.8	18.1	3.3	8.8	0.3	0.3	3.4	SLIM	5			31	1057	1.9
4	18.2	20.1	1.9	27.5	0.4	0.4	1.4	S-SL*	9	36	29	96	3302	
5	20.1	21.0	0.9	52.8	0.4	0.2	0.7	SAND*	10	53	32	185		
6	21.1	23.9	2.8	27.4	0.4	0.2	1.5	S-SL*	9	33	29	96	3287	
7	23.9	25.8	1.9	4.8	0.2	0.4	4.0	SLIM	3			17	574	0.7
% THK:		3	0.9	52.8	0.4	0.2	0.7	SAND	10	52	32	185		
% THK:		71	18.2	25.6	0.3	0.1	1.1	S-SL	8	44	31	89	3064	
% THK:		24	6.3	7.2	0.2	0.3	3.1	SLIM	4			25	866	5.7

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 031

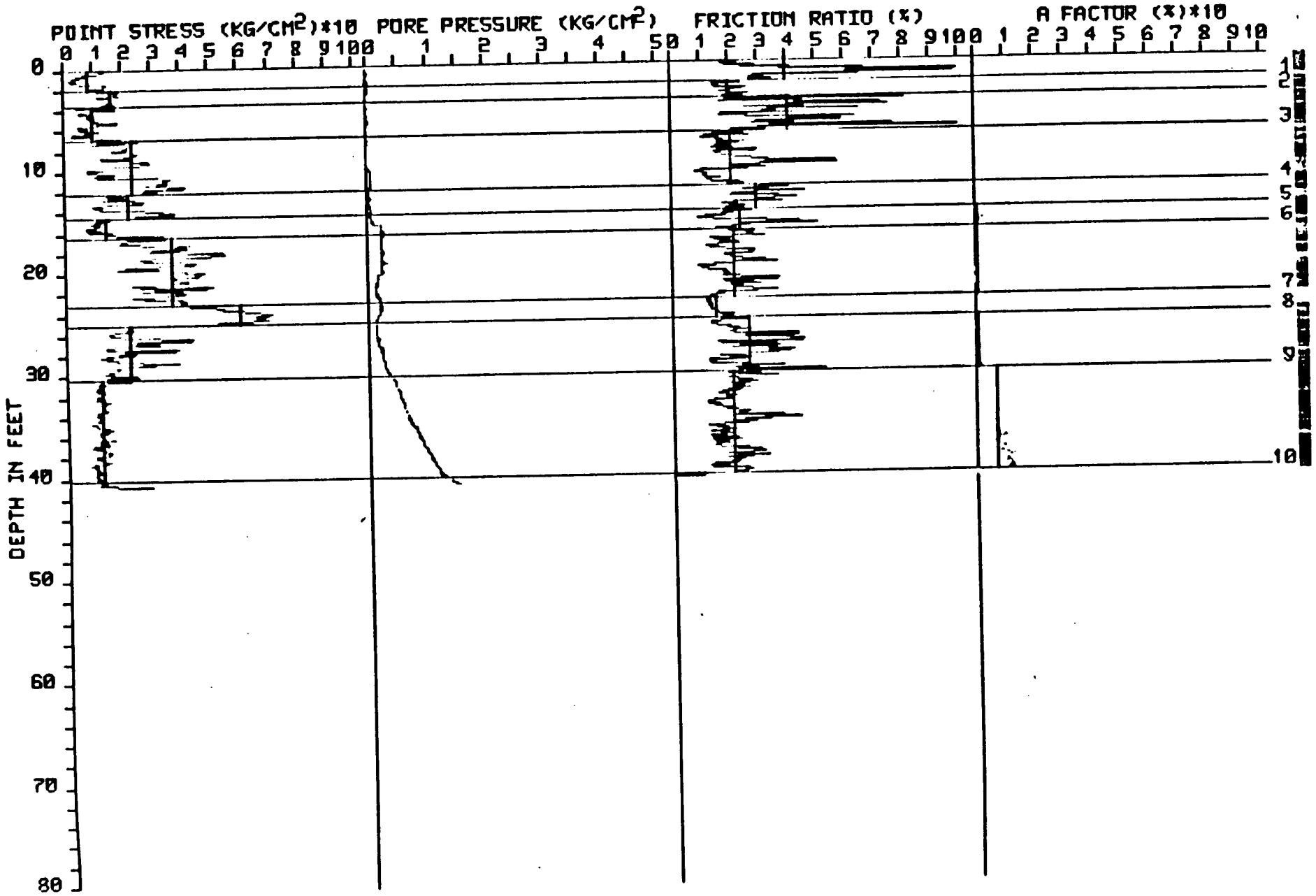


74

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 032

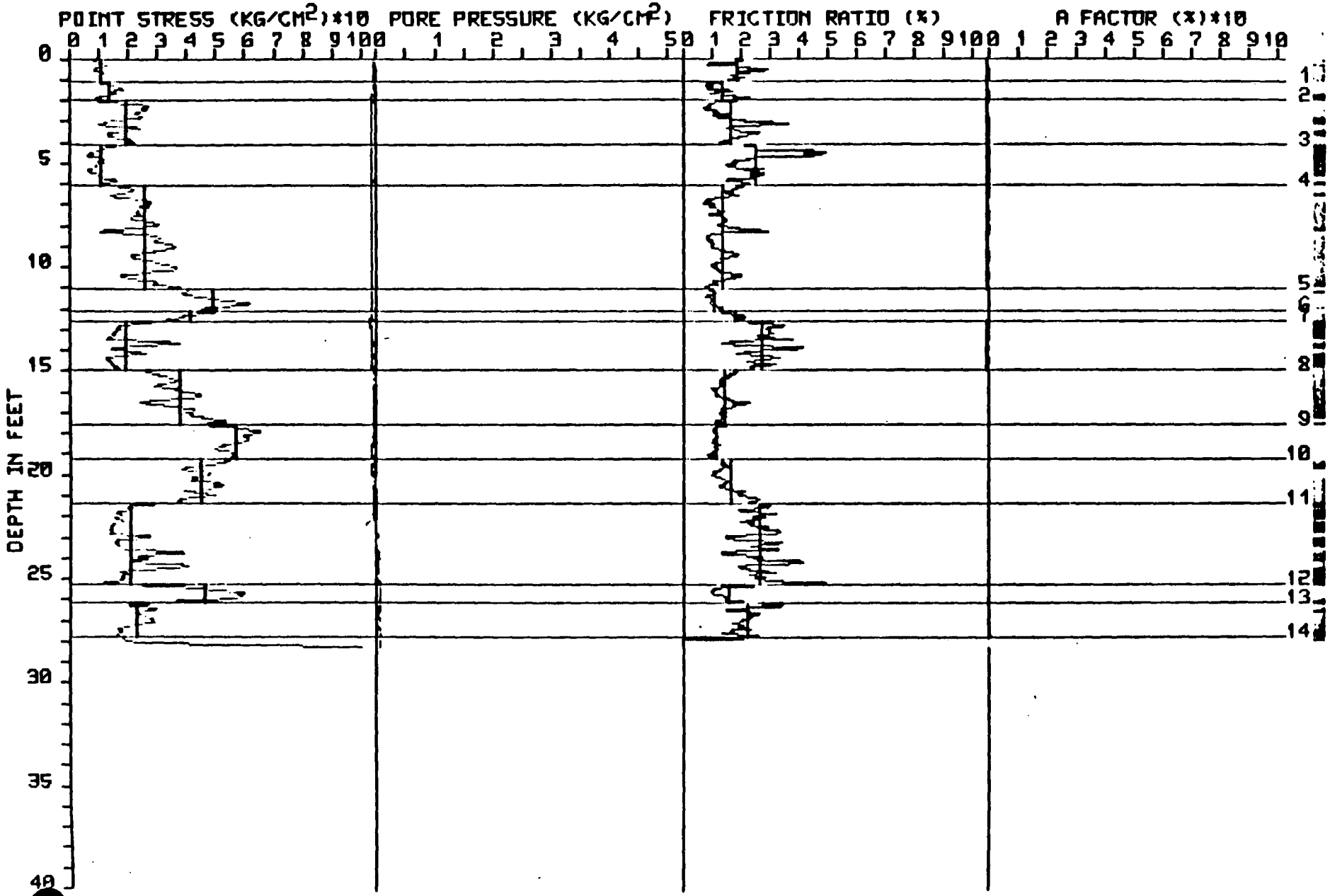


75

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 033

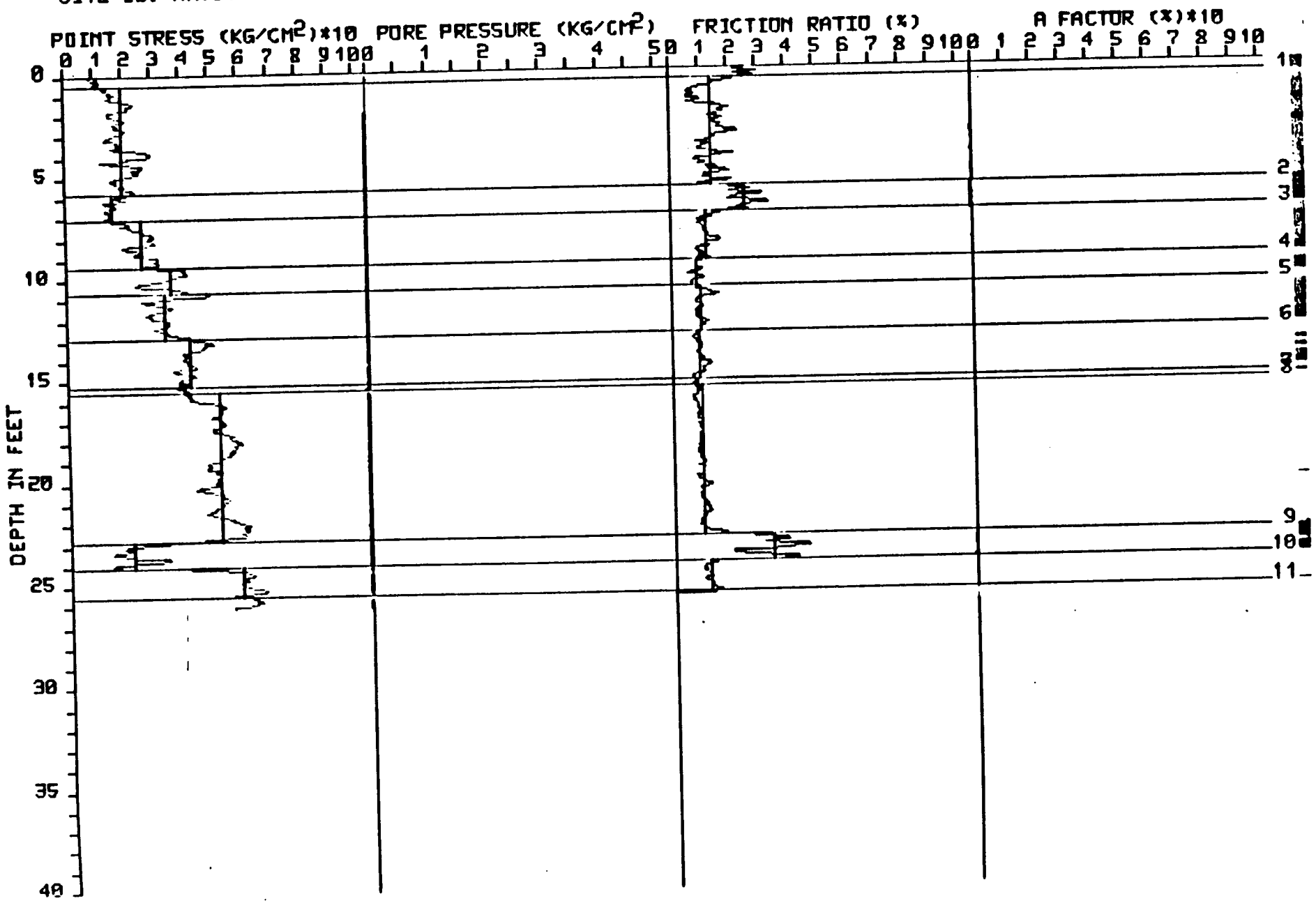


76

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

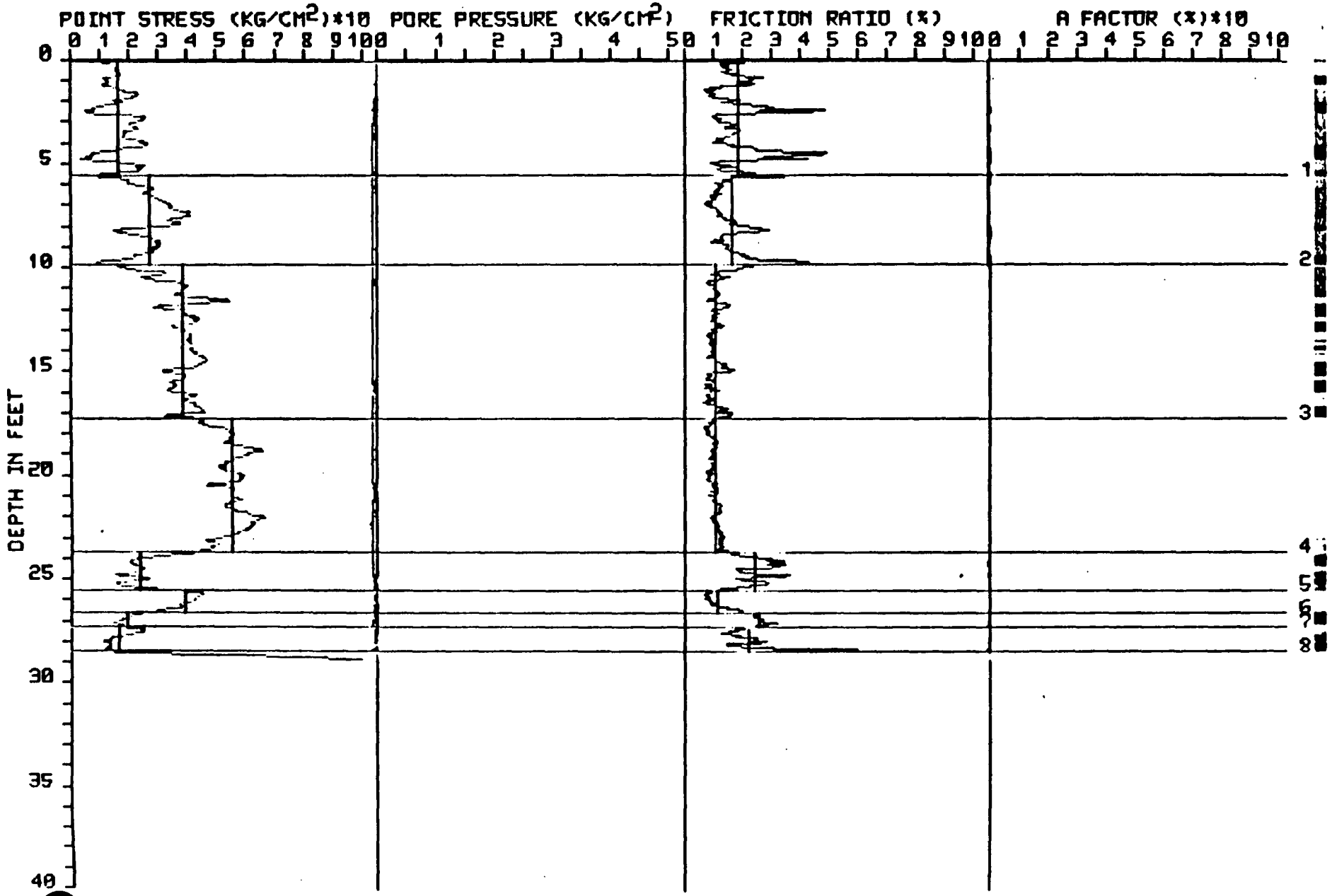
LOCATION ID: 034



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

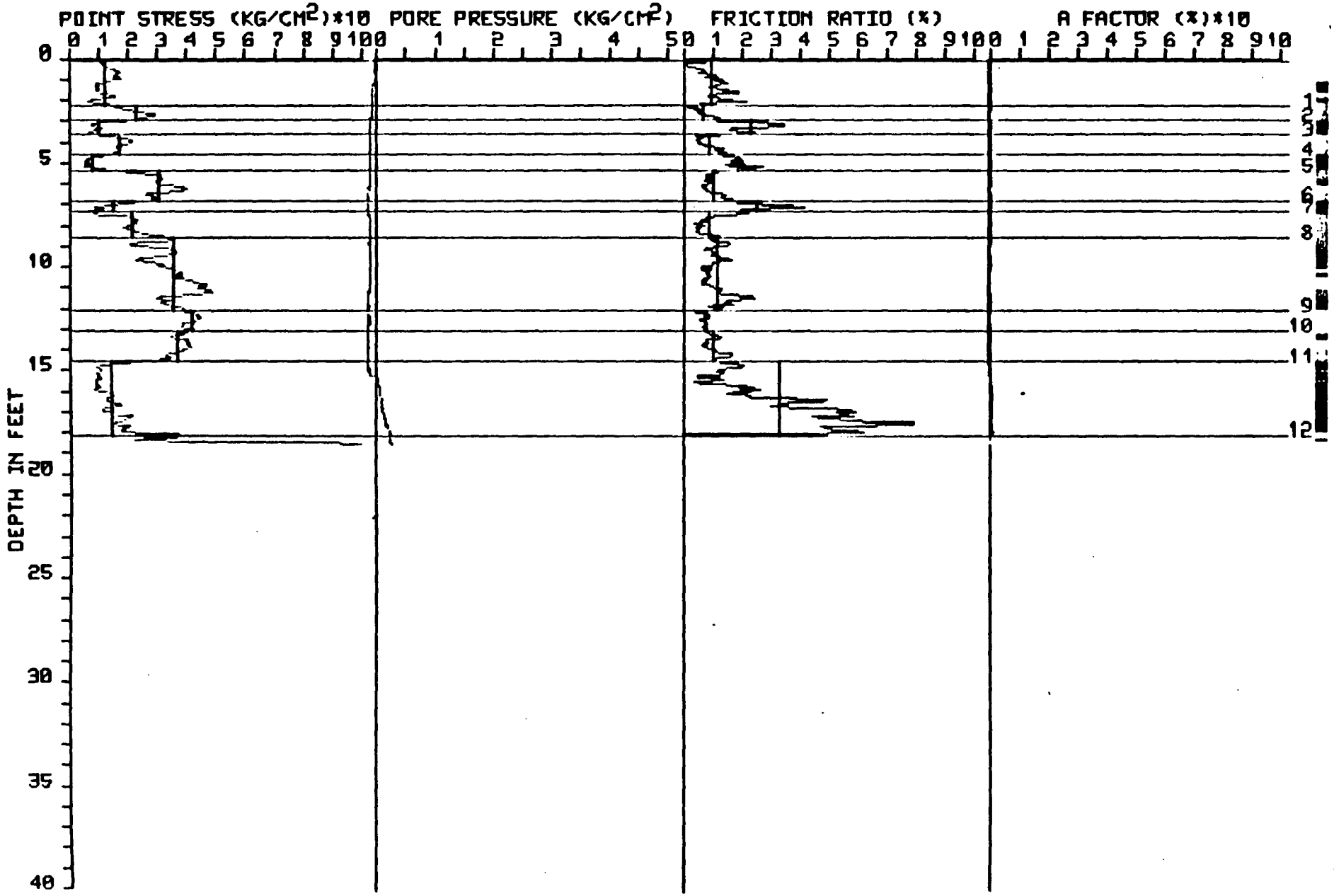
LOCATION ID: 035



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 036

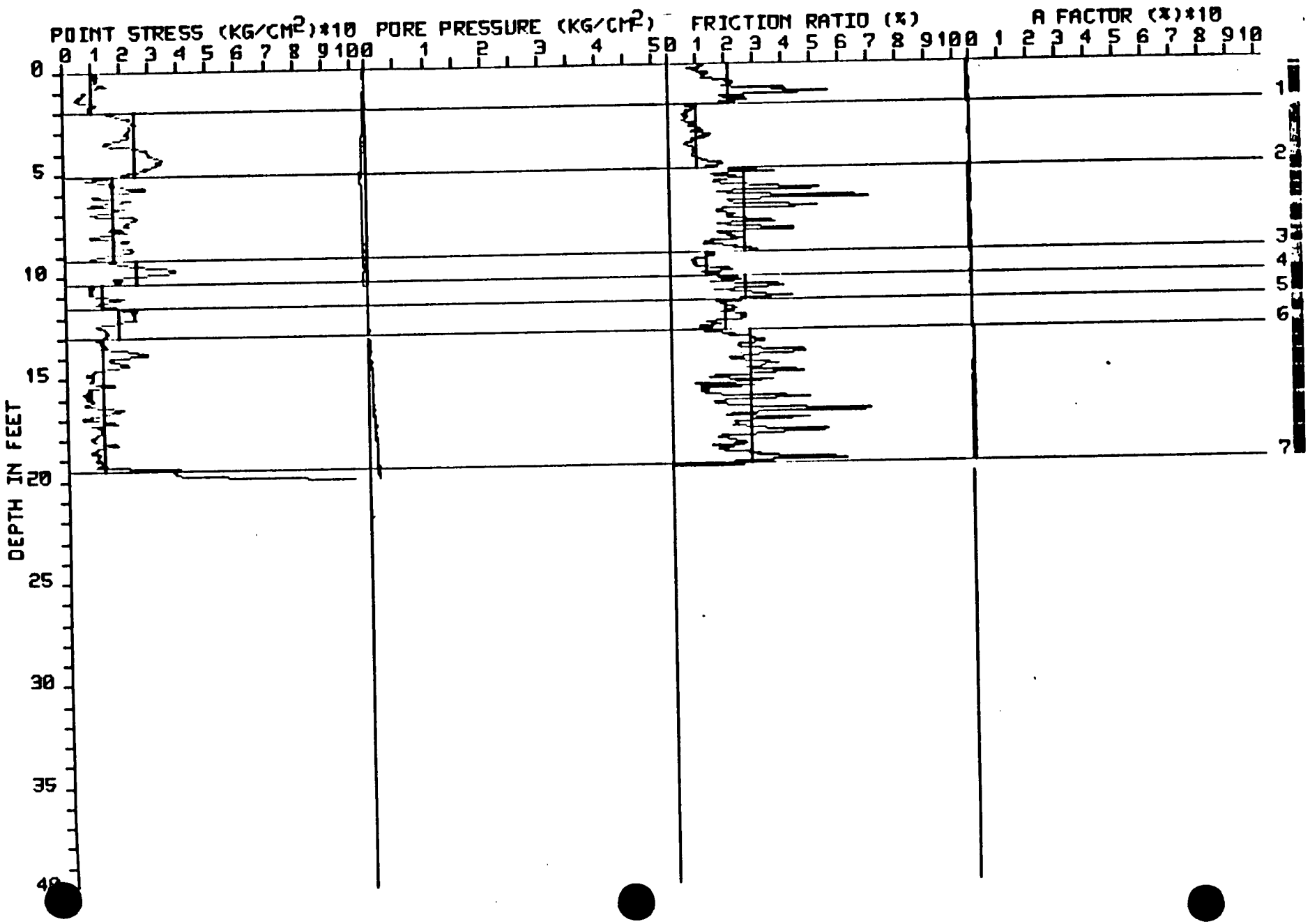


78

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

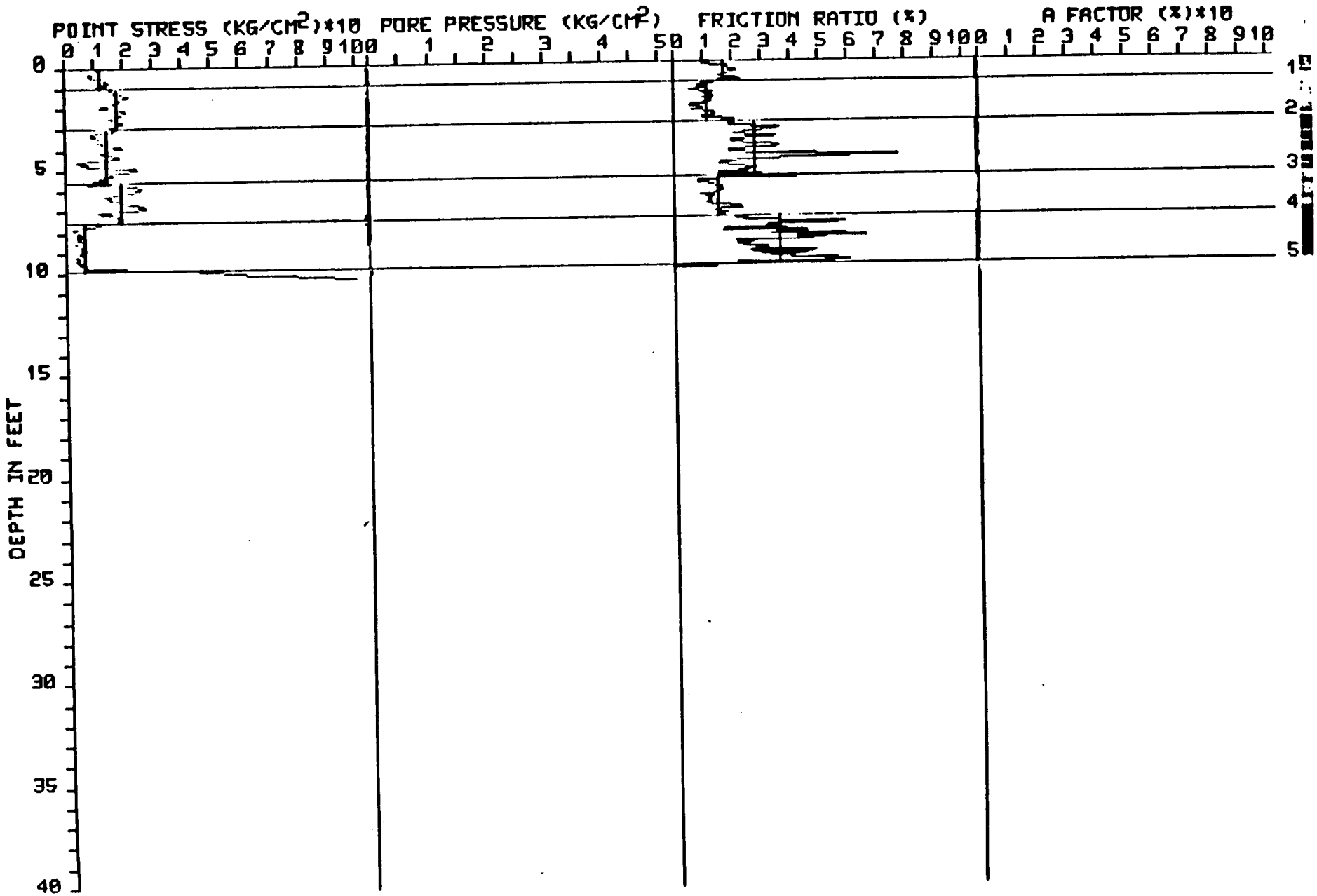
LOCATION ID: 037



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

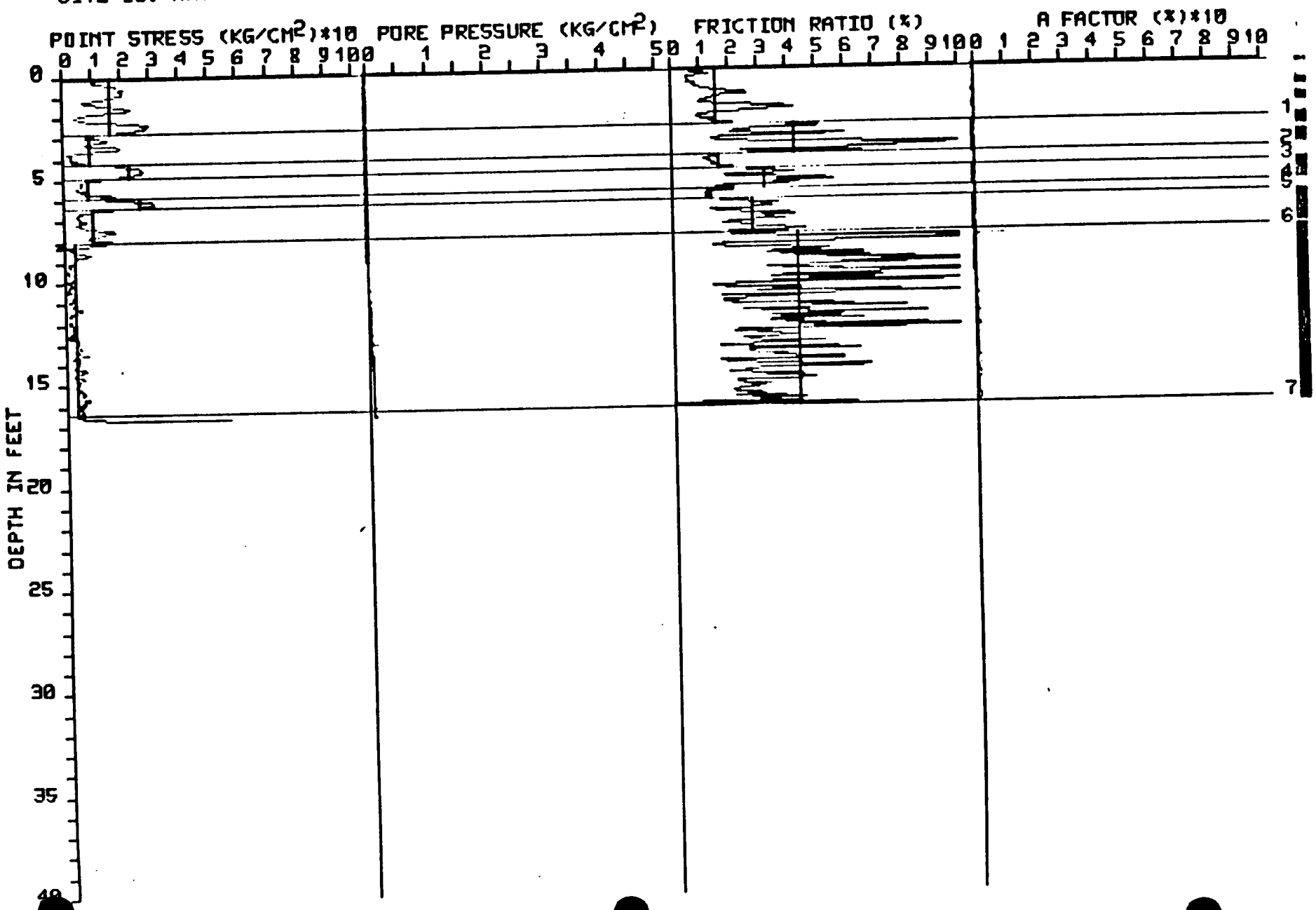
LOCATION ID: 038



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 039



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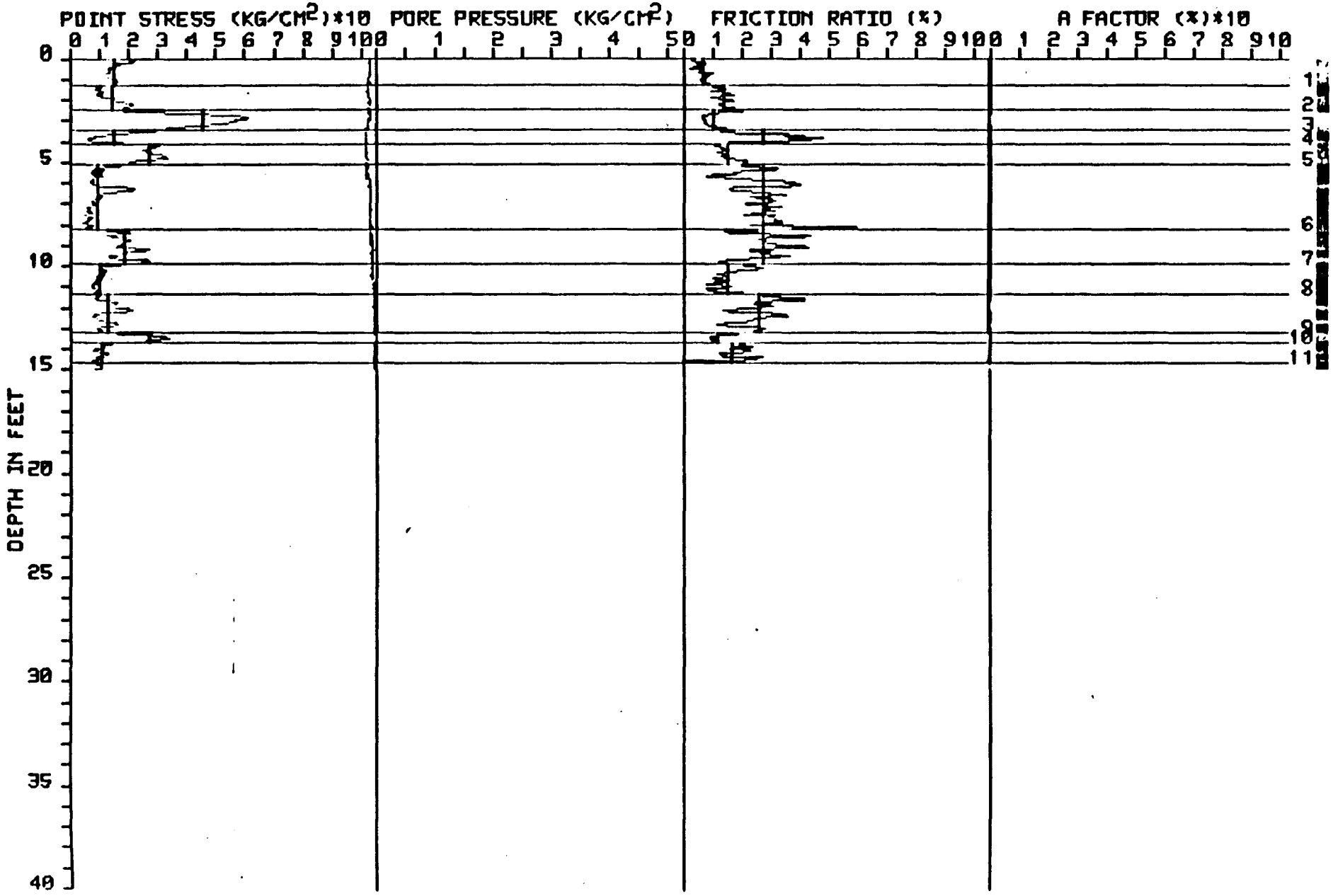
PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 040



SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 006
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	3.0	2.9	16.8	0.1	-0.0	0.5	S-SL*	5	40	30	59	2014	
2	3.0	5.1	2.1	6.5	0.2	-0.1	3.0	SLIM	4			23	778	6.5
3	5.1	9.1	4.0	21.0	0.2	-0.0	1.2	S-SL*	7	45	31	74	2520	
4	9.2	11.8	2.6	12.6	0.1	-0.0	1.1	S-SL*	4	27	29	44	1518	
5	11.8	19.2	7.3	7.1	0.2	0.5	3.1	SLIM	4			25	857	1.8
% THK:		50	9.5	17.4	0.1	0.0	1.0	S-SL	5	38	30	61	2091	
% THK:		49	9.4	7.0	0.2	0.4	3.1	SLIM	4			24	839	2.8

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 007
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	9.9	0.2	0.0	2.0	SLIM	6			34	1182	39.5
2	1.0	3.9	2.8	15.5	0.2	0.0	1.2	S-SL*	5	38	30	54	1864	
3	3.9	13.0	9.1	7.4	0.3	-0.0	4.2	SLIM	4			26	887	3.8
% THK:		21	2.8	15.5	0.2	0.0	1.2	S-SL	5	38	30	54	1863	
% THK:		78	10.1	7.6	0.3	0.0	4.0	SLIM	4			26	916	7.3

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 008
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	9.5	0.1	-0.0	1.4	SLIM	6			33	1144	32.2
2	1.3	3.9	2.6	22.4	0.2	-0.0	1.0	S-SL*	7	48	31	78	2690	
3	3.9	7.2	3.3	11.6	0.3	-0.0	2.8	SLIM	7			41	1393	7.8
4	7.3	16.3	9.1	5.1	0.2	-0.1	3.3	SLIM	3			18	608	2.0
% THK:		16	2.6	22.4	0.2	0.0	1.0	S-SL	7	48	31	78	2690	
% THK:		83	13.6	7.1	0.2	-0.1	3.0	SLIM	4			24	845	6.1

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 009
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	3.4	3.3	18.2	0.1	-0.0	0.7	S-SL*	6	42	30	64	2183	
2	3.4	4.8	1.4	9.9	0.3	0.0	2.8	SLIM	6			35	1194	8.8
3	4.9	6.0	1.2	33.2	0.2	0.1	0.7	S-SL*	11	60	33	116	3980	
4	6.1	6.5	0.4	12.9	0.3	0.1	2.1	SLIM	8			45	1553	7.8
% THK:		71	4.5	22.2	0.1	0.0	0.7	S-SL	7	46	31	77	2662	
% THK:		28	1.8	10.6	0.3	0.0	2.6	SLIM	6			37	1273	8.6

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 010
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.0	1.9	14.2	0.1	-0.1	0.5	S-SL*	4	35	29	50	1701	
2	2.0	3.6	1.6	7.0	0.1	-0.0	1.6	SLIM	4			25	842	9.0
% THK:		54	1.9	14.2	0.1	-0.1	0.5	S-SL	4	35	29	50	1701	
% THK:		45	1.6	7.0	0.1	0.0	1.6	SLIM	4			25	842	9.0

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SITE ID: HAT01 LOCATION ID: 011

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	36.1	0.6	0.0	1.7	S-SL*	12	63	33	126	4326	
2	0.8	2.5	1.6	56.8	0.5	0.0	0.8	SAND*	11	78	36	199		
3	2.5	9.8	7.3	26.2	0.2	0.2	0.7	S-SL*	8	52	32	92	3147	
4	9.9	10.8	0.9	15.8	0.2	3.0	1.5	S-SL	5	32	29	55	1891	
5	10.8	12.2	1.4	21.5	0.3	1.5	1.5	S-SL*	7	39	30	75	2583	
6	12.3	16.3	4.0	7.0	0.0	1.4	0.7	SLIM*	4			24	839	1.9
% THK:		10	1.6	56.8	0.5	0.0	0.8	SAND	11	78	36	199		
% THK:		64	10.3	25.3	0.2	0.6	0.9	S-SL	7	49	32	88	3040	
% THK:		25	4.0	7.0	0.0	1.4	0.7	SLIM	4			24	839	1.9

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 012
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	17.4	0.2	-0.0	1.4	S-SL*	5	41	30	61	2086	
2	0.8	1.5	0.7	53.2	0.5	0.1	0.9	SAND*	10	76	35	186		
3	1.5	2.7	1.2	28.7	0.3	0.0	1.1	S-SL*	9	56	32	101	3448	
4	2.7	3.6	0.9	37.3	0.3	0.1	0.7	SAND*	7	64	34	131		
5	3.7	6.8	3.1	21.9	0.2	0.1	1.0	S-SL*	7	47	31	77	2631	
6	6.8	7.4	0.7	9.5	0.2	0.2	1.9	SLIM	6			33	1138	5.6
7	7.5	8.2	0.7	18.4	0.2	0.2	0.9	S-SL*	6	42	30	64	2207	
8	8.2	8.9	0.7	32.1	0.3	0.2	0.8	S-SL*	10	57	33	112	3852	
9	8.9	11.1	2.1	19.7	0.2	0.3	1.2	S-SL*	6	39	30	69	2360	
10	11.1	12.0	0.9	7.1	0.1	0.6	1.9	SLIM	4			25	855	2.6
% THK:		13	1.6	44.3	0.4	0.1	0.8	SAND	8	69	34	155		
% THK:		72	8.5	22.5	0.2	0.1	1.1	S-SL	7	46	31	78	2700	
% THK:		13	1.6	8.2	0.1	0.4	1.9	SLIM	4			28	978	3.9

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 013
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	13.2	0.1	-0.1	0.9	S-SL*	4	33	29	46	1579	
2	1.0	1.7	0.7	9.7	0.2	-0.1	1.8	SLIM	6			34	1167	19.3
3	1.8	5.5	3.8	16.6	0.2	-0.0	1.3	S-SL*	5	39	30	58	1989	
4	5.6	10.1	4.5	31.2	0.2	-0.1	0.8	S-SL*	10	56	32	109	3740	
% THK:		93	9.3	23.3	0.2	-0.1	1.0	S-SL	7	46	31	81	2792	
% THK:		6	0.7	9.7	0.2	-0.1	1.8	SLIM	6			34	1167	19.3

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 014
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	1.1	0.9	17.6	0.3	-0.2	1.7	S-SL	5	41	30	61	2107	
2	1.1	2.0	0.9	7.1	0.2	-0.2	2.4	SLIM	4			25	858	14.0
3	2.1	5.1	3.1	14.0	0.3	-0.2	1.9	SLIM	9			49	1682	12.5
4	5.1	8.0	2.9	17.3	0.3	-0.2	1.6	S-SL	5	40	30	61	2078	
5	8.0	9.7	1.6	45.5	0.3	-0.2	0.7	SAND*	9	67	34	159		
% THK:		17	1.6	45.5	0.3	-0.2	0.7	SAND	9	67	34	159		
% THK:		40	3.8	17.4	0.3	-0.2	1.6	S-SL	4	40	30	60	2084	
% THK:		42	4.0	12.4	0.3	-0.2	2.0	SLIM	7			43	1496	12.8

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 015
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	2.4	2.2	7.1	0.2	0.0	2.9	SLIM	4			25	846	16.2
2	2.4	3.1	0.7	25.2	0.4	0.1	1.6	S-SL*	8	52	32	88	3021	
3	3.1	5.7	2.6	8.9	0.2	0.1	2.3	SLIM	5			31	1071	7.6
4	5.8	7.2	1.4	27.5	0.3	0.2	1.3	S-SL*	9	54	32	96	3294	
5	7.2	9.1	1.9	14.1	0.3	0.2	2.1	SLIM	9			49	1697	6.6
6	9.1	10.6	1.4	28.8	0.2	0.3	0.8	S-SL*	9	50	32	101	3456	
7	10.6	11.7	1.1	16.8	0.3	0.3	1.9	SLIM	11			59	2015	5.0
8	11.8	16.5	4.8	27.3	0.4	0.3	1.3	S-SL*	9	41	30	95	3270	
9	16.6	18.4	1.9	49.0	0.5	0.3	1.0	SAND*	9	54	32	172		
10	18.5	19.9	1.4	28.0	0.4	0.3	1.5	S-SL*	9	36	29	98	3355	
11	19.9	22.0	2.1	42.6	0.5	0.4	1.1	S-SL*	14	46	31	149	5109	
12	22.0	22.7	0.7	17.5	0.3	0.3	1.9	S-SL	5	23	28	61	2101	
13	22.8	25.1	2.4	16.9	0.2	0.4	0.9	S-SL*	5	21	28	59	2024	
% THK:		7	1.9	49.0	0.5	0.3	1.0	SAND	9	54	32	172		
% THK:		60	14.9	27.4	0.3	0.3	1.2	S-SL	8	39	30	95	3289	
% THK:		31	7.8	10.8	0.2	0.1	2.4	SLIM	6			37	1293	9.4

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 016
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	4.4	4.4	8.2	0.2	0.1	2.3	SLIM	5			29	988	12.1
2	4.4	5.1	0.7	22.4	0.3	0.3	1.4	S-SL*	7	48	31	79	2694	
3	5.1	7.3	2.1	10.8	0.3	0.2	2.4	SLIM	7			38	1292	6.8
4	7.3	9.2	1.9	28.0	0.4	0.8	1.5	S-SL*	9	53	32	98	3365	
5	9.2	10.6	1.4	17.2	0.4	0.8	2.2	SLIM	11			60	2066	6.0
6	10.6	15.6	5.0	29.2	0.4	0.7	1.3	S-SL*	9	45	31	102	3506	
7	15.6	16.1	0.5	14.6	0.5	0.6	3.2	SLIM	9			51	1756	2.9
% THK:		47	7.6	28.3	0.4	0.7	1.4	S-SL	8	47	31	98	3395	
% THK:		52	8.4	10.7	0.3	0.3	2.4	SLIM	6			37	1289	9.2

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 017
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	5.5	5.4	8.2	0.3	-0.0	3.1	SLIM	5			29	989	10.1
2	5.6	7.0	1.4	26.2	0.3	0.1	1.3	S-SL*	8	53	32	92	3139	
3	7.0	9.3	2.4	13.1	0.4	0.1	2.7	SLIM	8			46	1575	6.2
4	9.4	11.5	2.1	40.7	0.4	0.1	0.9	SAND*	8	60	33	143		
5	11.5	12.5	0.9	36.5	0.6	0.1	1.6	S-SL*	12	53	32	128	4376	
6	12.5	13.0	0.5	13.8	0.5	0.1	3.3	SLIM	9			48	1660	3.7
7	13.0	17.3	4.3	31.8	0.4	0.1	1.1	S-SL*	10	44	31	111	3812	
8	17.3	19.4	2.1	17.5	0.4	0.1	2.5	SLIM	11			61	2094	2.8
9	19.4	20.1	0.7	35.6	0.5	0.2	1.4	S-SL*	11	42	30	124	4268	
10	20.1	21.8	1.6	12.8	0.5	0.2	4.0	SLIM	8			45	1536	1.9
11	21.8	23.2	1.4	24.4	0.5	0.2	2.0	SLIM	16			85	2923	2.7
12	23.3	30.4	7.1	8.4	0.2	2.5	2.9	SLIM	5			29	1006	1.0
13	30.4	31.3	0.9	28.6	0.4	1.8	1.3	S-SL*	9	29	29	100	3426	
14	31.4	31.8	0.5	15.0	0.1	1.6	1.0	S-SL*	4	16	26	52	1797	
% THK:		6	2.1	40.7	0.4	0.1	0.9	SAND	8	60	33	143		
% THK:		27	8.7	30.4	0.4	0.4	1.2	S-SL	9	43	31	106	3643	
% THK:		65	20.5	11.4	0.3	0.9	2.9	SLIM	7			39	1367	4.4

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 018
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	3.6	3.6	13.4	0.1	-0.0	1.0	S-SL*	4	34	29	47	1609	
2	3.7	4.8	1.1	13.1	0.3	0.0	2.0	SLIM	8			46	1572	10.5
3	4.9	8.4	3.5	21.5	0.2	0.1	1.1	S-SL*	7	47	31	75	2584	
4	8.4	11.7	3.3	32.4	0.3	0.1	0.9	S-SL*	10	53	32	113	3890	
5	11.8	13.4	1.6	13.7	0.3	0.1	2.2	SLIM	9			48	1644	3.7
6	13.4	15.6	2.1	25.5	0.3	0.2	1.2	S-SL*	8	39	30	89	3056	
7	15.6	16.8	1.1	40.8	0.3	0.2	0.6	SAND*	8	50	32	143		
8	16.8	18.4	1.6	40.6	0.5	0.2	1.1	S-SL*	13	48	31	142	4867	
% THK:		6	1.1	40.8	0.3	0.2	0.6	SAND	8	50	32	143		
% THK:		78	14.1	24.7	0.2	0.1	1.0	S-SL	7	44	31	86	2970	
% THK:		15	2.7	13.5	0.3	0.1	2.1	SLIM	8			47	1614	6.5

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 019
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	0.8	0.7	13.4	0.1	-0.1	0.8	S-SL*	4	34	29	47	1613	
% THK:		100	0.7	13.4	0.1	-0.1	0.8	S-SL	4	34	29	46	1613	

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 020
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	1.0	1.0	15.2	0.1	-0.2	0.8	S-SL*	5	37	30	53	1827	
2	1.0	2.0	1.0	6.7	0.1	-0.1	1.8	SLIM	4			23	798	13.9
3	2.0	3.1	1.1	15.9	0.2	-0.1	1.4	S-SL*	5	38	30	56	1905	
4	3.2	6.5	3.3	10.1	0.2	-0.1	2.4	SLIM	6			35	1208	7.9
5	6.5	9.3	2.8	27.2	0.2	0.0	0.7	S-SL*	9	53	32	95	3265	
6	9.4	10.3	0.9	13.3	0.2	0.0	1.4	S-SL	4	29	29	47	1599	
7	10.3	11.3	1.0	31.7	0.2	0.0	0.6	S-SL*	10	51	32	111	3800	
% THK:		61	6.8	22.4	0.2	-0.0	0.9	S-SL	7	44	31	78	2691	
% THK:		38	4.3	9.3	0.2	-0.1	2.3	SLIM	5			32	1112	9.3

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 021
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	1.2	1.2	7.2	0.1	-0.2	2.0	SLIM	4			25	869	27.7
2	1.3	2.5	1.2	14.8	0.3	-0.1	1.7	S-SL	4	36	29	52	1777	
3	2.5	4.9	2.4	8.2	0.2	0.0	2.6	SLIM	5			29	978	8.2
4	4.9	8.2	3.3	26.4	0.3	0.1	1.1	S-SL*	8	53	32	92	3163	
5	8.2	9.2	0.9	51.8	0.4	0.2	0.8	SAND*	10	72	35	181		
6	9.2	9.9	0.7	15.4	0.3	0.2	2.1	SLIM	10			54	1847	5.8
7	9.9	10.6	0.7	26.5	0.3	0.2	1.2	S-SL*	8	47	31	93	3183	
8	10.6	12.3	1.6	38.8	0.4	0.2	1.0	S-SL*	12	56	32	136	4657	
9	12.3	13.0	0.7	19.0	0.6	0.2	3.0	SLIM	12			67	2283	4.7
10	13.0	16.6	3.5	28.9	0.4	0.3	1.6	S-SL*	9	42	30	101	3465	
11	16.6	18.2	1.6	40.6	0.5	0.4	1.1	S-SL*	13	48	31	142	4872	
12	18.3	19.2	0.9	19.6	0.5	0.3	2.5	SLIM	13			69	2352	2.9
% THK:		4	0.9	51.8	0.4	0.2	0.8	SAND	10	72	35	181		
% THK:		63	11.9	29.5	0.4	0.2	1.3	S-SL	9	47	31	103	3543	
% THK:		31	5.9	11.9	0.3	0.1	2.5	SLIM	7			41	1423	10.7

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 022
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.5	2.4	16.5	0.1	0.0	0.8	S-SL*	5	39	30	58	1986	
2	2.5	5.4	2.9	4.5	0.1	0.1	1.7	SLIM	2			16	538	5.0
3	5.4	7.5	2.1	20.0	0.2	0.3	1.0	S-SL*	6	45	31	70	2405	
4	7.5	8.4	0.9	8.9	0.2	0.5	1.8	SLIM	5			31	1064	4.8
5	8.5	11.8	3.3	26.9	0.2	0.5	0.6	S-SL*	8	47	31	94	3233	
6	11.8	13.2	1.4	43.6	0.2	0.6	0.6	SAND*	8	58	33	153		
7	13.3	15.1	1.9	27.9	0.2	0.5	0.7	S-SL*	9	42	30	98	3352	
8	15.2	16.1	0.9	45.0	0.2	0.5	0.5	SAND*	9	54	32	158		
9	16.1	17.2	1.1	30.2	0.3	0.6	1.0	S-SL*	10	41	30	106	3626	
10	17.3	18.7	1.4	44.7	0.4	0.7	0.8	SAND*	8	51	32	156		
% THK:		20	3.7	44.4	0.3	0.6	0.7	SAND	8	54	32	155		
% THK:		59	10.8	23.8	0.2	0.4	0.8	S-SL	7	43	31	83	2855	
% THK:		20	3.8	5.5	0.1	0.2	1.7	SLIM	2			19	662	5.0

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 023
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	7.2	7.2	6.4	0.2	0.3	3.1	SLIM	4			22	769	7.0
2	7.2	8.2	1.0	16.6	0.3	0.5	1.6	S-SL	5	39	30	58	1987	
3	8.2	14.1	5.8	6.6	0.2	0.7	2.5	SLIM	4			23	792	2.6
4	14.1	16.0	1.9	27.7	0.3	1.0	1.2	S-SL*	9	41	30	97	3330	
5	16.0	23.6	7.6	4.5	0.2	2.1	3.5	SLIM	2			16	537	0.9
% THK:		12	2.9	23.9	0.3	0.8	1.3	S-SL	7	40	30	83	2866	
% THK:		87	20.6	5.8	0.2	1.1	3.1	SLIM	3			20	689	3.5

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 024
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.2	2.1	11.3	0.2	0.0	1.6	SLIM	7			40	1359	24.8
2	2.3	24.7	22.4	4.5	0.2	0.5	4.3	SLIM	2			16	536	1.5
% THK:		100	24.5	5.1	0.2	0.5	4.1	SLIM	2			18	606	3.5

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 025
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	18.7	0.2	-0.2	1.1	S-SL*	6	43	30	65	2245	
2	1.3	3.0	1.6	7.7	0.2	-0.1	2.1	SLIM	5			27	922	11.8
3	3.0	4.1	1.1	20.4	0.3	-0.1	1.6	S-SL*	6	45	31	72	2454	
4	4.2	5.3	1.2	13.9	0.4	-0.1	2.8	SLIM	9			49	1666	10.1
5	5.4	6.8	1.4	9.5	0.1	-0.1	1.4	SLIM	6			33	1137	6.3
6	6.8	10.6	3.8	8.9	0.3	-0.0	3.0	SLIM	5			31	1069	4.3
7	10.6	12.0	1.4	13.8	0.2	0.0	1.6	SLIM	9			48	1652	4.3
8	12.1	15.1	3.1	10.2	0.2	0.1	2.3	SLIM	6			36	1223	2.7
% THK:		15	2.3	19.5	0.2	-0.2	1.3	S-SL	5	43	31	68	2344	
% THK:		84	12.5	10.2	0.2	-0.0	2.4	SLIM	6			35	1218	5.6

(03)

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 026
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	5.1	5.0	14.2	0.1	-0.0	0.9	S-SL*	4	35	29	50	1703	
2	5.1	6.1	0.9	8.2	0.2	0.0	2.3	SLIM	5			29	989	6.1
3	6.1	9.0	2.9	22.9	0.3	0.2	1.1	S-SL*	7	48	31	80	2753	
4	9.0	9.7	0.7	13.2	0.2	0.2	1.6	SLIM	8			46	1588	5.3
% THK:		83	7.9	17.4	0.2	0.1	1.0	S-SL	5	39	30	61	2088	
% THK:		16	1.6	10.4	0.2	0.1	2.0	SLIM	6			36	1251	5.8

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 027
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.8	1.7	12.8	0.2	-0.1	1.3	S-SL	4	33	29	45	1533	
2	1.8	6.5	4.7	7.1	0.2	0.0	2.8	SLIM	4			25	856	6.8
3	6.6	9.4	2.9	21.5	0.4	-0.0	1.8	S-SL	7	46	31	75	2579	
4	9.4	13.2	3.8	22.3	0.3	-0.0	1.3	S-SL*	7	40	30	78	2680	
5	13.2	13.9	0.7	8.4	0.0	-0.0	0.5	SLIM*	5			29	1007	2.3
6	14.0	16.1	2.1	30.8	0.4	0.0	1.2	S-SL*	10	43	31	108	3700	
7	16.1	16.8	0.7	14.0	0.5	0.2	3.6	SLIM	9			49	1680	2.7
8	16.8	17.3	0.5	26.3	0.5	0.3	1.8	S-SL	8	37	29	92	3162	
% THK:		64	11.0	22.4	0.3	-0.0	1.4	S-SL	7	40	31	78	2692	
% THK:		35	6.1	8.0	0.2	0.0	2.6	SLIM	4			28	967	5.8

105

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 028
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	3.0	2.9	13.4	0.1	-0.2	0.6	S-SL*	4	34	29	47	1609	
2	3.0	3.7	0.7	8.8	0.1	-0.2	1.0	SLIM*	5			31	1052	9.4
3	3.7	5.6	1.9	17.6	0.1	-0.2	0.5	S-SL*	5	41	30	62	2115	
4	5.6	10.6	5.0	4.9	0.0	-0.1	0.2	SLIM*	3			17	593	3.0
% THK:		45	4.8	15.1	0.1	-0.2	0.6	S-SL	4	36	30	52	1809	
% THK:		54	5.7	5.4	0.0	-0.1	0.3	SLIM	3			18	649	3.8

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 029
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	7.0	6.9	11.2	0.3	-0.1	2.6	SLIM	7			39	1342	10.7
2	7.1	10.1	3.1	3.2	0.3	0.3	8.2	SLIM	2			11	383	2.0
% THK:		100	10.0	8.7	0.3	0.0	4.3	SLIM	5			30	1044	8.0

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 030
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	11.1	0.2	-0.1	1.4	SLIM	7			39	1329	41.3
2	1.1	6.5	5.4	6.1	0.1	-0.0	2.1	SLIM	4			21	734	6.5
3	6.6	8.5	1.9	18.6	0.3	-0.0	1.7	S-SL	6	42	30	65	2229	
4	8.5	12.8	4.3	6.9	0.2	0.2	2.9	SLIM	4			24	828	2.8
% THK:		15	1.9	18.6	0.3	0.0	1.7	S-SL	6	42	30	65	2229	
% THK:		84	10.7	6.9	0.1	0.1	2.4	SLIM	4			23	827	8.3

108

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 031
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.5	2.4	6.5	0.2	0.0	3.1	SLIM	4			23	775	15.2
2	2.5	4.1	1.6	18.9	0.3	-0.0	1.7	S-SL	6	43	30	66	2269	
3	4.2	7.2	3.1	5.8	0.2	0.0	3.9	SLIM	3			20	701	4.6
4	7.3	8.5	1.2	18.8	0.4	0.1	2.0	SLIM	12			66	2252	8.5
5	8.5	11.5	3.1	8.6	0.2	0.1	2.9	SLIM	5			30	1033	3.6
6	11.6	12.8	1.2	15.1	0.3	0.2	1.9	SLIM	10			53	1811	4.2
7	12.8	13.9	1.1	6.7	0.3	0.2	3.8	SLIM	4			23	799	2.0
8	14.0	14.7	0.7	16.3	0.4	0.4	2.7	SLIM	10			57	1953	3.6
9	14.7	15.8	1.1	12.2	0.4	0.4	3.6	SLIM	8			43	1469	2.7
10	15.9	17.5	1.6	32.7	0.7	0.4	2.3	S-SL	10	43	30	115	3926	
11	17.5	19.9	2.4	16.0	0.5	0.4	2.8	SLIM	10			56	1924	2.5
12	19.9	21.6	1.6	9.2	0.2	0.5	1.8	SLIM	6			32	1107	1.5
13	21.6	25.4	3.8	11.3	0.4	0.8	3.6	SLIM	7			39	1354	1.5
14	25.4	26.8	1.4	12.1	0.3	1.4	2.8	SLIM	8			42	1451	1.3
15	26.9	27.8	0.9	15.5	0.3	1.7	1.8	S-SL	5	18	27	54	1856	
16	27.8	28.7	0.9	9.1	0.3	2.0	2.9	SLIM	6			32	1094	1.0
17	28.8	30.4	1.6	16.5	0.4	1.4	2.6	SLIM	10			58	1978	1.4
18	30.4	32.1	1.6	10.7	0.1	0.8	1.3	SLIM	7			37	1282	1.0
% THK:		13	4.1	23.5	0.5	0.5	2.0	S-SL	7	37	30	82	2824	
% THK:		86	27.2	10.9	0.3	0.5	2.9	SLIM	6			38	1313	3.9

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 032
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	2.1	1.9	8.6	0.3	0.0	3.4	SLIM	5			30	1031	20.4
2	2.1	3.5	1.4	16.0	0.3	0.0	2.0	SLIM	10			56	1918	16.5
3	3.6	6.9	3.3	10.2	0.4	-0.0	3.5	SLIM	6			36	1224	7.5
4	6.9	12.1	5.2	23.1	0.4	0.0	1.8	S-SL	7	44	31	81	2771	
5	12.2	14.5	2.4	22.1	0.6	0.0	2.7	SLIM	14			77	2647	4.9
6	14.6	16.4	1.9	14.4	0.3	0.2	2.2	SLIM	9			50	1725	3.0
7	16.5	23.1	6.7	36.6	0.7	0.2	2.0	S-SL*	12	43	30	128	4394	
8	23.2	25.0	1.9	60.3	0.9	0.2	1.5	SAND*	12	54	32	211		
9	25.1	30.3	5.2	22.1	0.6	0.2	2.6	SLIM	14			77	2654	2.0
10	30.3	40.3	10.0	11.9	0.3	0.8	2.1	SLIM	7			42	1427	0.9
% THK:		4	1.9	60.3	0.9	0.2	1.5	SAND	12	54	32	211		
% THK:		29	11.9	30.7	0.6	0.1	1.9	S-SL	9	43	31	107	3684	
% THK:		65	26.1	14.8	0.4	0.4	2.5	SLIM	9			51	1777	4.7

011

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 033
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.1	1.0	10.5	0.2	-0.0	1.9	SLIM	7			37	1262	38.9
2	1.1	2.0	0.9	13.3	0.2	-0.1	1.3	S-SL	4	34	29	47	1601	
3	2.1	4.2	2.1	19.1	0.3	-0.1	1.5	S-SL*	6	43	31	67	2296	
4	4.2	6.1	1.9	10.4	0.3	-0.1	2.4	SLIM	6			36	1245	7.7
5	6.1	11.1	5.0	25.9	0.3	-0.1	1.3	S-SL*	8	49	31	91	3105	
6	11.2	12.1	1.0	48.7	0.5	-0.1	1.1	SAND*	9	63	33	171		
7	12.1	12.6	0.5	41.2	0.7	-0.1	1.8	S-SL*	13	56	32	144	4944	
8	12.6	15.0	2.4	19.0	0.5	-0.1	2.6	SLIM	12			67	2283	4.2
9	15.0	17.6	2.6	37.8	0.5	-0.0	1.4	S-SL*	12	48	31	132	4536	
10	17.6	19.3	1.6	56.9	0.6	-0.1	1.1	SAND*	11	58	33	199		
11	19.3	21.4	2.1	44.9	0.7	-0.0	1.6	S-SL*	14	48	31	157	5385	
12	21.5	25.3	3.8	20.6	0.5	-0.0	2.6	SLIM	13			72	2469	2.3
13	25.3	26.2	0.9	46.0	0.7	0.1	1.5	S-SL*	15	44	31	161	5519	
14	26.2	27.9	1.6	22.6	0.5	0.0	2.2	S-SL	7	25	28	79	2714	
% THK:		9	2.6	53.7	0.6	-0.1	1.1	SAND	10	59	33	188		
% THK:		57	15.7	30.1	0.4	-0.0	1.5	S-SL	9	44	31	105	3609	
% THK:		33	9.1	16.9	0.4	-0.0	2.5	SLIM	10			59	2031	8.0

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 034
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.6	0.5	11.2	0.3	-0.0	2.6	SLIM	7			39	1343	63.1
2	0.6	5.8	5.2	19.9	0.3	-0.0	1.4	S-SL*	6	44	31	69	2383	
3	5.9	7.1	1.2	16.4	0.4	-0.1	2.5	SLIM	10			57	1969	9.1
4	7.1	9.4	2.4	26.3	0.3	-0.1	1.2	S-SL*	8	51	32	92	3161	
5	9.5	10.7	1.2	36.5	0.3	-0.1	0.9	S-SL*	12	57	33	128	4385	
6	10.8	12.9	2.1	34.4	0.4	-0.1	1.0	S-SL*	11	52	32	121	4133	
7	12.9	15.3	2.3	42.9	0.4	-0.1	1.0	SAND*	8	55	32	150		
8	15.3	15.5	0.2	40.1	0.3	-0.1	0.8	SAND*	8	51	32	141		
9	15.5	22.9	7.3	52.8	0.5	-0.1	1.0	SAND*	10	55	32	185		
10	22.9	24.1	1.2	22.3	0.7	-0.1	3.3	SLIM	14			78	2679	2.4
11	24.1	25.6	1.4	60.0	0.7	-0.0	1.2	SAND*	11	53	32	210		
% THK:		44	11.2	51.4	0.5	-0.1	1.0	SAND	9	54	32	180		
% THK:		43	10.9	25.9	0.3	-0.1	1.2	S-SL	8	48	32	90	3111	
% THK:		11	2.9	17.9	0.5	-0.1	2.8	SLIM	11			62	2154	15.6

211

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 035
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	5.6	5.5	16.5	0.3	-0.1	1.7	S-SL	5	39	30	58	1985	
2	5.6	9.9	4.3	27.0	0.4	-0.1	1.5	S-SL*	8	52	32	94	3237	
3	9.9	17.3	7.4	38.6	0.4	-0.1	1.1	S-SL*	12	52	32	135	4628	
4	17.4	23.7	6.4	55.4	0.6	-0.1	1.1	SAND*	11	55	32	194		
5	23.8	25.6	1.8	23.2	0.6	-0.1	2.4	S-SL	7	27	29	81	2778	
6	25.6	26.6	1.0	39.1	0.4	-0.0	1.1	S-SL*	13	39	30	137	4693	
7	26.7	27.4	0.7	18.9	0.5	-0.1	2.6	SLIM	12			66	2263	1.8
8	27.4	28.5	1.1	16.4	0.3	-0.0	2.1	SLIM	10			57	1971	1.6
% THK:		22	6.4	55.4	0.6	-0.1	1.1	SAND	11	55	32	194		
% THK:		70	20.0	28.7	0.4	-0.1	1.5	S-SL	8	45	31	100	3438	
% THK:		6	1.8	17.4	0.4	-0.0	2.3	SLIM	10			60	2084	1.7

113

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 036
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.3	2.1	12.3	0.1	-0.1	0.8	S-SL*	4	32	29	43	1477	
2	2.3	3.0	0.7	22.6	0.2	-0.1	0.7	S-SL*	7	48	31	79	2709	
3	3.0	3.7	0.7	10.1	0.2	-0.1	2.1	SLIM	6			35	1211	10.3
4	3.7	4.7	0.9	17.2	0.1	-0.1	0.8	S-SL*	5	40	30	60	2064	
5	4.7	5.4	0.7	7.4	0.1	-0.1	1.9	SLIM	4			26	887	6.1
6	5.4	6.8	1.4	30.7	0.3	-0.1	1.0	S-SL*	10	58	33	107	3685	
7	6.9	7.4	0.6	14.8	0.3	-0.2	2.3	SLIM	9			52	1773	7.8
8	7.4	8.6	1.2	21.7	0.2	-0.1	0.8	S-SL*	7	46	31	76	2598	
9	8.7	12.2	3.5	35.3	0.4	-0.1	1.1	S-SL*	11	55	32	124	4241	
10	12.2	13.1	0.9	41.7	0.3	-0.1	0.7	SAND*	8	56	32	146		
11	13.2	14.6	1.4	37.2	0.4	-0.2	1.0	S-SL*	12	51	32	130	4459	
12	14.6	18.1	3.5	14.2	0.5	0.1	3.5	SLIM	9			50	1705	2.7
% THK:		5	0.9	41.7	0.3	-0.1	0.7	SAND	8	56	32	146		
% THK:		63	11.2	26.9	0.3	-0.1	0.9	S-SL	8	47	31	94	3233	
% THK:		31	5.5	12.9	0.4	0.0	3.0	SLIM	7			45	1545	4.7

SITE ID: HAT01 LOCATION ID: 037

GROUND WATER DEPTH: 50.0 (FT.) AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.0	1.9	9.9	0.2	-0.0	1.9	SLIM	6			35	1183	24.1
2	2.0	5.1	3.1	24.5	0.2	-0.1	1.0	S-SL*	8	51	32	86	2940	
3	5.1	9.2	4.0	17.3	0.4	-0.1	2.4	SLIM	11			60	2073	8.6
4	9.2	10.4	1.1	24.5	0.3	-0.1	1.2	S-SL*	8	45	31	86	2946	
5	10.4	11.6	1.2	12.7	0.3	-0.0	2.6	SLIM	8			44	1519	4.2
6	11.6	13.0	1.4	18.1	0.4	-0.0	2.0	S-SL	6	33	29	63	2177	
7	13.0	19.6	6.6	13.0	0.4	0.1	2.7	SLIM	8			46	1565	2.6
% THK:		29	5.6	22.9	0.3	-0.1	1.3	S-SL	7	45	31	80	2750	
% THK:		70	13.7	13.8	0.4	0.0	2.5	SLIM	8			48	1656	7.5

S1

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 038
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.0	1.0	11.9	0.2	-0.0	1.7	SLIM	7			42	1430	43.6
2	1.1	3.0	1.9	17.7	0.2	-0.0	1.2	S-SL*	5	41	30	62	2120	
3	3.1	5.6	2.6	13.8	0.4	-0.1	2.5	SLIM	9			48	1659	10.8
4	5.7	7.6	1.9	19.2	0.3	-0.1	1.5	S-SL*	6	43	31	67	2302	
5	7.6	9.9	2.3	6.2	0.2	-0.0	3.2	SLIM	4			22	744	3.2
% THK:		39	3.8	18.5	0.2	-0.1	1.4	S-SL	5	42	31	64	2211	
% THK:		60	5.9	10.5	0.3	-0.0	2.6	SLIM	6			36	1263	13.4

911

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 039
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	2.8	2.6	16.4	0.2	-0.0	1.3	S-SL*	5	39	30	57	1967	
2	2.8	4.2	1.4	9.2	0.3	-0.1	3.1	SLIM	6			32	1103	9.3
3	4.3	5.0	0.7	22.7	0.4	-0.1	1.6	S-SL*	7	48	31	79	2725	
4	5.0	5.9	0.9	8.5	0.2	-0.1	2.9	SLIM	5			30	1015	6.3
5	5.9	6.4	0.4	26.1	0.4	-0.0	1.4	S-SL*	8	53	32	92	3138	
6	6.4	8.0	1.6	9.9	0.3	-0.1	2.6	SLIM	6			35	1183	5.7
7	8.1	16.4	8.3	3.7	0.1	0.0	3.5	SLIM	2			13	442	1.5
% THK:		23	3.7	18.6	0.3	-0.0	1.4	S-SL	5	42	31	64	2236	
% THK:		76	12.2	5.5	0.2	-0.0	3.3	SLIM	3			19	657	3.3

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 040
AVERAGE SOIL WEIGHT: 100.0 (PSF)

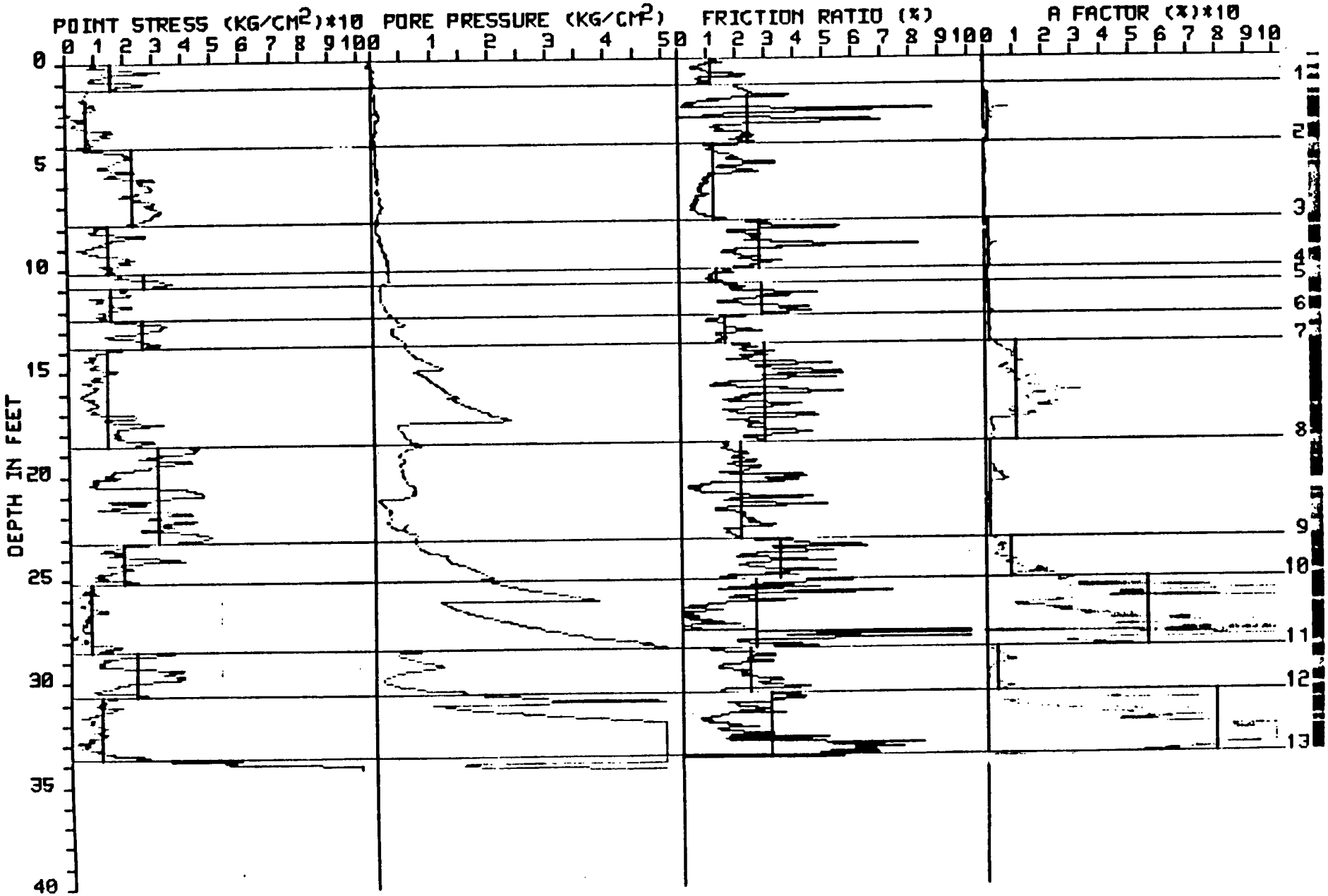
LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	15.0	0.1	-0.1	0.6	S-SL*	4	37	29	52	1797	
2	1.3	2.5	1.1	14.1	0.2	-0.2	1.4	S-SL	4	35	29	49	1689	
3	2.5	3.4	0.9	45.4	0.4	-0.2	0.9	SAND*	9	71	35	159		
4	3.5	4.2	0.7	15.1	0.3	-0.2	2.2	SLIM	10			53	1816	12.7
5	4.2	5.1	0.9	27.2	0.4	-0.2	1.5	S-SL*	9	54	32	95	3264	
6	5.1	8.2	3.1	9.1	0.2	-0.1	2.6	SLIM	6			32	1093	5.7
7	8.3	9.9	1.6	18.8	0.5	-0.1	2.6	SLIM	12			66	2252	7.1
8	9.9	11.3	1.4	10.1	0.2	-0.1	1.6	SLIM	6			35	1217	3.7
9	11.3	13.3	1.9	12.6	0.3	-0.1	2.4	SLIM	8			44	1507	3.6
10	13.3	13.7	0.4	27.2	0.3	-0.0	1.1	S-SL*	9	42	30	95	3261	
11	13.7	14.7	0.9	10.5	0.2	-0.0	1.7	SLIM	6			37	1260	2.6
% THK:		6	0.9	45.4	0.4	-0.2	0.9	SAND	9	71	35	159		
% THK:		25	3.6	19.1	0.2	-0.1	1.1	S-SL	5	41	30	66	2293	
% THK:		68	9.6	12.1	0.3	-0.1	2.3	SLIM	7			42	1454	5.4

811

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 001

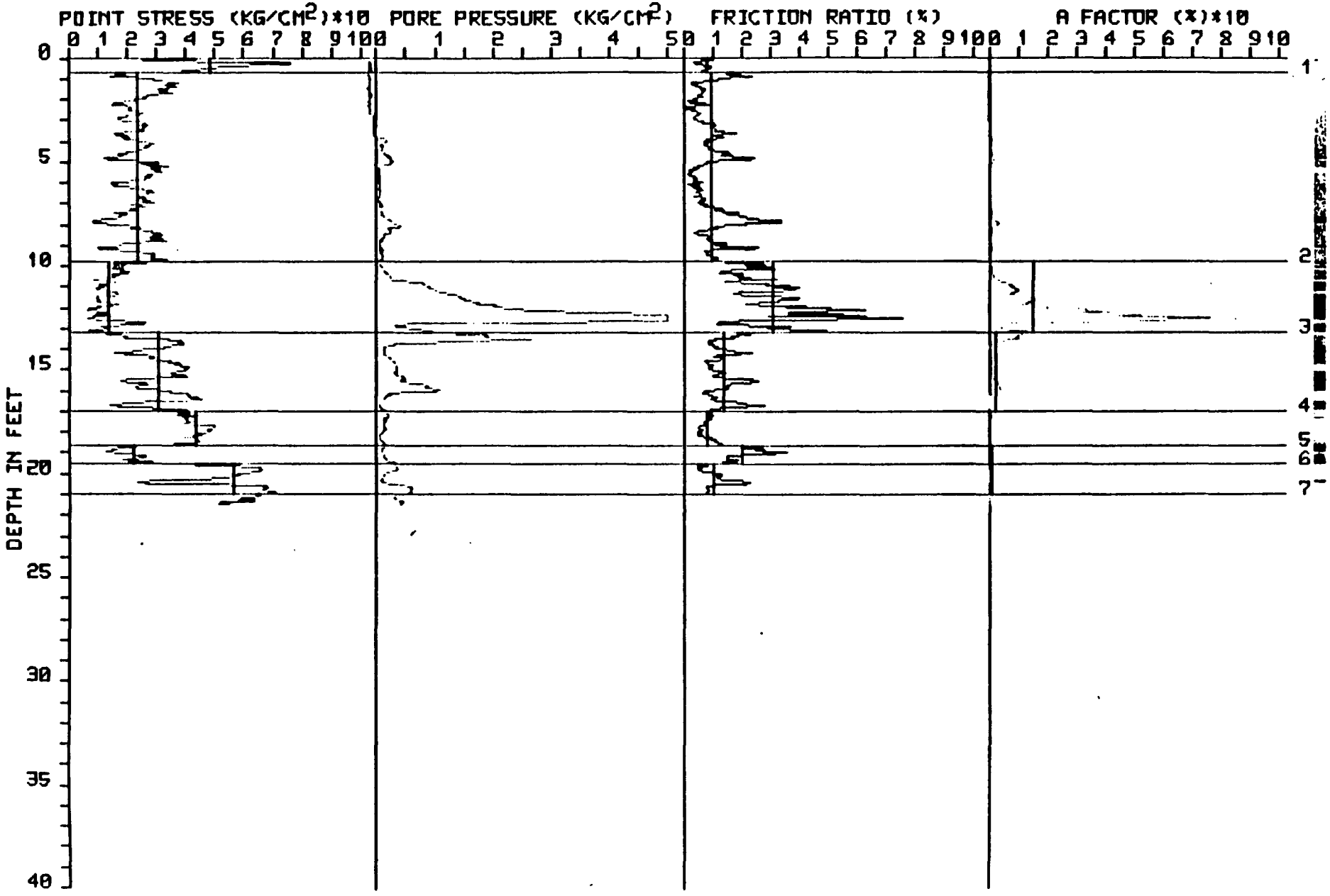


611

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 002

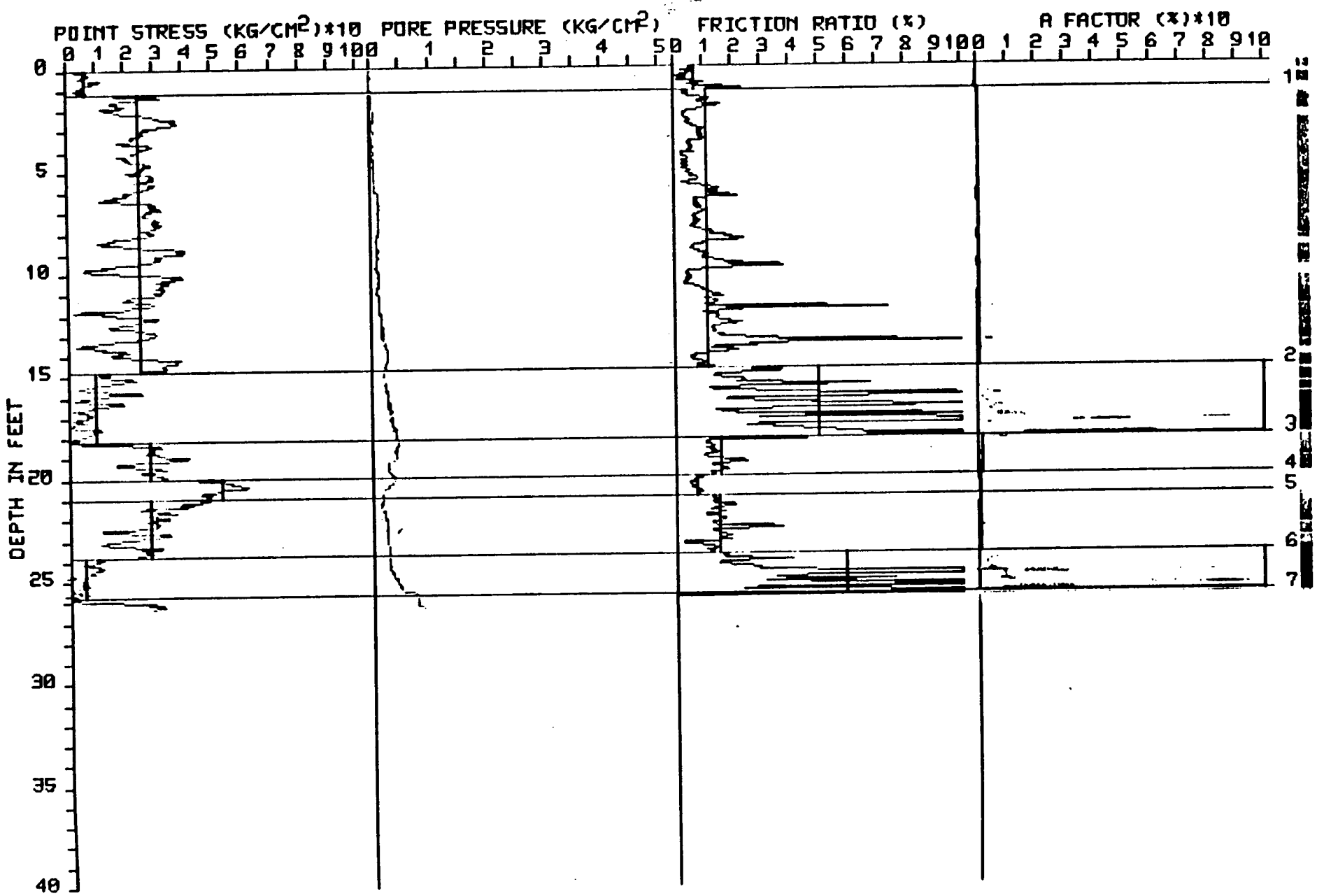


120

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 003

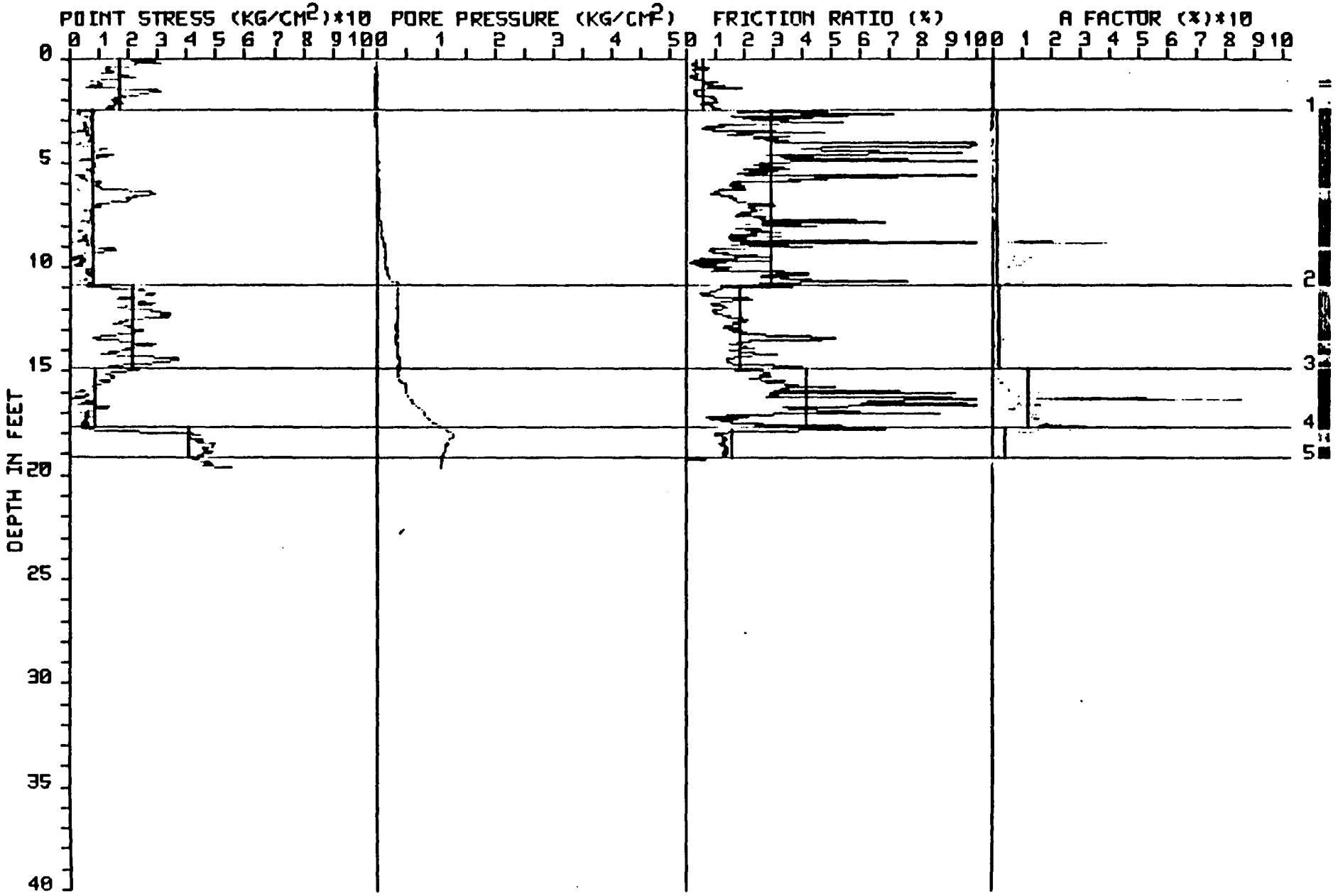


121

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 004

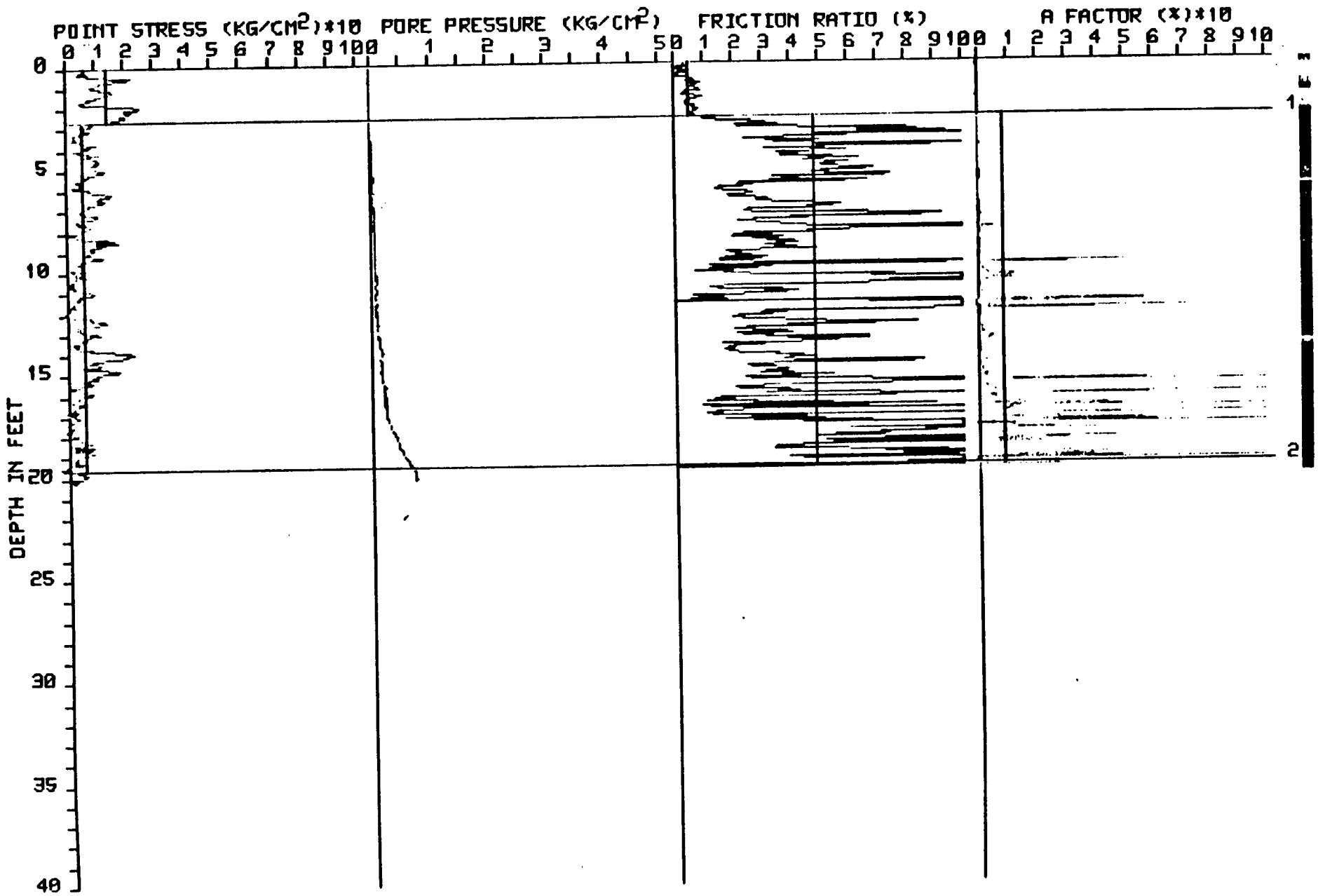


121

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 005

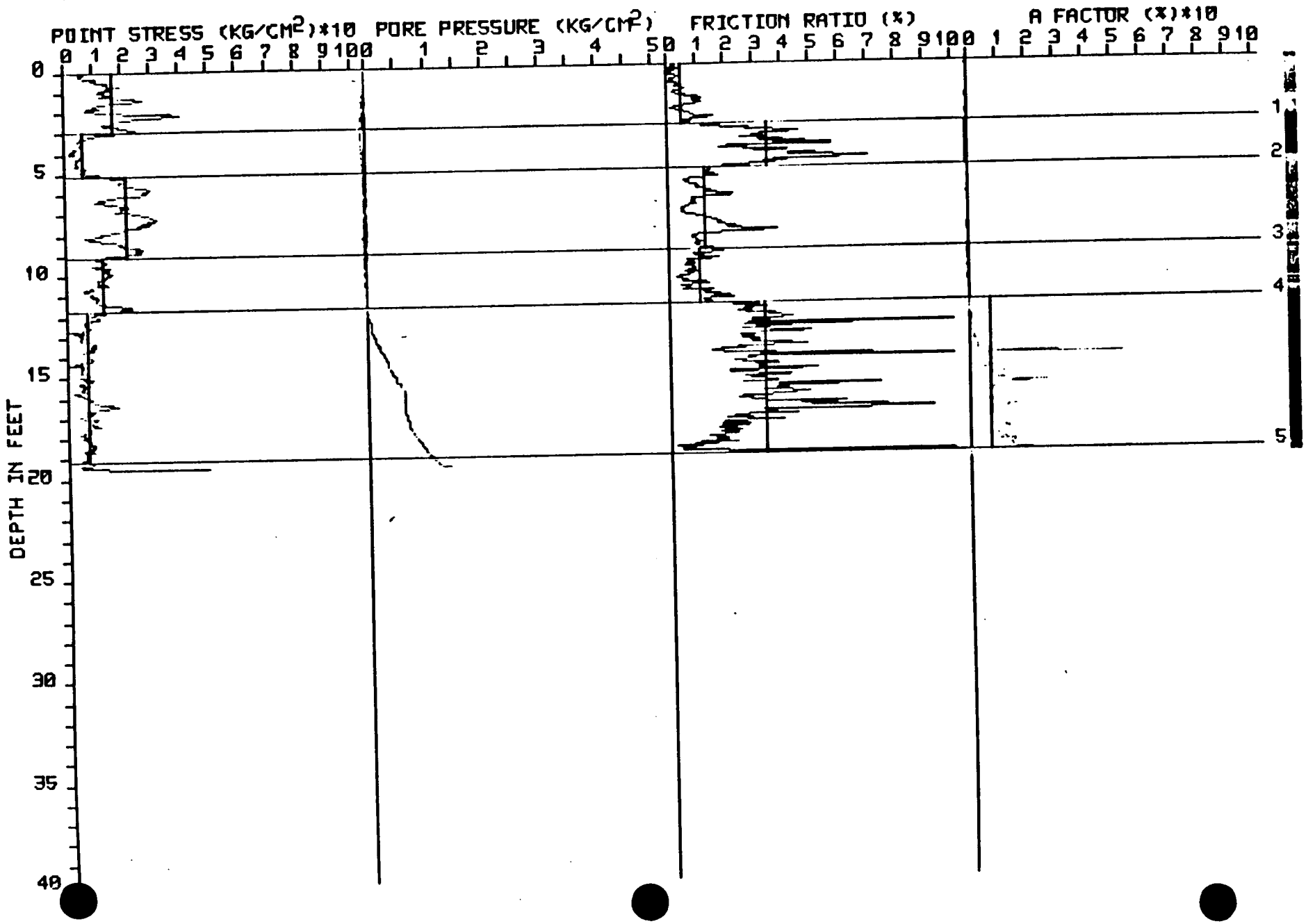


123

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 006

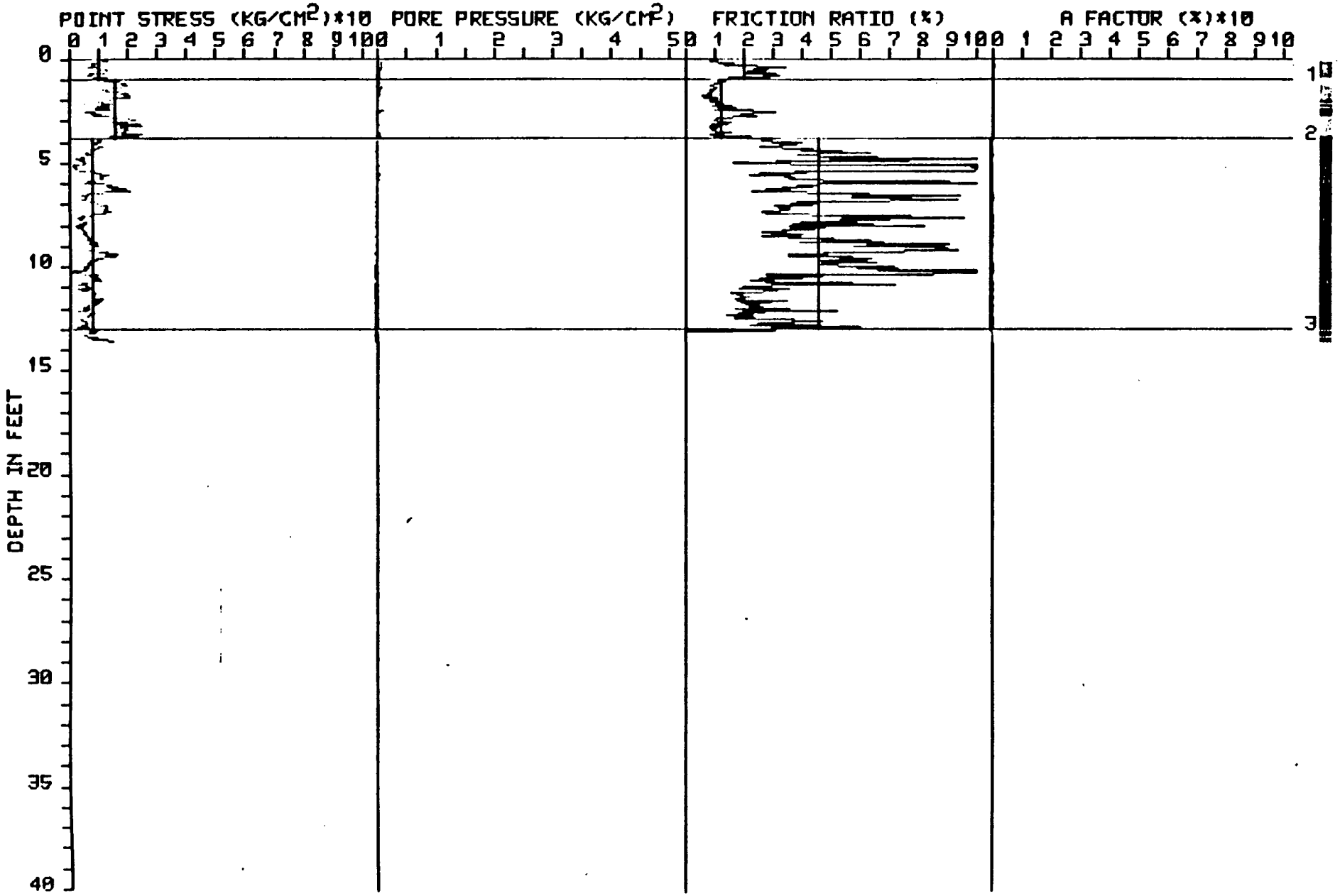


124

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 007

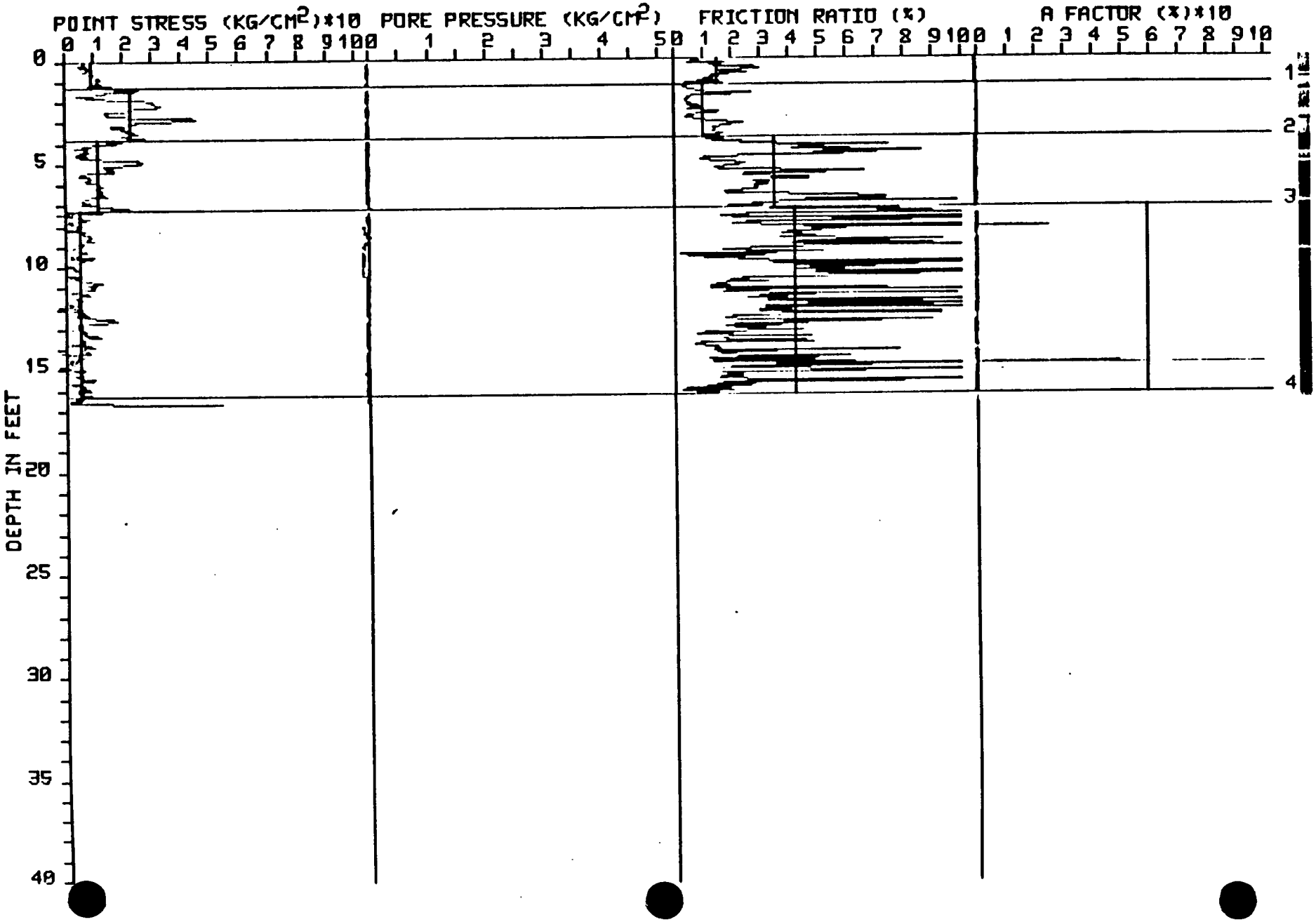


105

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

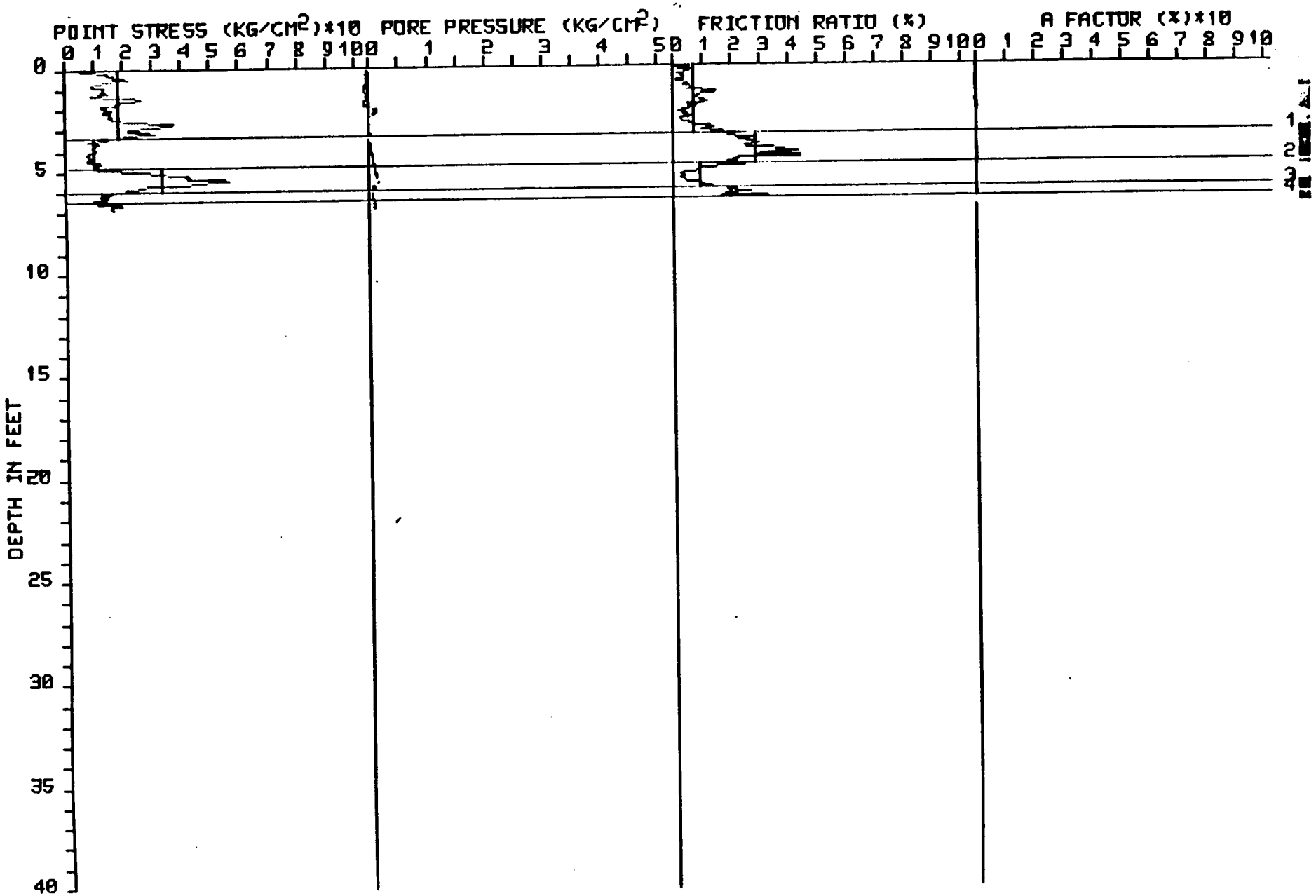
LOCATION ID: 008



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 009

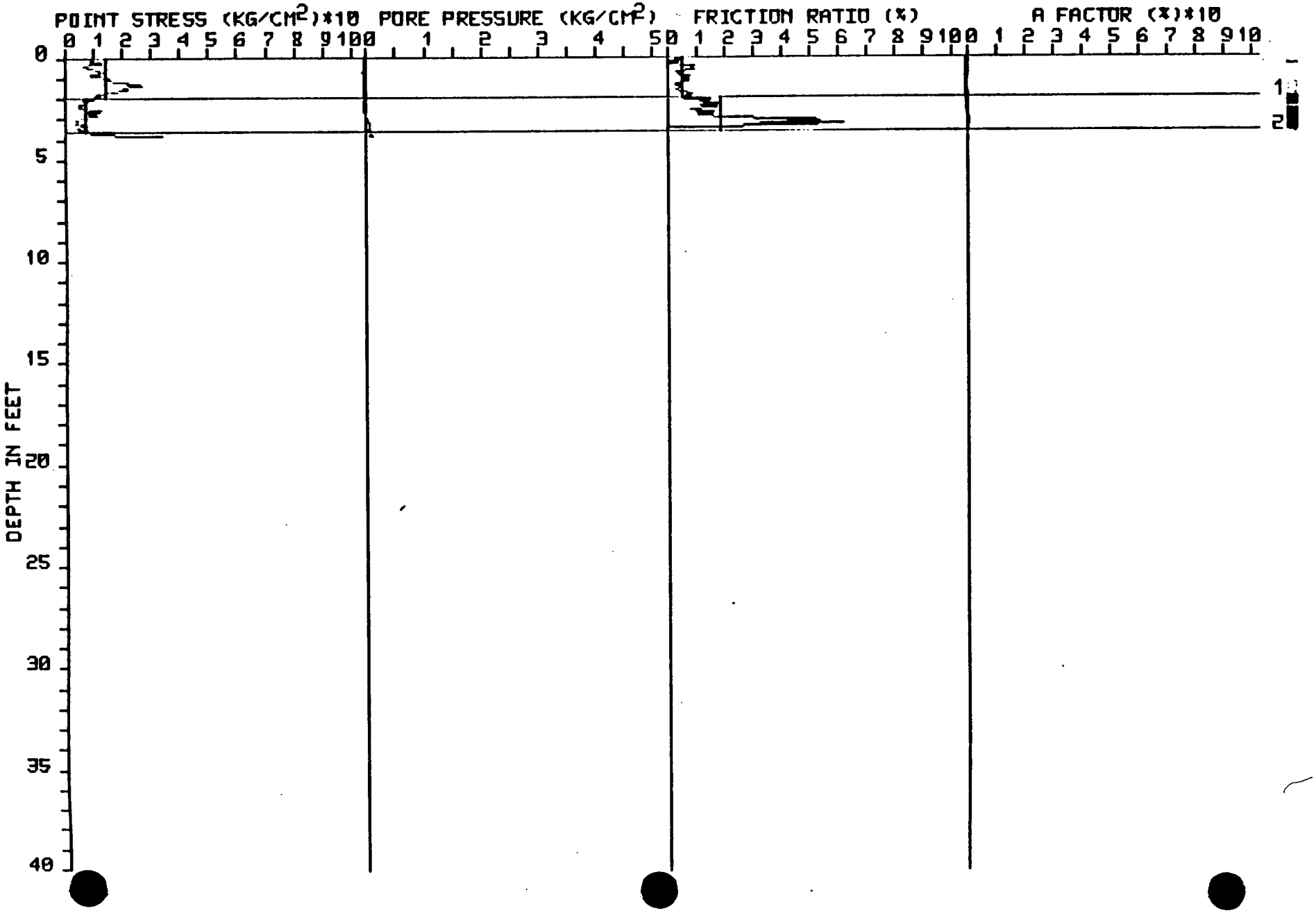


[27]

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 010

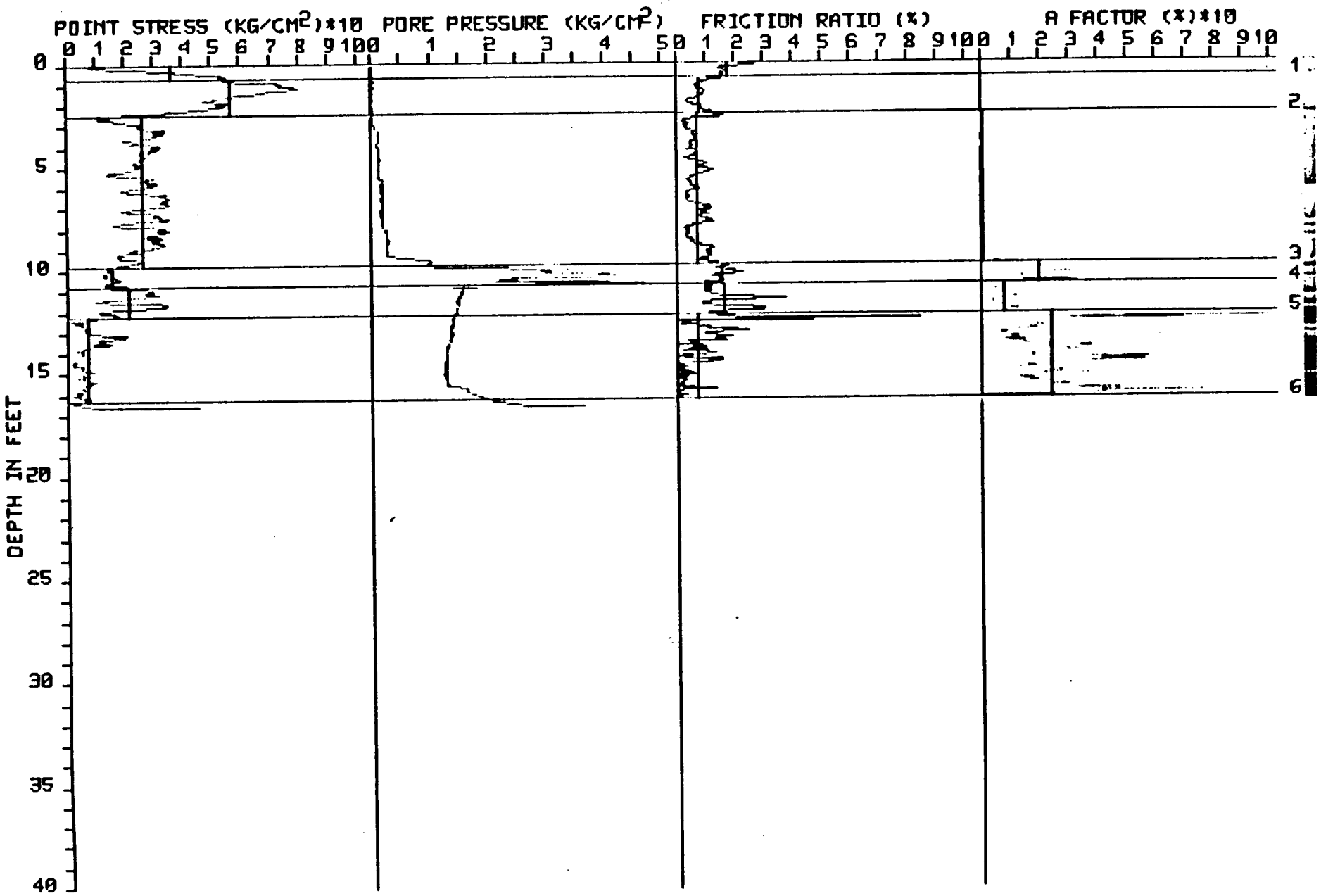


128

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 011

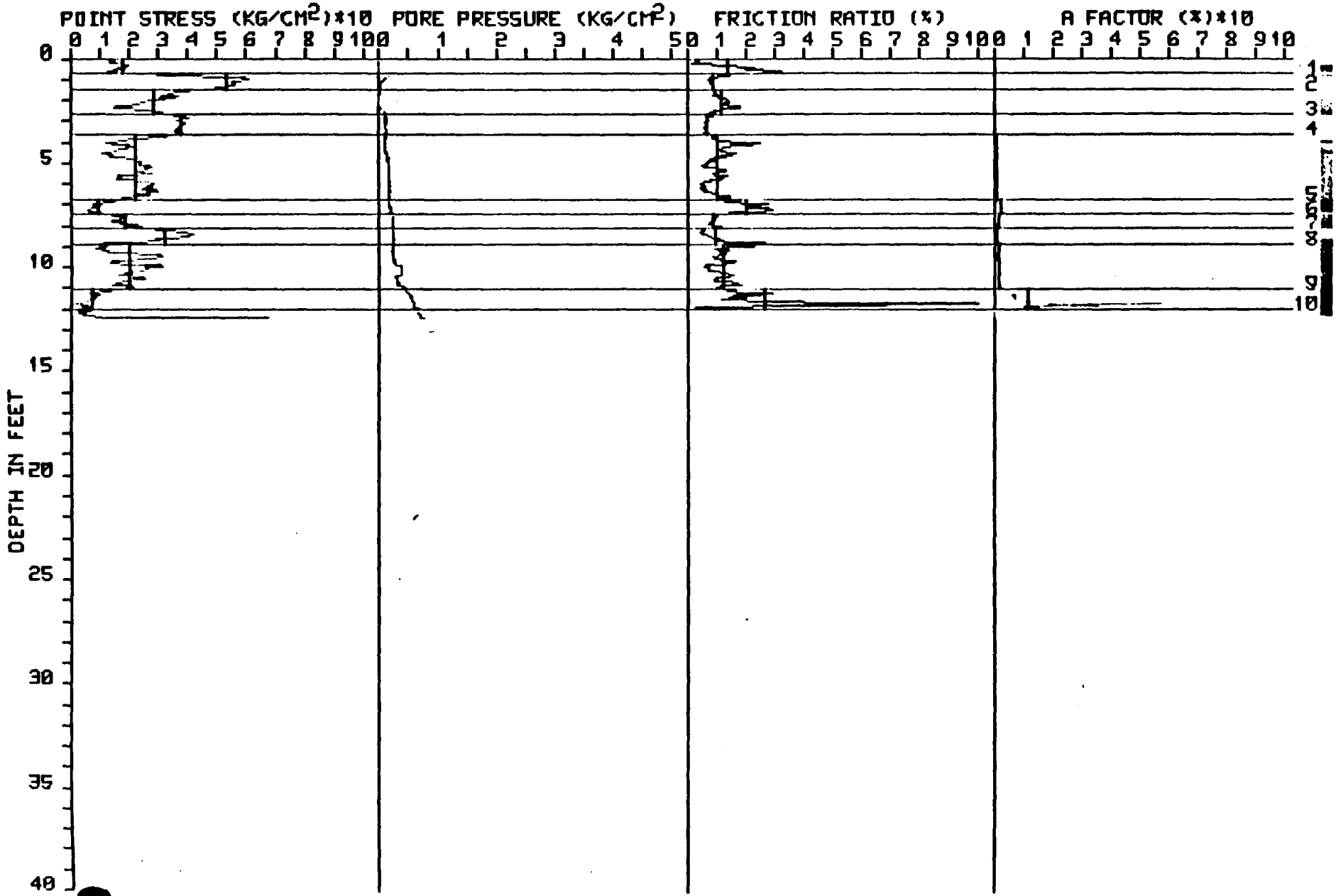


129

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 012

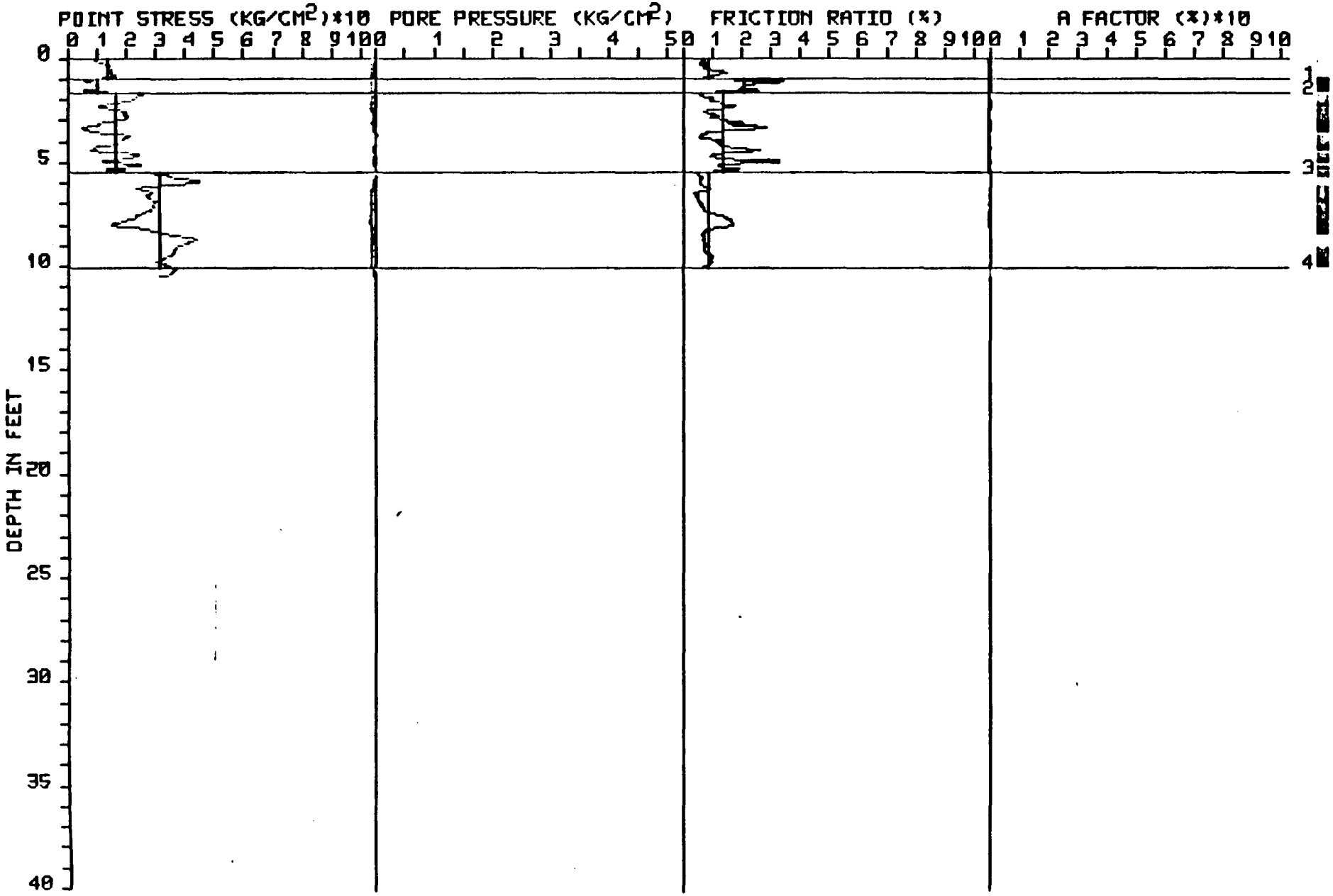


C21

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 013

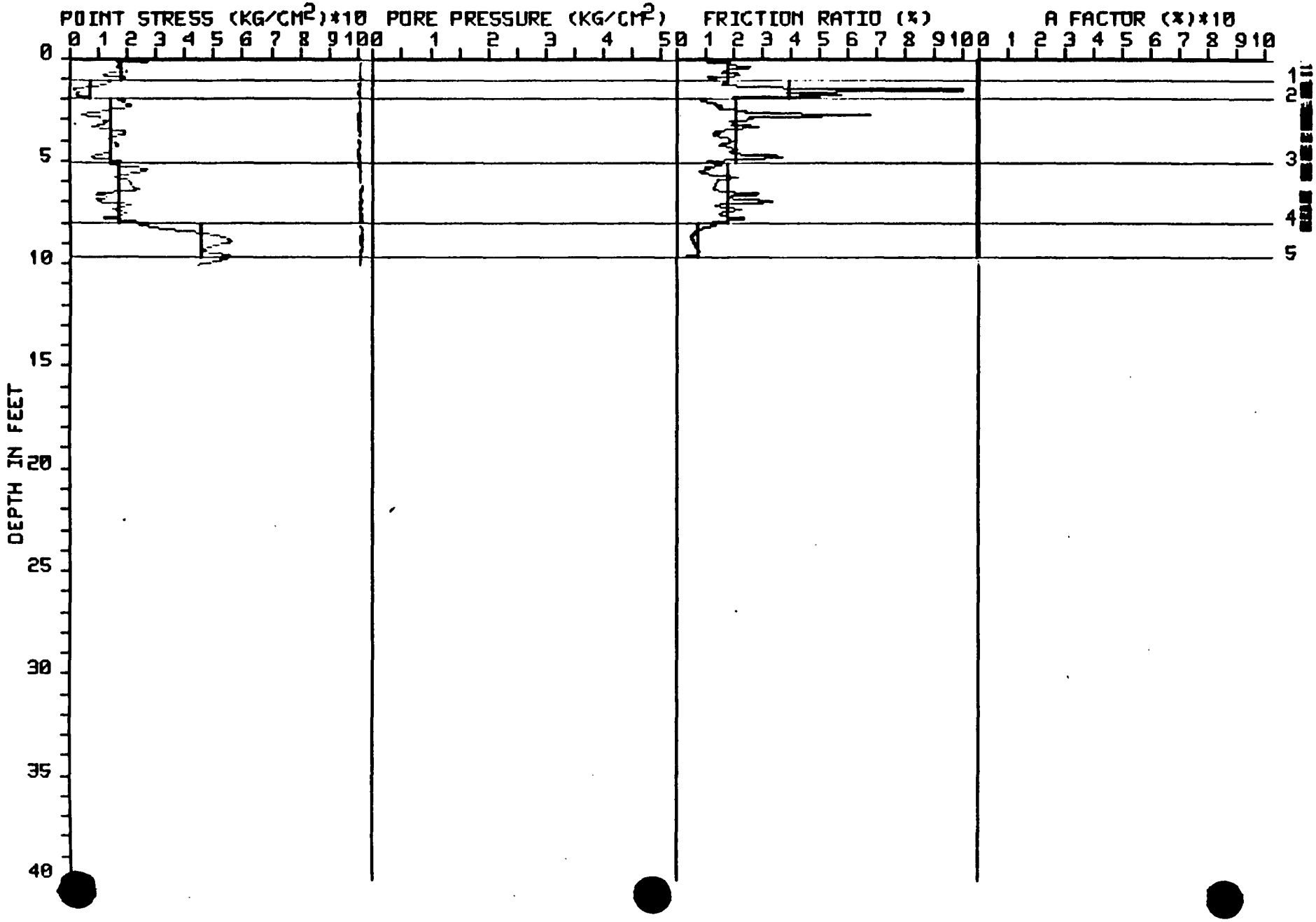


131

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 014

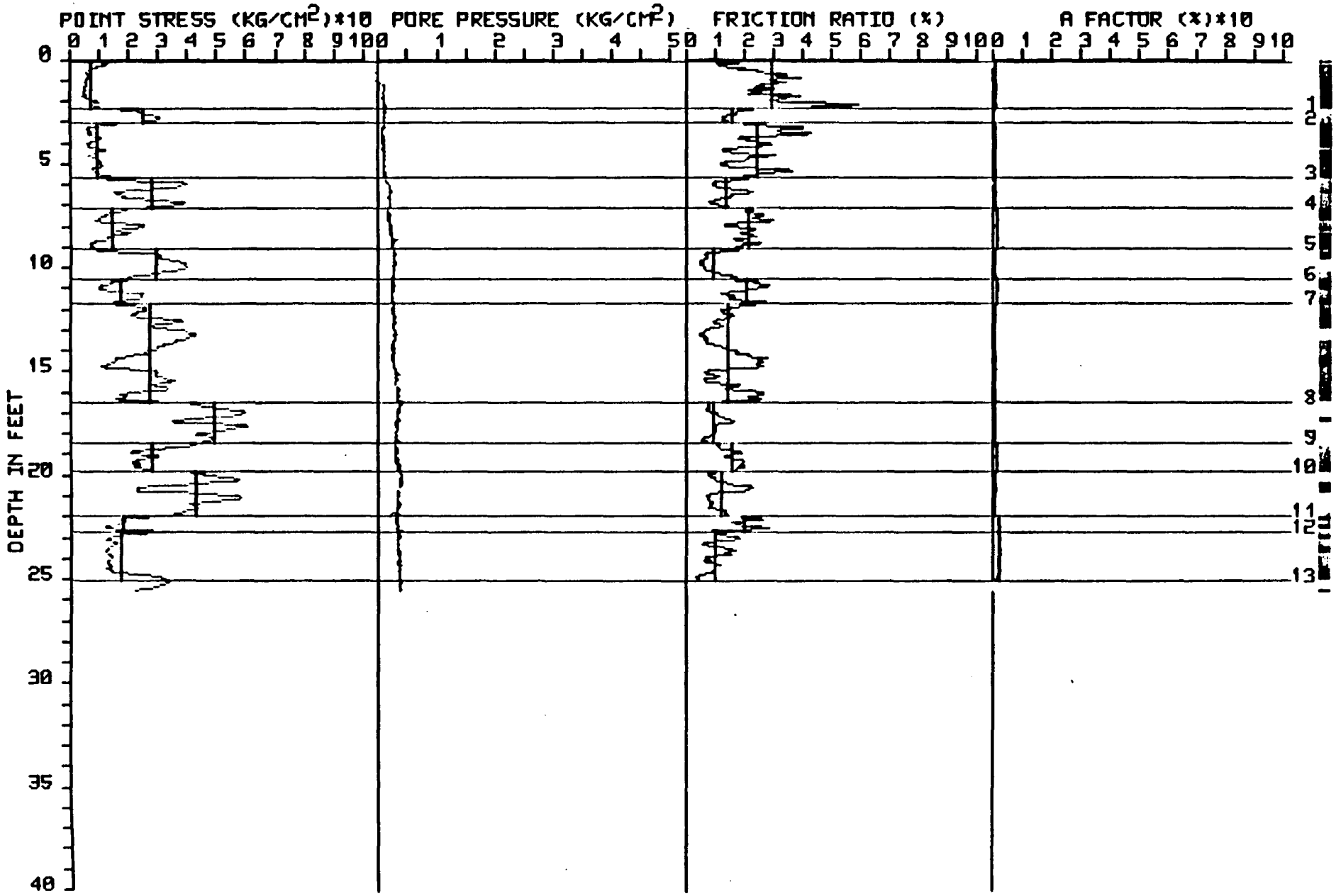


132

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 015

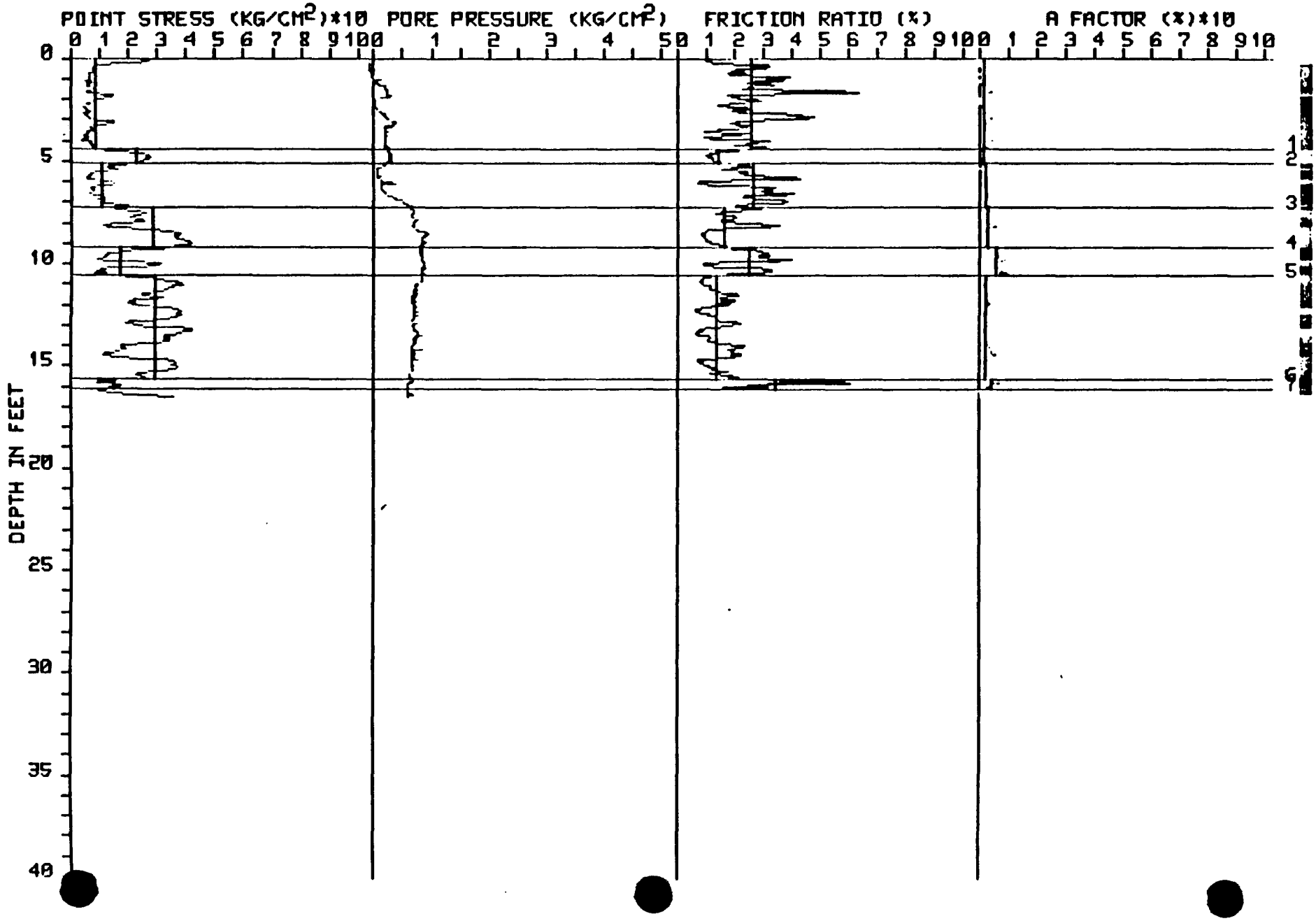


133

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 016

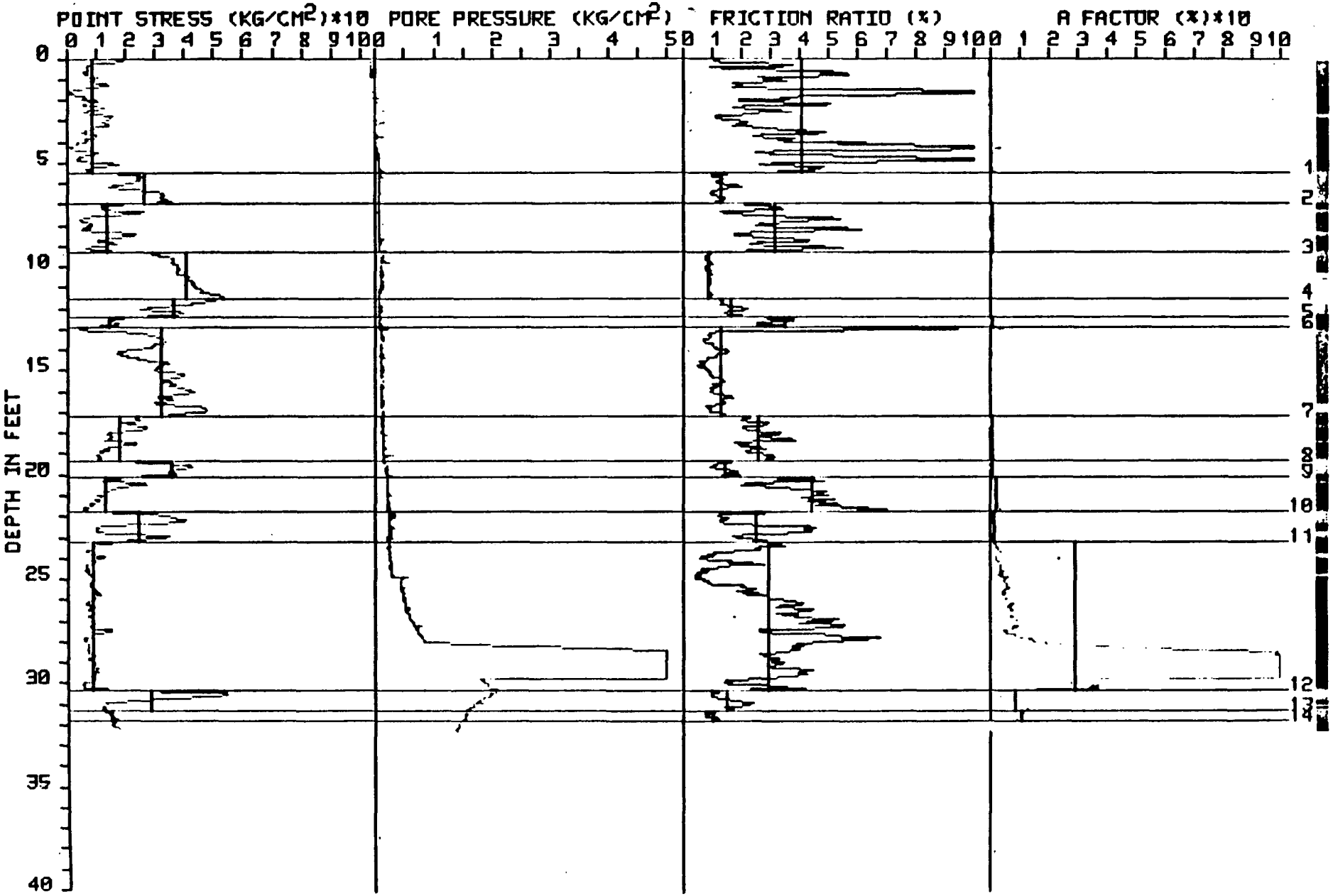


134

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 017

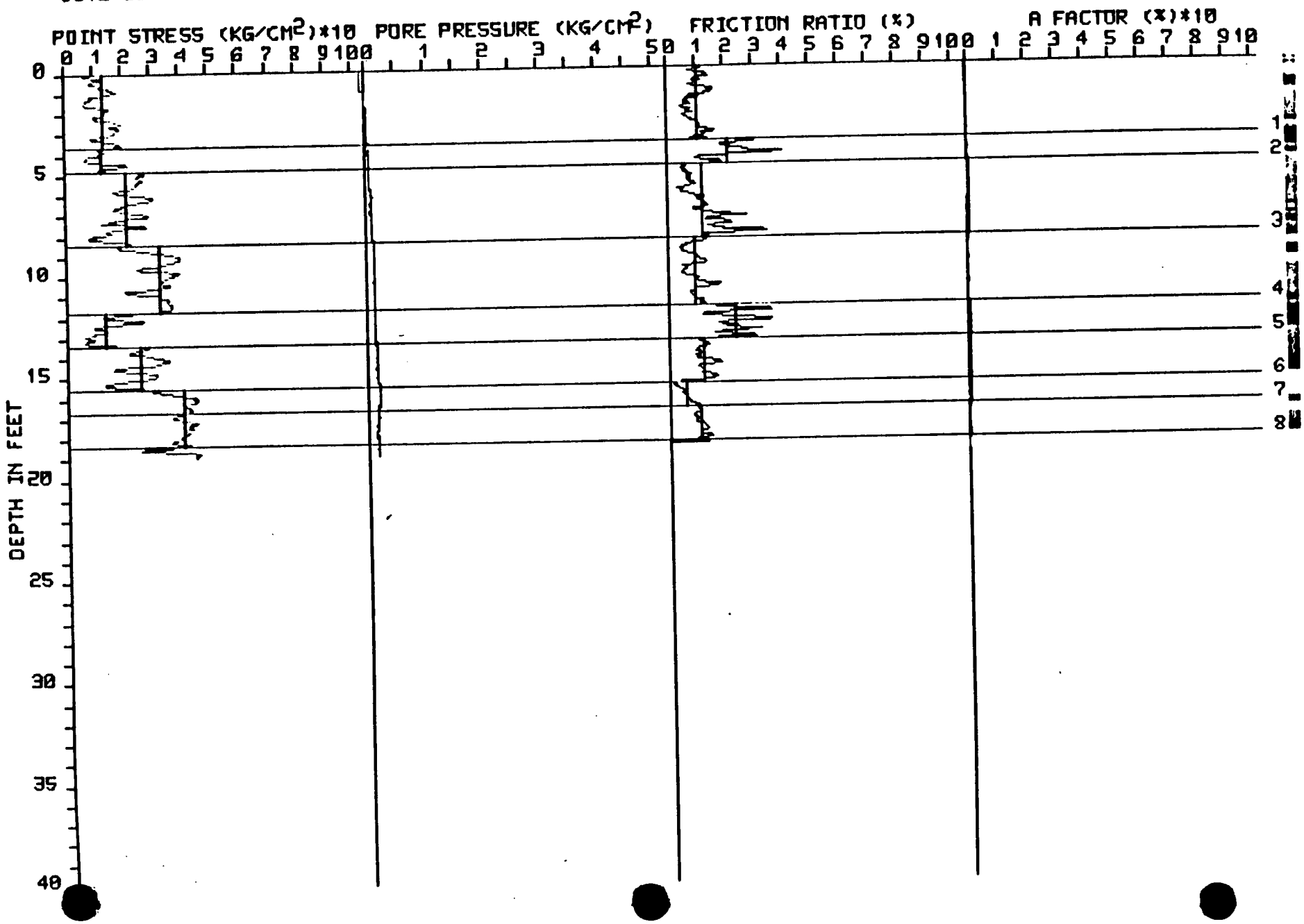


135

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 018

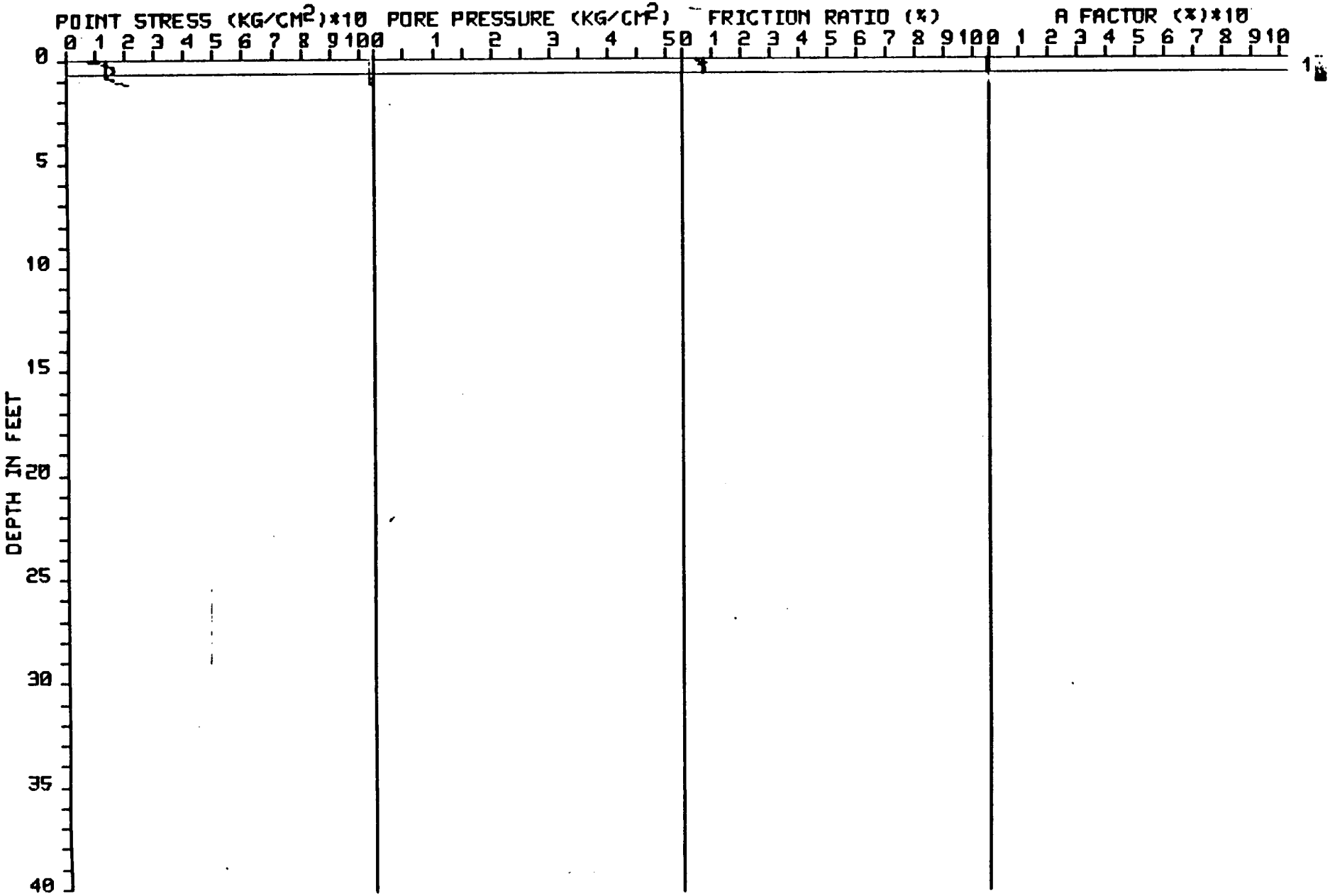


136

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 019

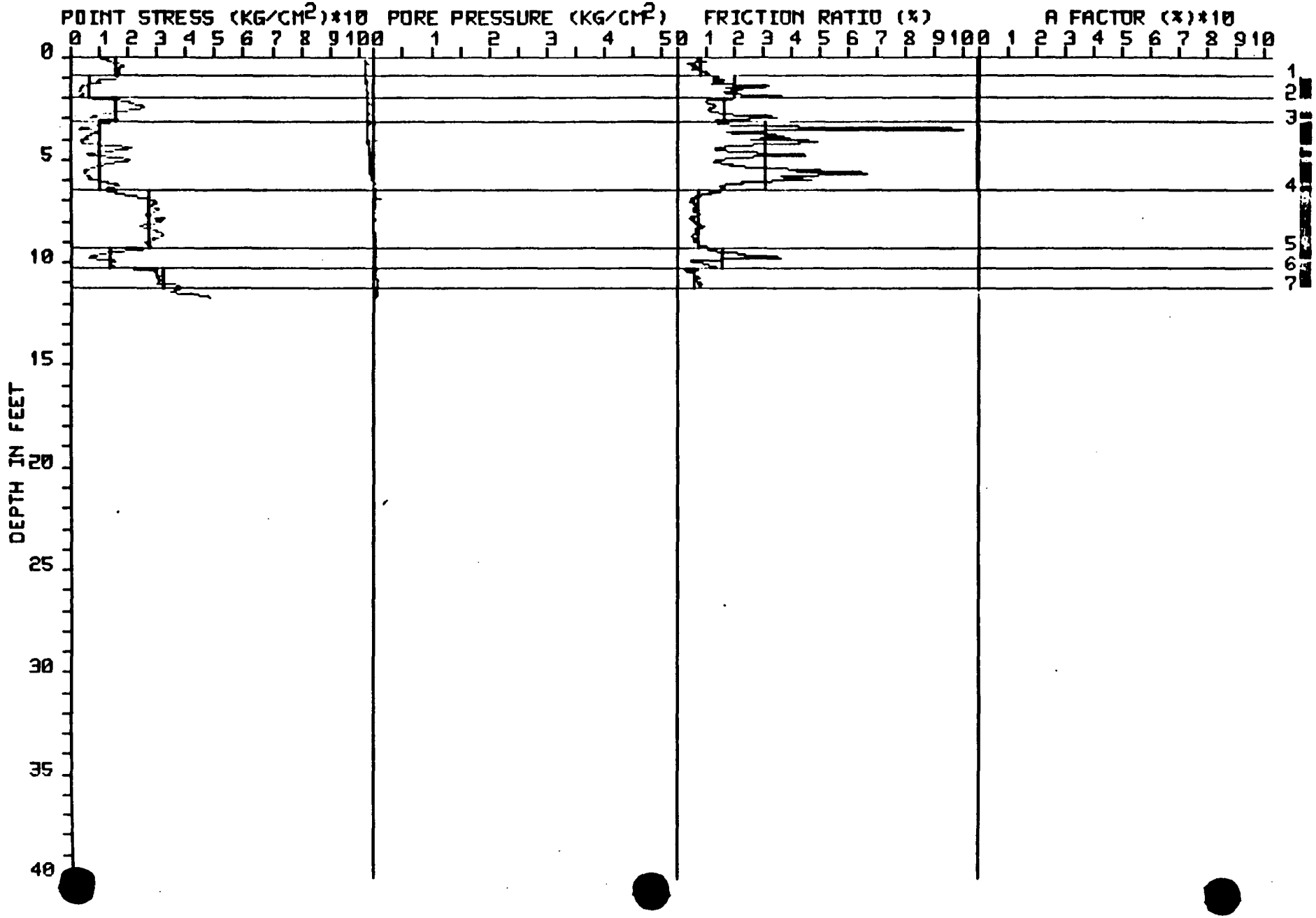


132

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 020

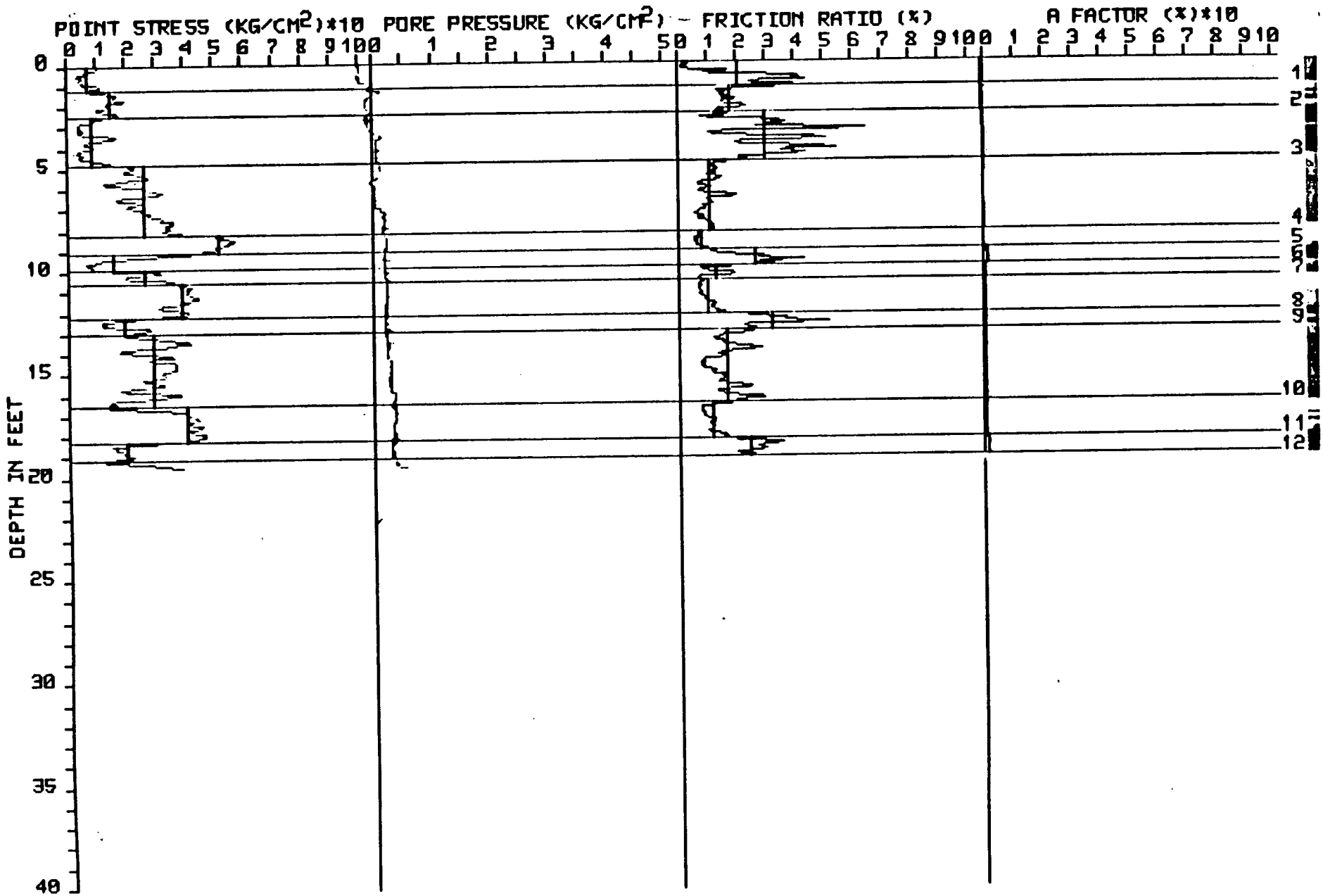


138

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 021

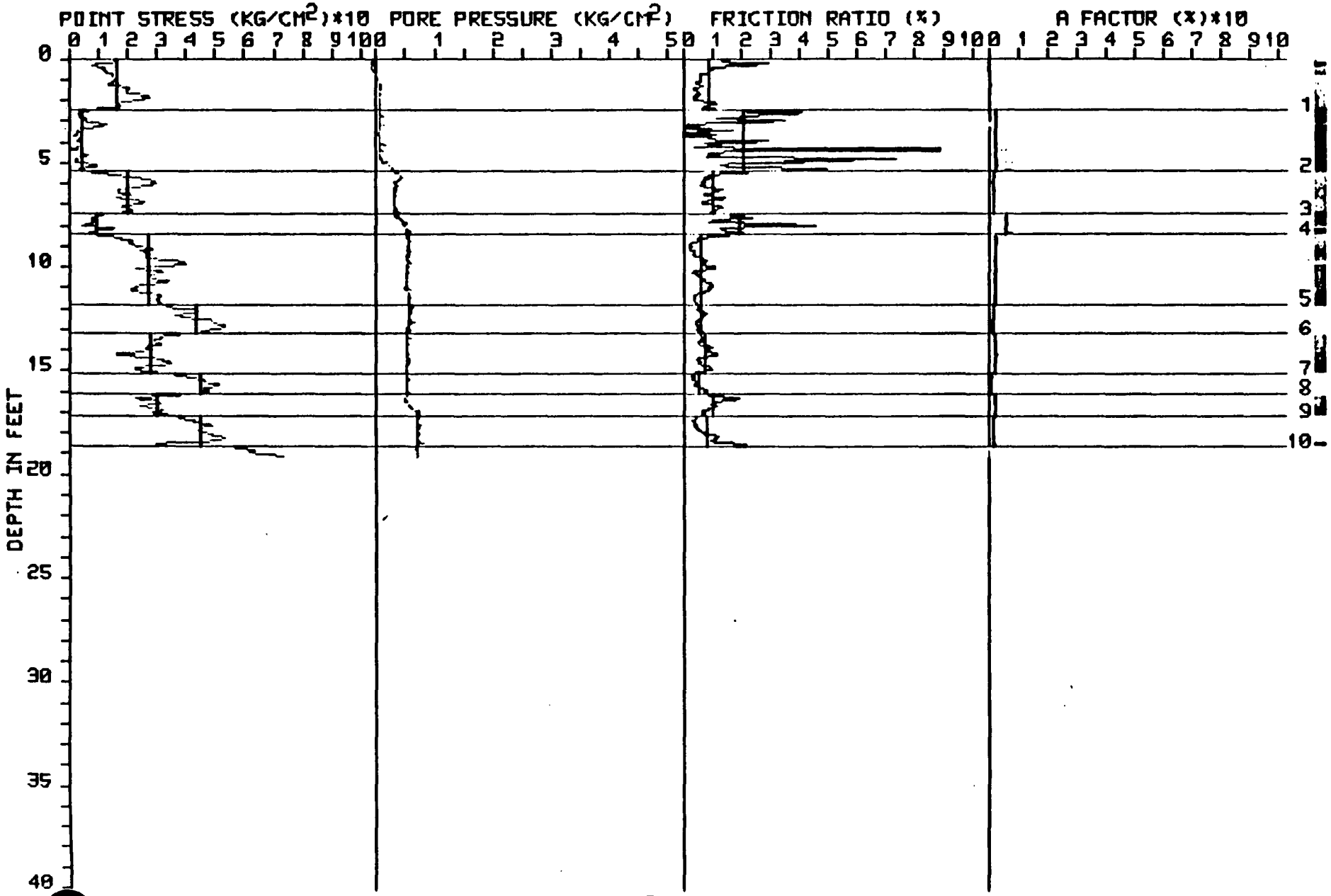


139

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 022

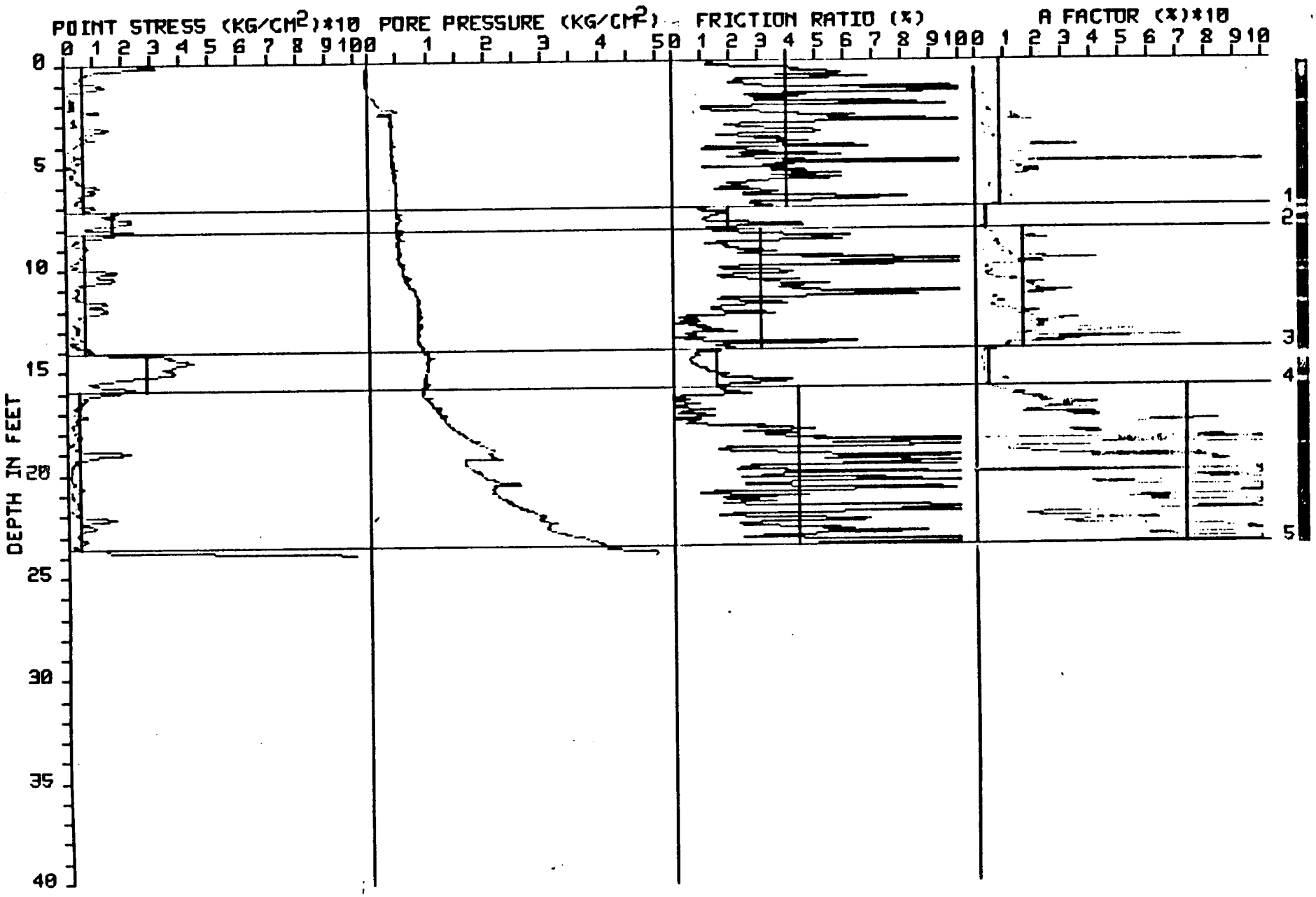


041

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 023

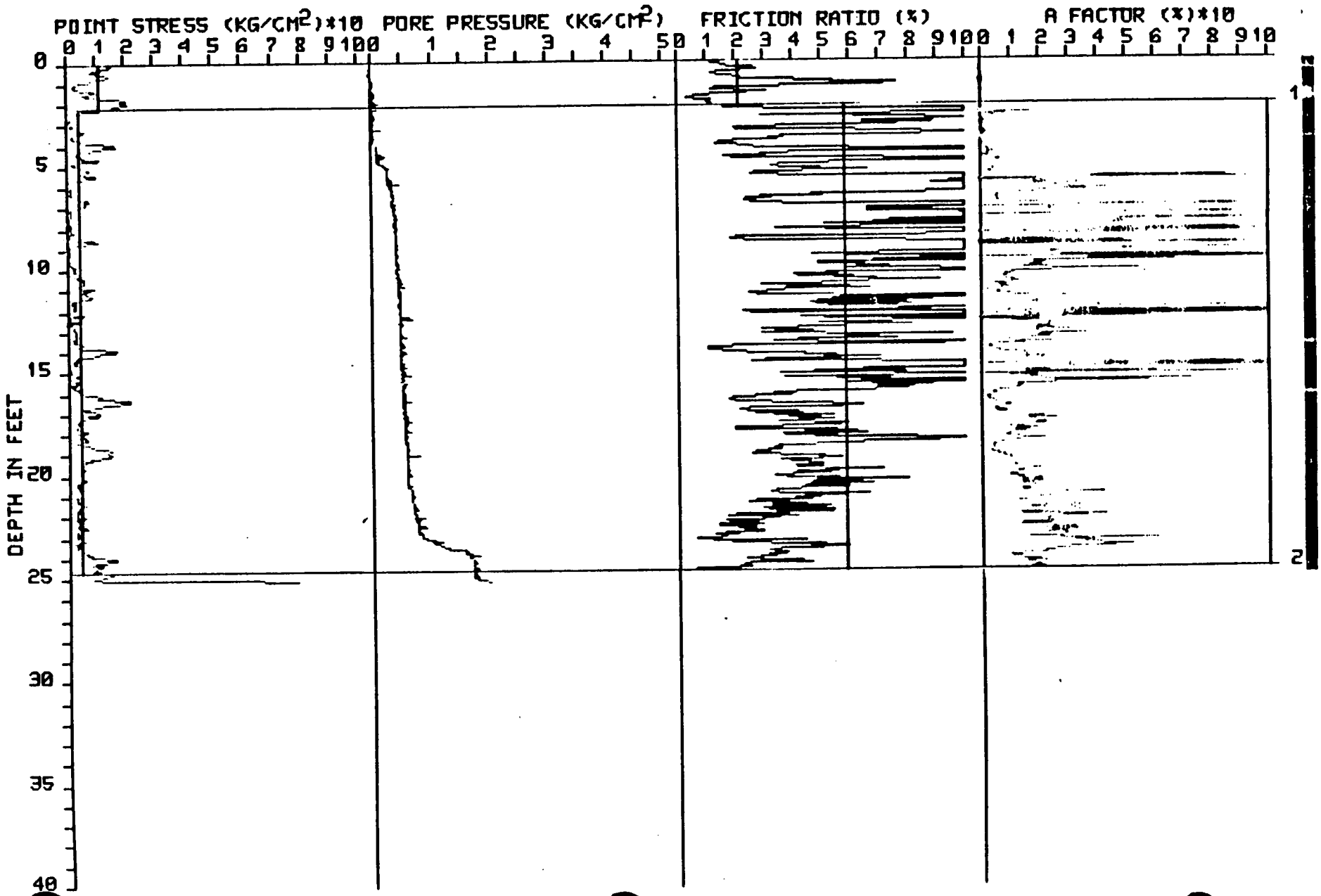


44

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

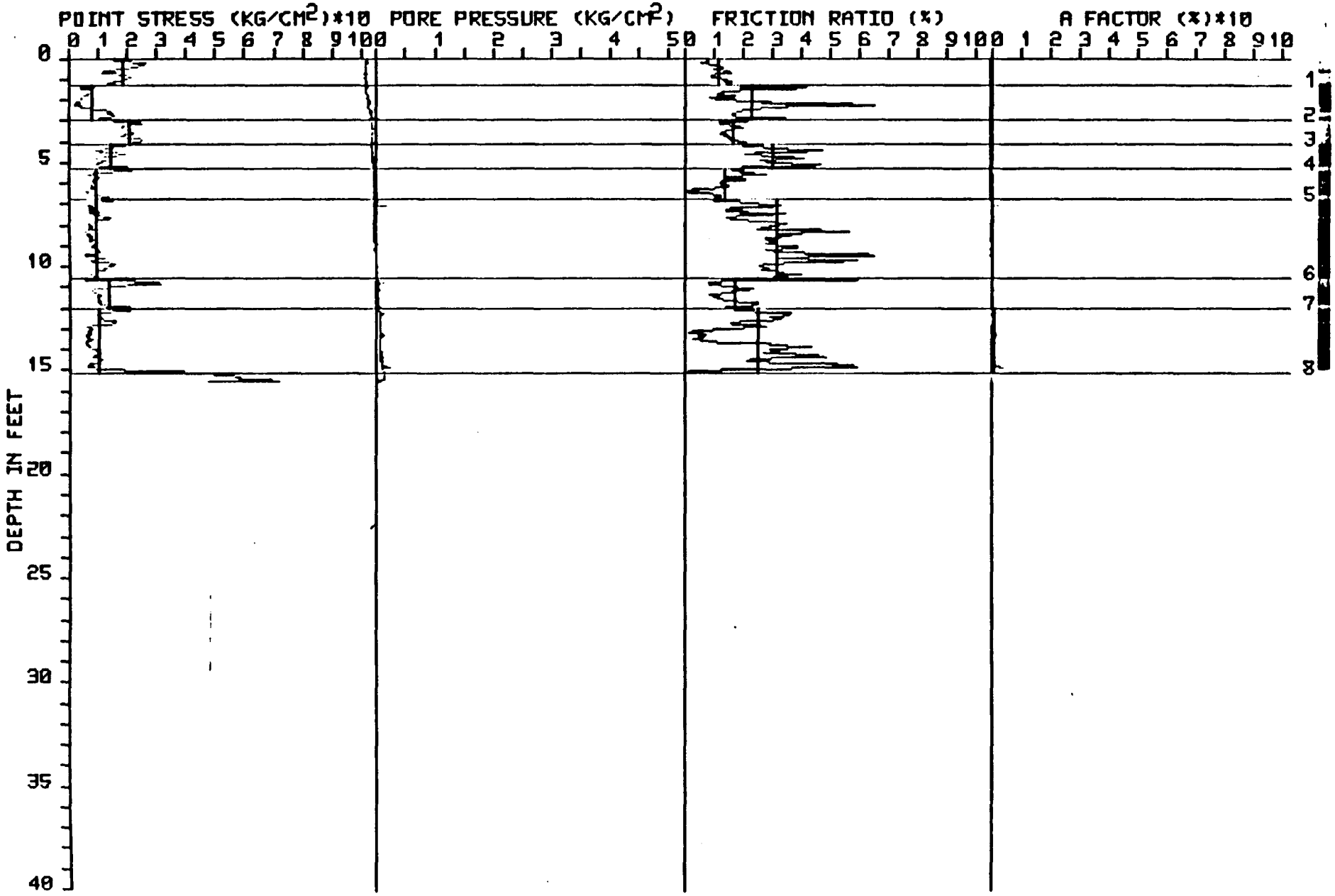
LOCATION ID: 024



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 025



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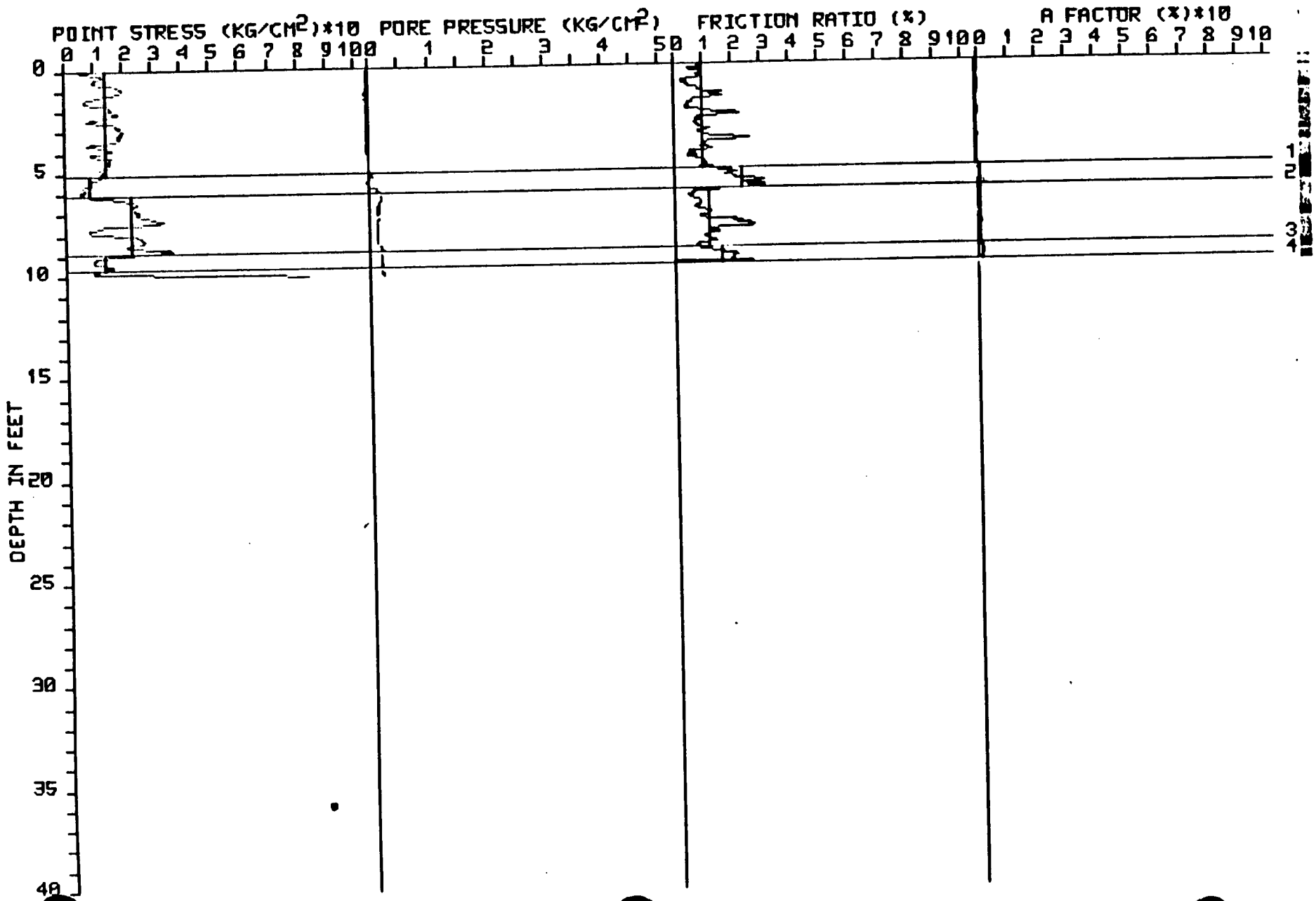
SITE ID: HAT01

LOCATION ID: 026

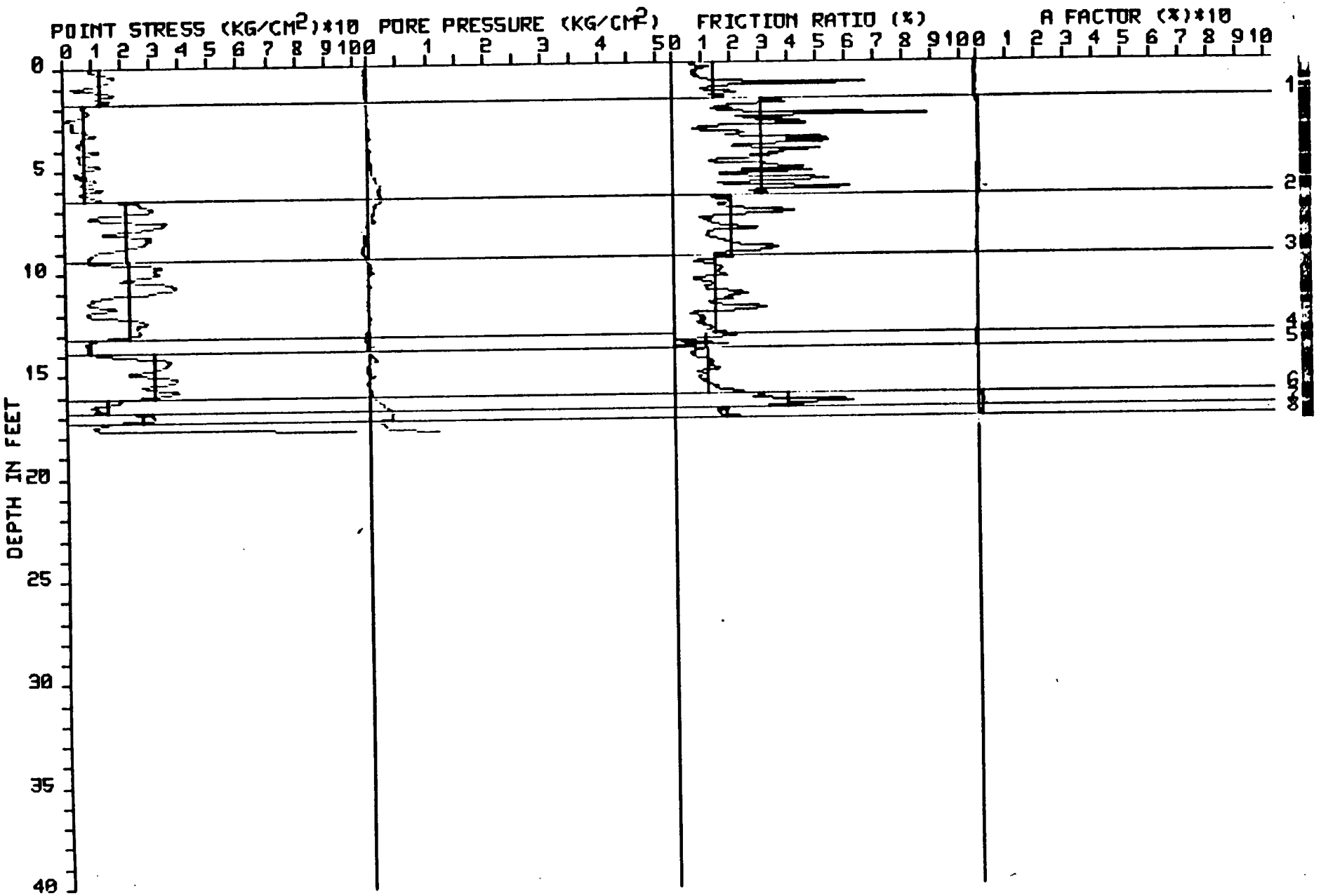


144

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 027

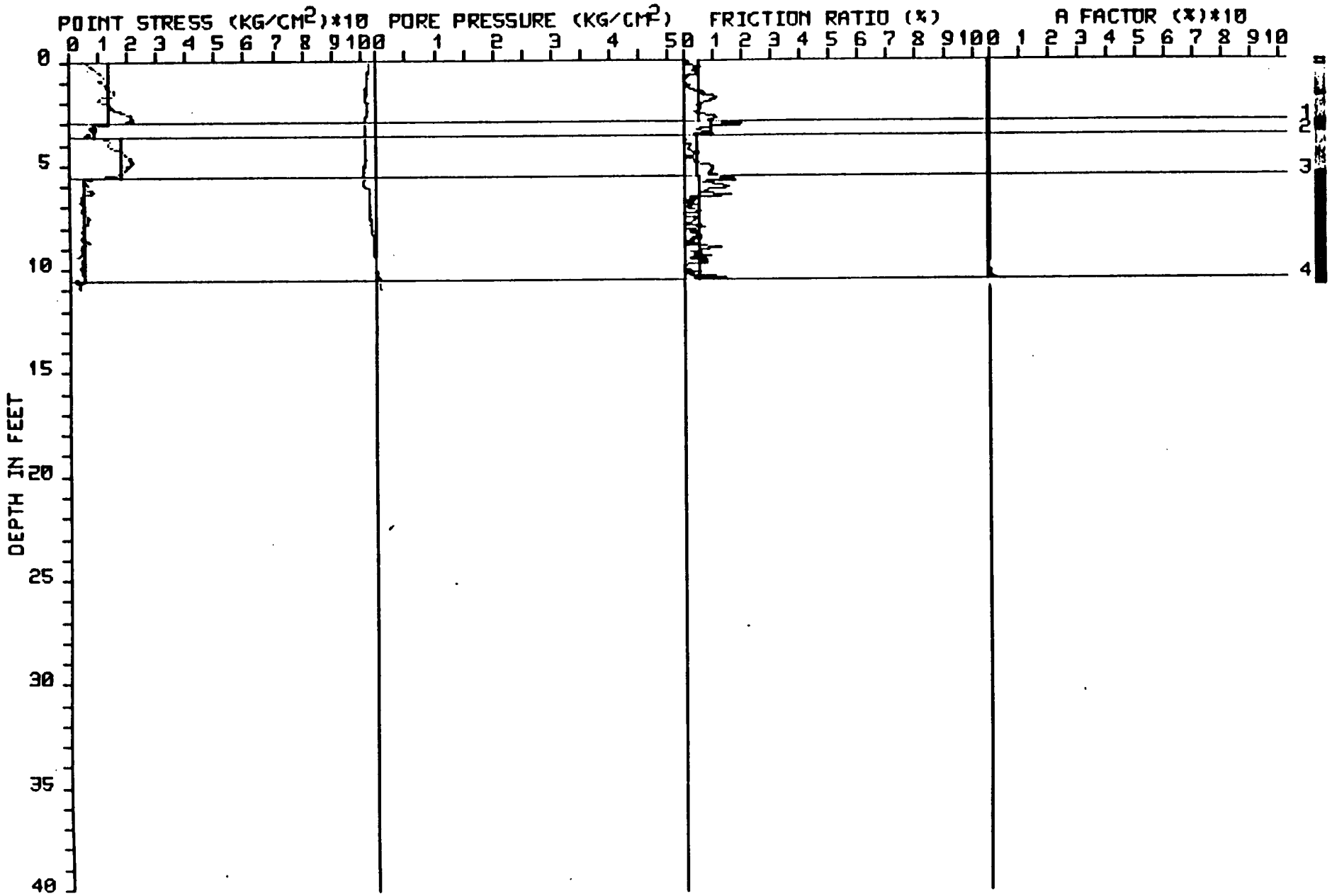


145

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 028

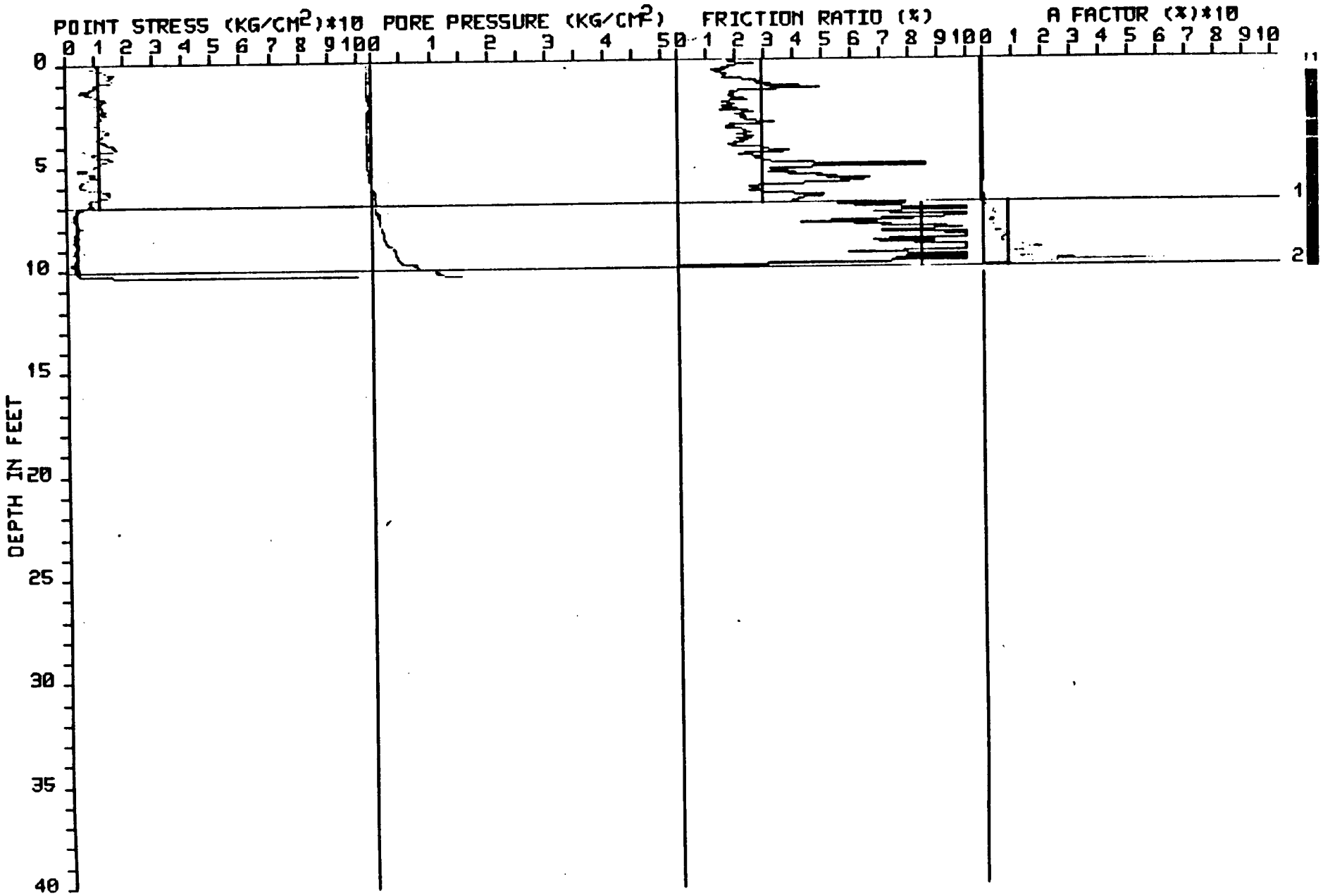


146

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 029



141

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 030

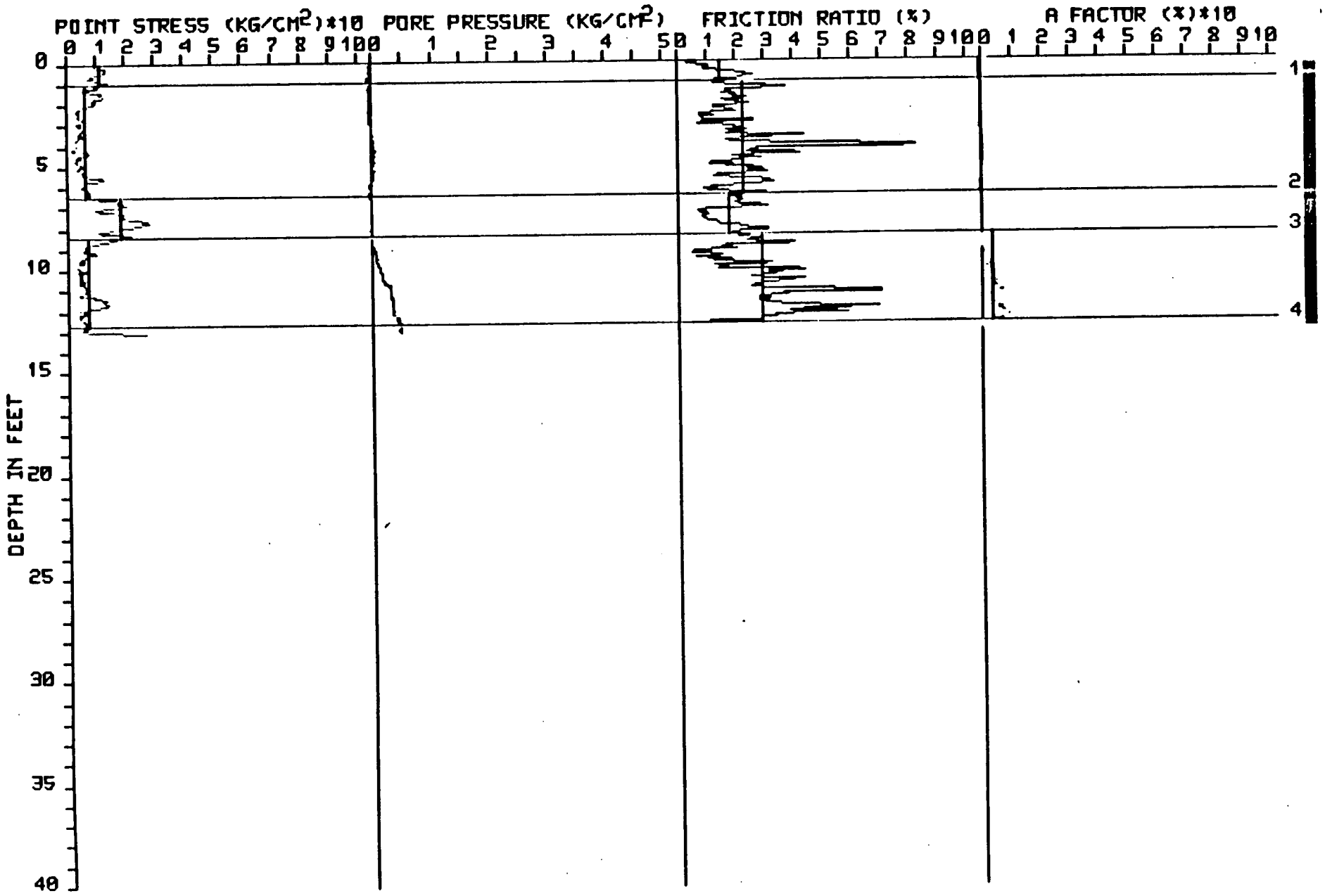


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Table D6.1 Geochemical analyses of Colorado State University borings

Boring Number[a]	Sample depth (feet)	pH	Electrical conductivity (mhos/centimeter)	Constituent[b] SO_4	Fe	Ca	Mg	Na	Cl	Al	Mn	As	Se	$CaCO_3$ equivalent (percent)
MH-200	2.5	8.1	1.8	3650	158	2660	782	323	130	812	252	4	3	10.4
MH-200	3.0	8.0	1.8	3140	130	2500	507	118	60	778	224	4	2	21.8
MH-200	3.5	8.1	2.0	4240	128	4260	473	161	60	675	183	4	4	19.3
MH-200	4.0	8.0	1.9	3870	110	3380	378	69	<20	781	159	4	4	21.8
MH-200	4.8	8.2	0.2	200	118	222	29	30	272	288	390	3	5	36.0
MH-200	6.0	8.6	0.1	111	84	131	21	16	<20	363	296	2	4	17.5
MH-200	10.0	8.6	0.2	270	115	217	53	41	<20	336	191	3	4	36.0
MH-200	15.0	8.6	0.1	67	106	114	30	49	<20	348	138	3	4	49.8
MH-200	19.0	8.5	0.1	134	82	155	35	29	<20	248	224	2	3	18.7
MH-205	5.5	8.5	0.2	173	112	167	65	35	<20	278	222	3	5	41.0
MH-205	6.0	8.3	0.8	160	215	1460	186	50	<20	325	610	2	3	29.6
MH-205	7.0	8.5	0.2	190	144	149	55	81	<20	306	228	3	2	36.4
MH-205	10.0	7.9	1.7	3050	96	2110	541	268	<20	931	194	2	<1	18.0
MH-205	12.5	8.1	0.2	300	78	105	60	29	30	609	89	1	1	11.5
MH-205	17.0	8.4	0.1	150	67	131	44	35	20	276	237	1	<1	12.8
MH-205	22.0	8.3	0.2	170	38	53	23	300	30	671	45	1	3	6.1
MH-205	25.5	8.6	0.1	155	87	130	37	36	20	277	193	13	<1	18.4
MH-208	27.0	6.4	2.0	5070	430	5470	177	96	<20	549	72	13	<1	0.84
MH-208	27.5	8.0	0.2	348	304	340	47	22	<20	253	271	4	6	34.4
MH-208	30.2	8.5	0.1	90	130	131	26	24	<20	263	231	4	6	32.0
MH-208	36.0	8.4	0.1	89	93	116	32	31	<20	260	208	2	3	31.4
MH-208	38.0	8.1	0.2	370	74	289	91	72	<20	845	128	2	<1	9.8
MH-208	43.0	8.6	0.1	67	119	111	32	35	<20	342	202	2	2	29.8
MH-208	49.0	8.1	0.2	120	52	124	47	98	<20	671	103	3	<1	18.0

[a]Boring numbers currently do not have DOE identification numbers; CSU boring numbers represent NX rock core samples.
[b]Analysis done by solute extraction; values are expressed in milligrams per gram of dry soil; SO_4 - sulfate; Fe - iron; Ca - calcium; Mg - magnesium; As - arsenic; Se - selenium.

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 001
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.3	1.2	16.4	0.2	0.0	1.0	S-SL*	5	39	30	57	1965	
2	1.3	4.1	2.8	7.3	0.1	0.1	1.4	SLIM	4			25	870	9.6
3	4.2	8.0	3.8	22.6	0.3	0.1	1.1	S-SL*	7	48	31	79	2709	
4	8.0	10.1	2.1	14.2	0.4	0.2	2.6	SLIM	9			50	1709	5.8
5	10.1	11.1	1.0	24.5	0.3	0.2	1.4	S-SL*	8	44	31	86	2937	
6	11.1	12.5	1.4	14.3	0.4	0.2	2.7	SLIM	9			50	1718	4.2
7	12.5	13.7	1.2	25.7	0.4	0.4	1.5	S-SL*	8	41	30	90	3086	
8	13.8	18.5	4.8	13.2	0.4	1.1	2.8	SLIM	8			46	1585	2.6
9	18.6	23.3	4.7	30.6	0.6	0.5	1.9	S-SL*	10	37	29	107	3671	
10	23.3	25.2	1.9	18.0	0.6	1.4	3.2	SLIM	12			63	2164	2.0
11	25.3	28.3	3.1	6.2	0.1	2.7	2.1	SLIM	4			22	742	0.8
12	28.3	30.7	2.3	21.8	0.5	1.0	2.2	SLIM	14			76	2615	1.8
13	30.7	33.8	3.1	11.8	0.4	6.6	3.3	SLIM	7			41	1414	1.0
% THK:		35	11.9	25.6	0.4	0.3	1.5	S-SL	8	41	30	89	3071	
% THK:		64	21.5	12.7	0.3	1.9	2.5	SLIM	7			44	1527	3.3

051

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 002
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	0.8	0.7	48.0	0.3	-0.1	0.7	SAND*	9	72	35	168		
2	0.8	9.8	9.1	23.7	0.2	0.0	0.8	S-SL*	7	49	31	83	2845	
3	9.9	13.2	3.3	13.4	0.4	1.6	2.7	SLIM	8			47	1611	4.1
4	13.2	17.0	3.8	30.4	0.4	0.5	1.2	S-SL*	10	43	30	106	3647	
5	17.1	18.6	1.6	43.1	0.3	0.1	0.8	SAND*	8	50	31	151		
6	18.7	19.6	0.9	22.2	0.4	0.2	1.9	S-SL	7	30	29	78	2662	
7	19.6	21.0	1.4	56.3	0.5	0.3	1.0	SAND*	11	55	32	197		
% THK:		17	3.7	49.0	0.4	0.1	0.9	SAND	9	56	32	171		
% THK:		66	13.8	25.4	0.3	0.2	1.0	S-SL	7	46	31	89	3053	
% THK:		15	3.3	13.4	0.4	1.6	2.7	SLIM	8			46	1611	4.1

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 003
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	1.2	1.1	6.7	0.0	-0.0	0.6	SLIM*	4			23	800	25.6
2	1.2	14.8	13.5	24.9	0.2	0.1	1.0	S-SL*	8	48	31	87	2985	
3	14.8	18.1	3.3	8.8	0.3	0.3	3.4	SLIM	5			31	1057	1.9
4	18.2	20.1	1.9	27.5	0.4	0.4	1.4	S-SL*	9	36	29	96	3302	
5	20.1	21.0	0.9	52.8	0.4	0.2	0.7	SAND*	10	53	32	185		
6	21.1	23.9	2.8	27.4	0.4	0.2	1.5	S-SL*	9	33	29	96	3287	
7	23.9	25.8	1.9	4.8	0.2	0.4	4.0	SLIM	3			17	574	0.7
% THK:		3	0.9	52.8	0.4	0.2	0.7	SAND	10	52	32	185		
% THK:		71	18.2	25.6	0.3	0.1	1.1	S-SL	8	44	31	89	3064	
% THK:		24	6.3	7.2	0.2	0.3	3.1	SLIM	4			25	866	5.7

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 004
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.5	2.4	17.3	0.1	-0.0	0.6	S-SL*	5	41	30	61	2076	
2	2.5	10.8	8.3	7.6	0.2	0.0	2.5	SLIM	5			27	917	4.9
3	10.9	14.9	4.0	21.7	0.4	0.3	1.7	S-SL	7	37	29	76	2598	
4	14.9	17.7	2.8	8.4	0.3	0.6	3.5	SLIM	5			29	1007	1.9
5	17.8	19.2	1.4	40.7	0.6	1.2	1.4	S-SL*	13	47	31	142	4882	
% THK:		41	7.8	23.8	0.3	0.4	1.3	S-SL	7	40	30	83	2847	
% THK:		58	11.1	7.8	0.2	0.2	2.8	SLIM	5			27	939	4.1

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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 005
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	- DEPTH - FROM	TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.7	2.6	13.8	0.1	-0.0	0.6	S-SL*	4	35	29	48	1661	
2	2.8	19.7	16.9	6.0	0.2	0.1	3.9	SLIM	3			21	718	2.5
% THK:		13	2.6	13.8	0.1	0.0	0.6	S-SL	4	35	29	48	1660	
% THK:		86	16.9	6.0	0.2	0.1	3.9	SLIM	3			21	718	2.5

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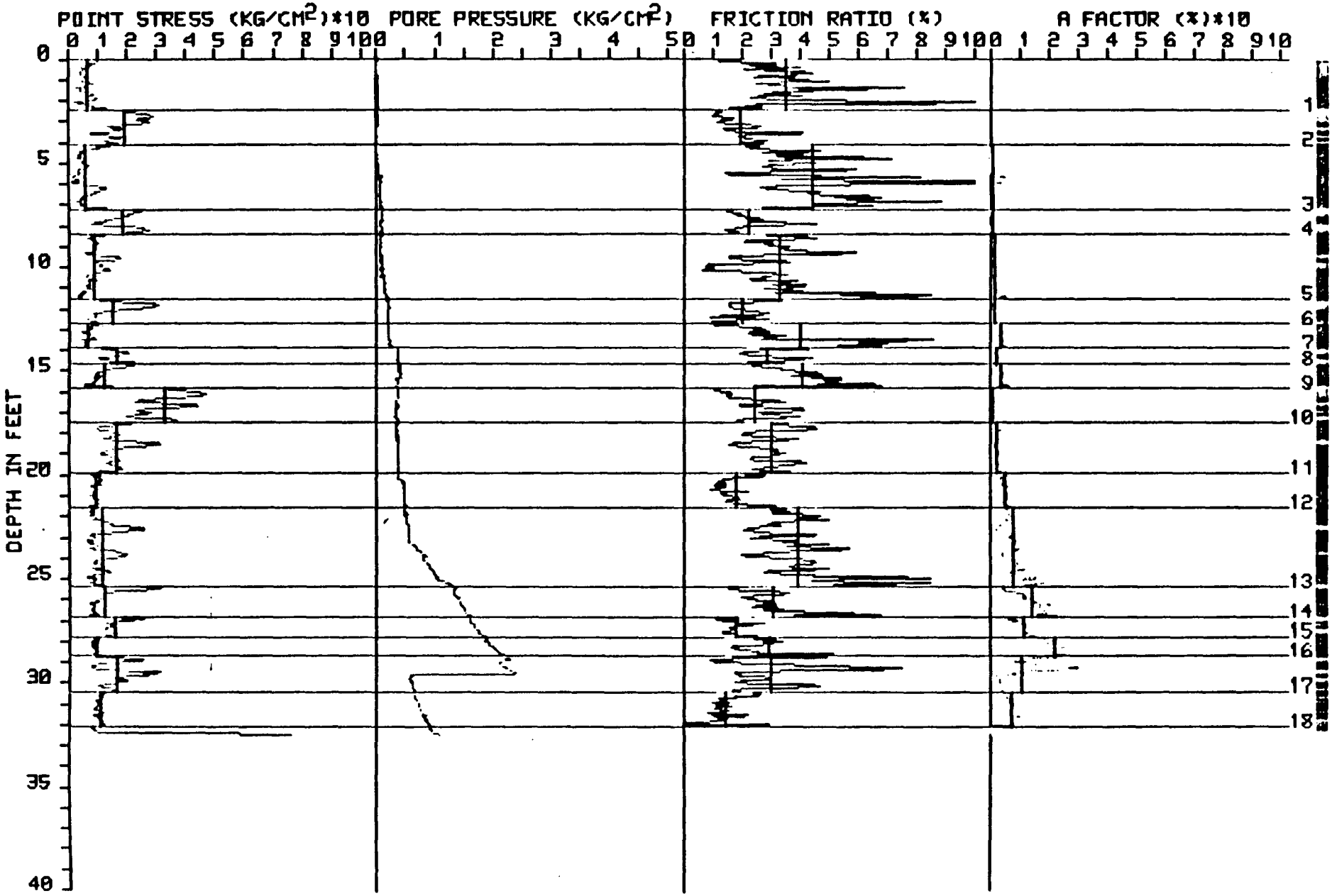
PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 031

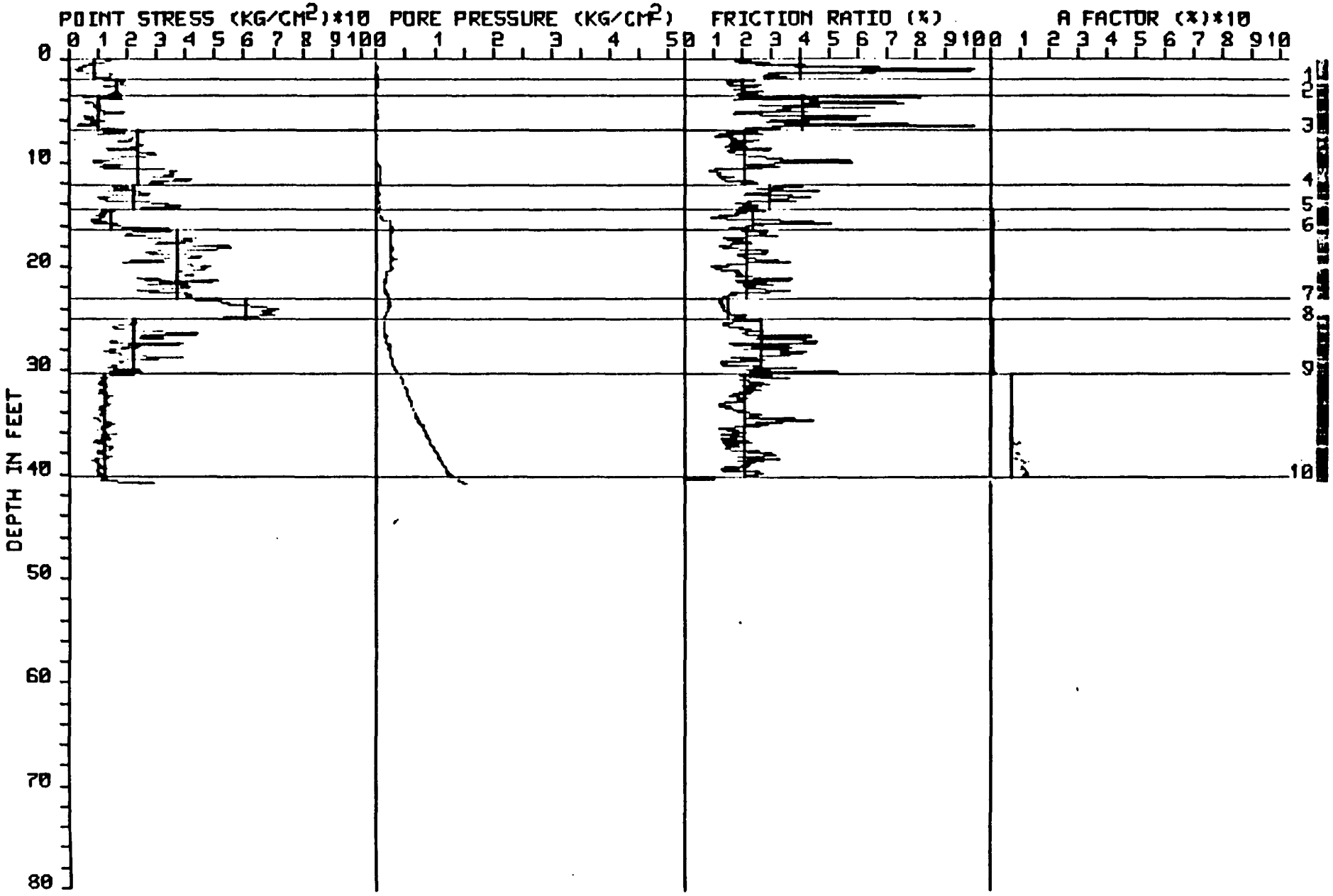


155

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

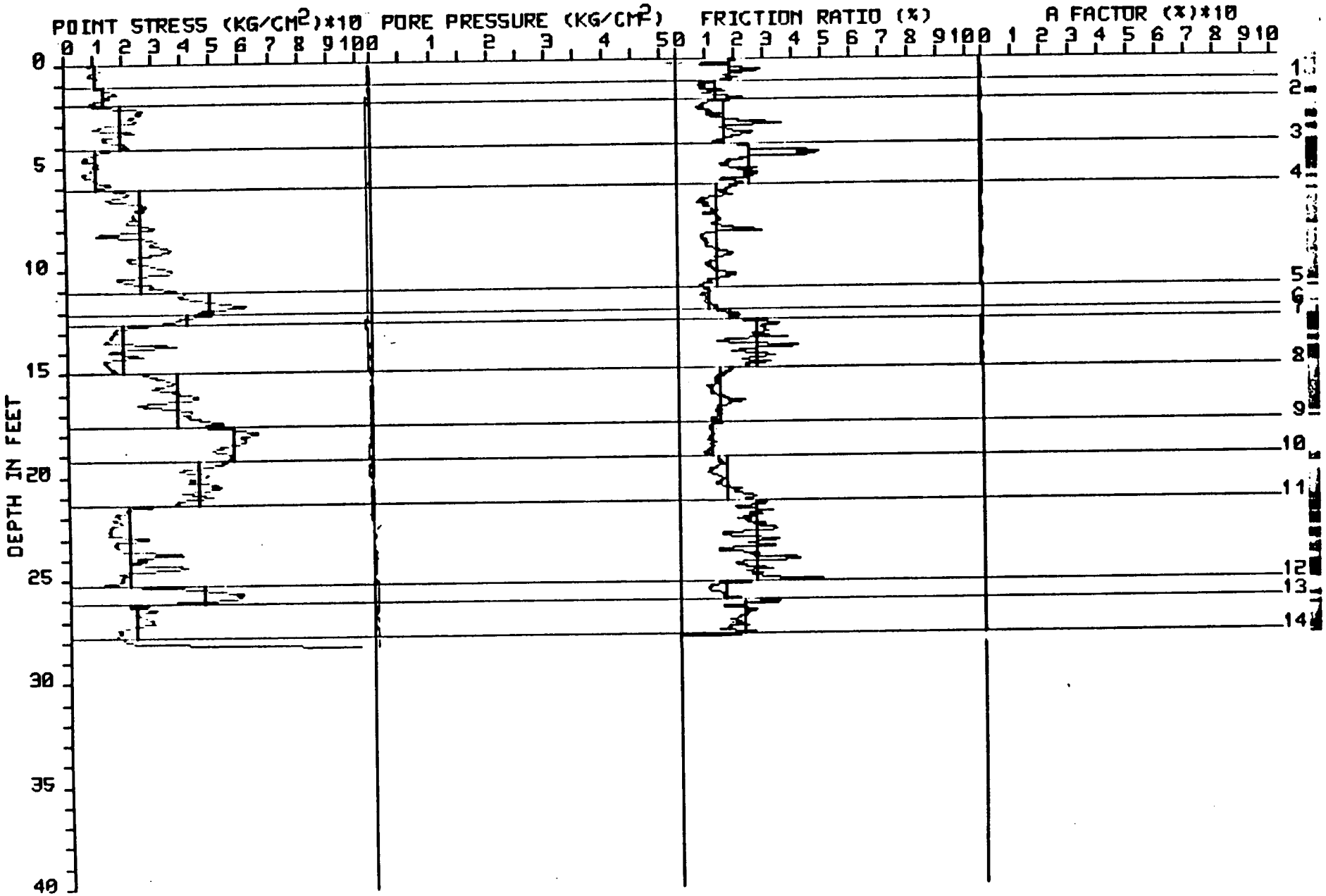
LOCATION ID: 032



PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 033

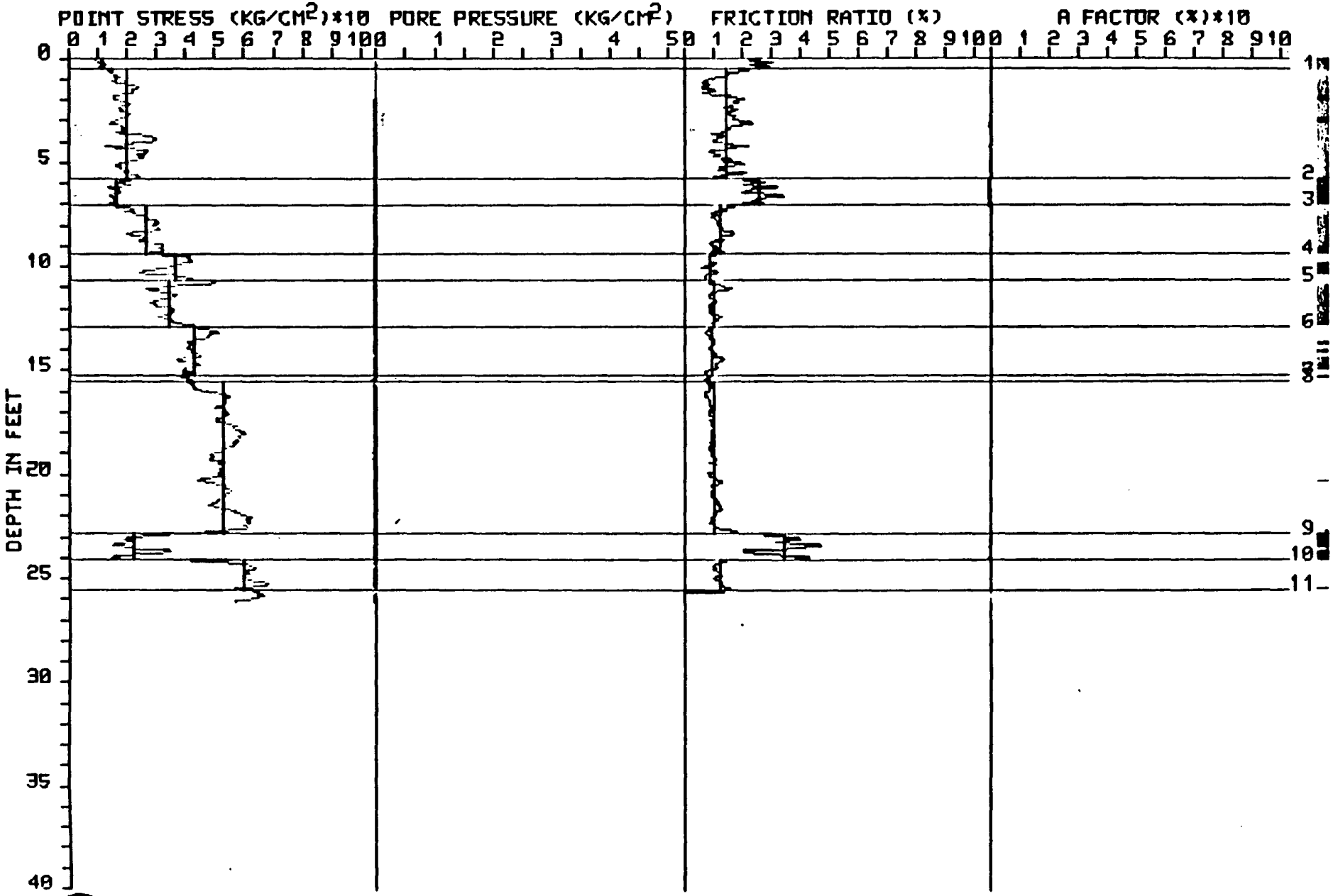


157

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 034

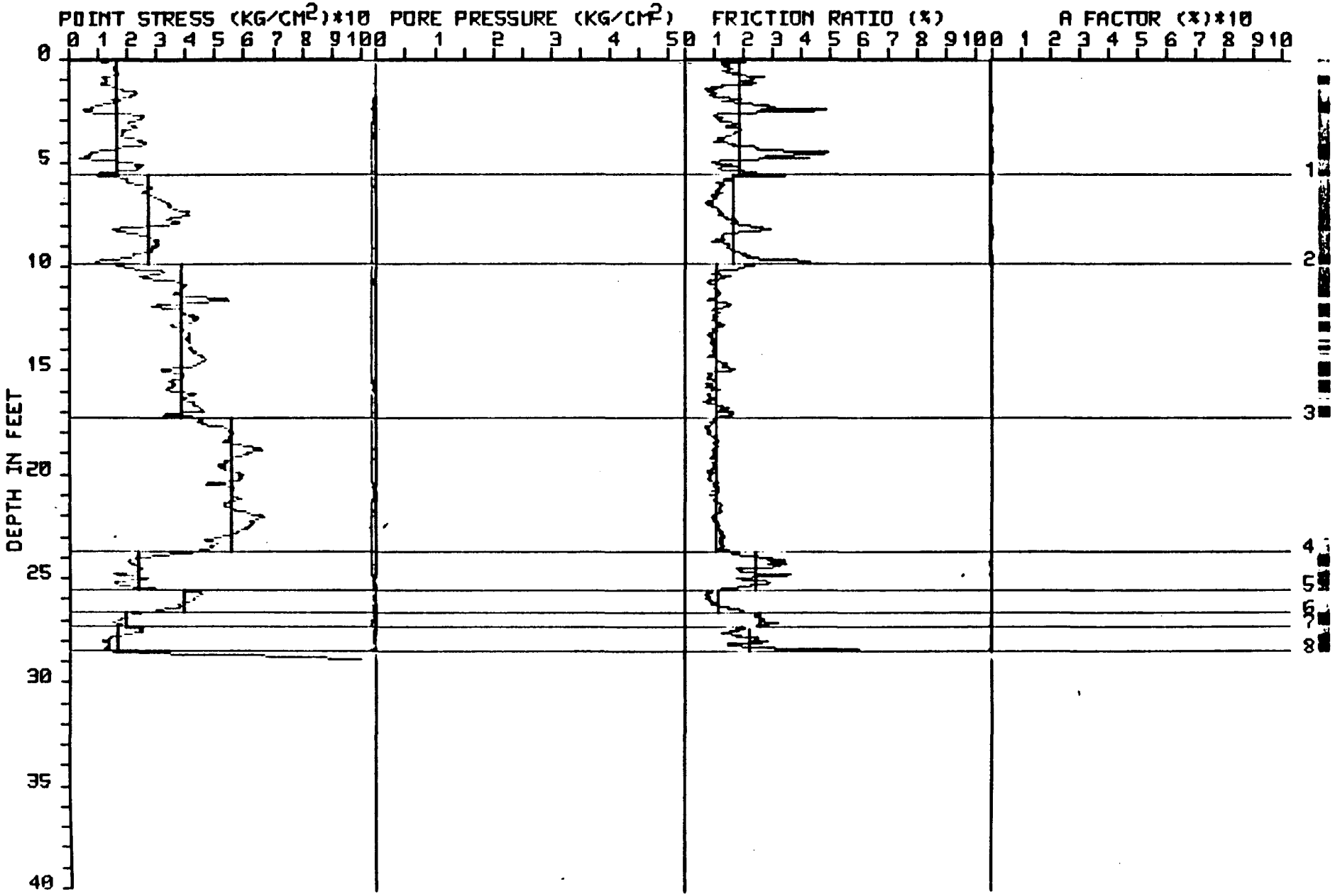


251

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 035

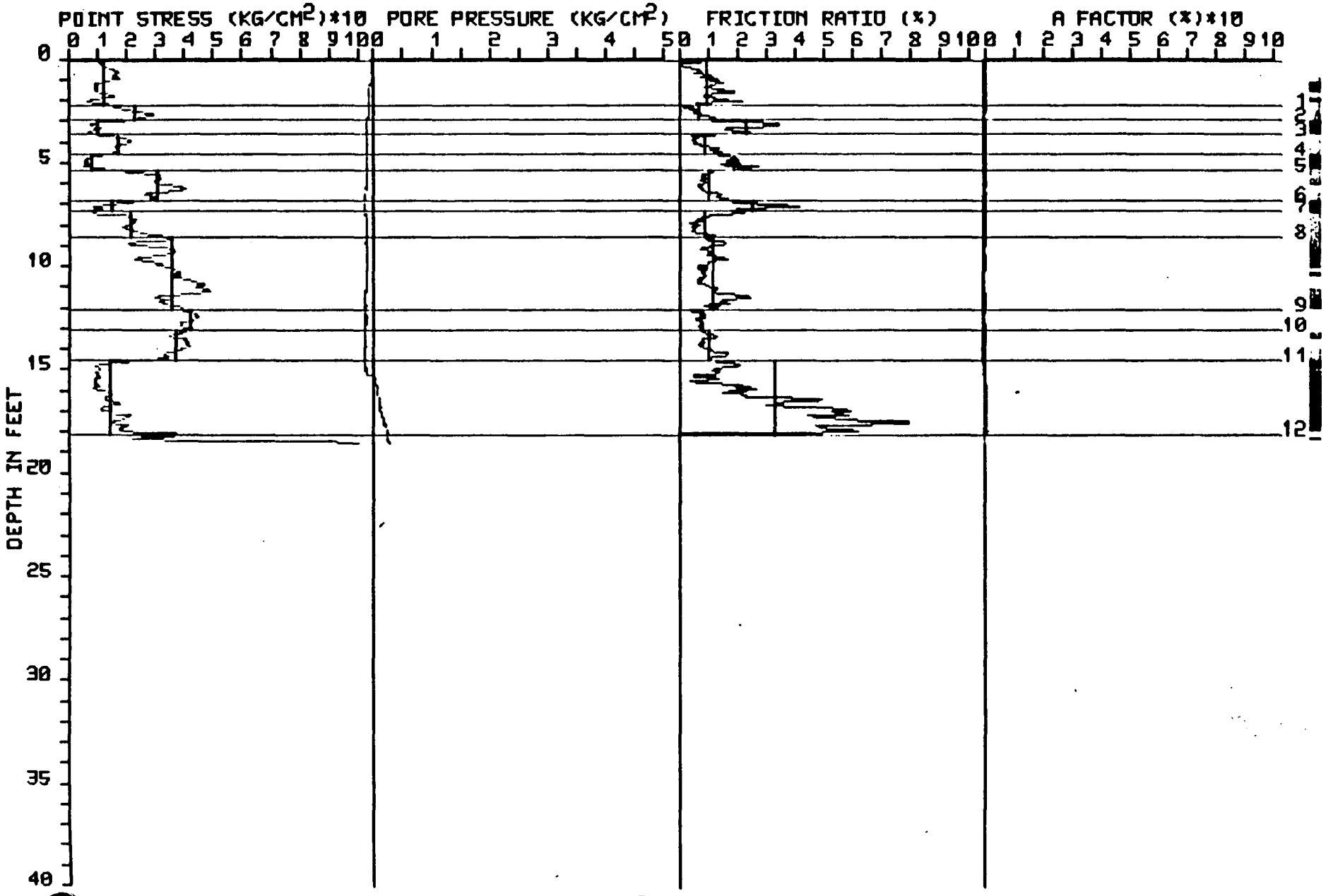


159

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 036

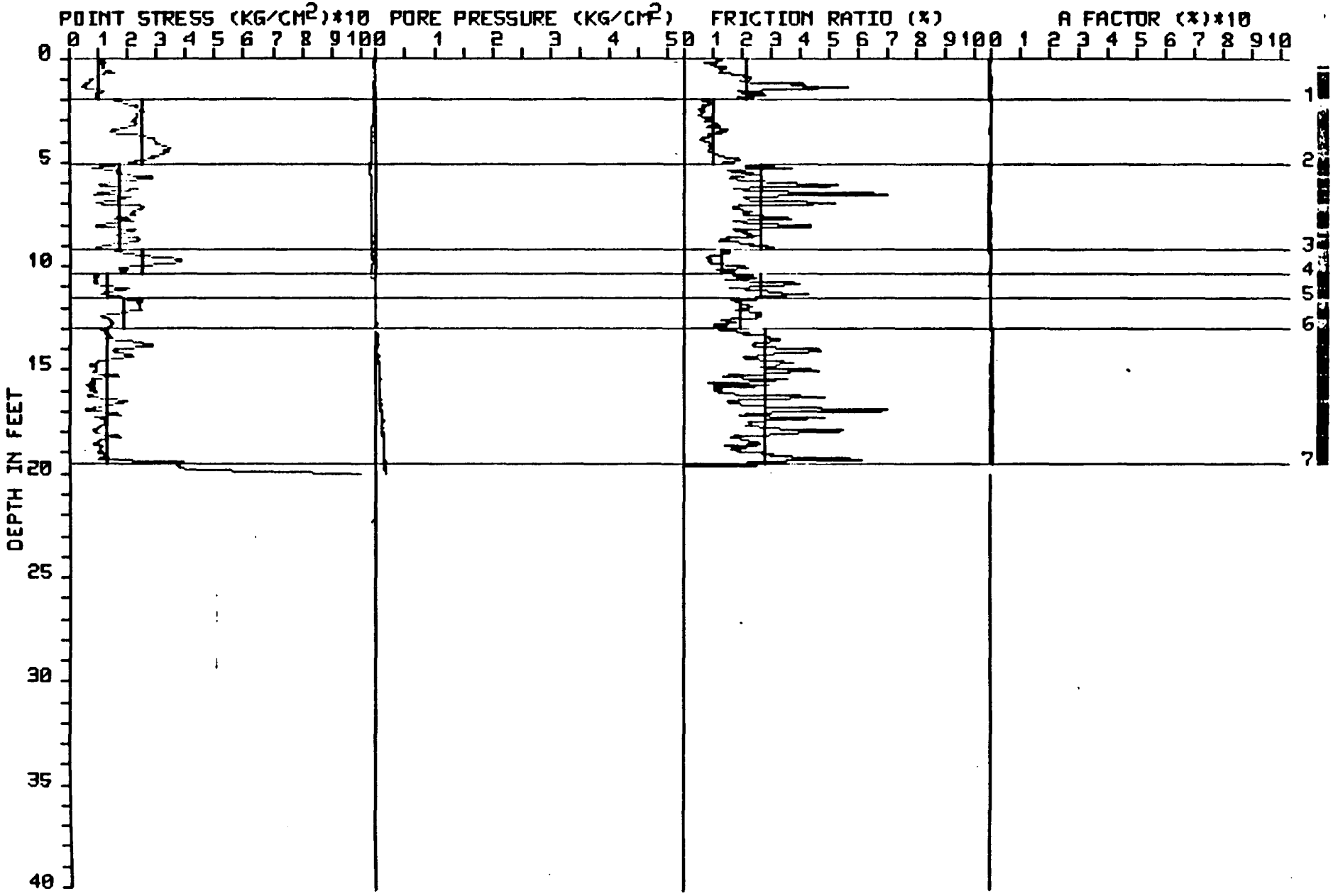


160

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 037

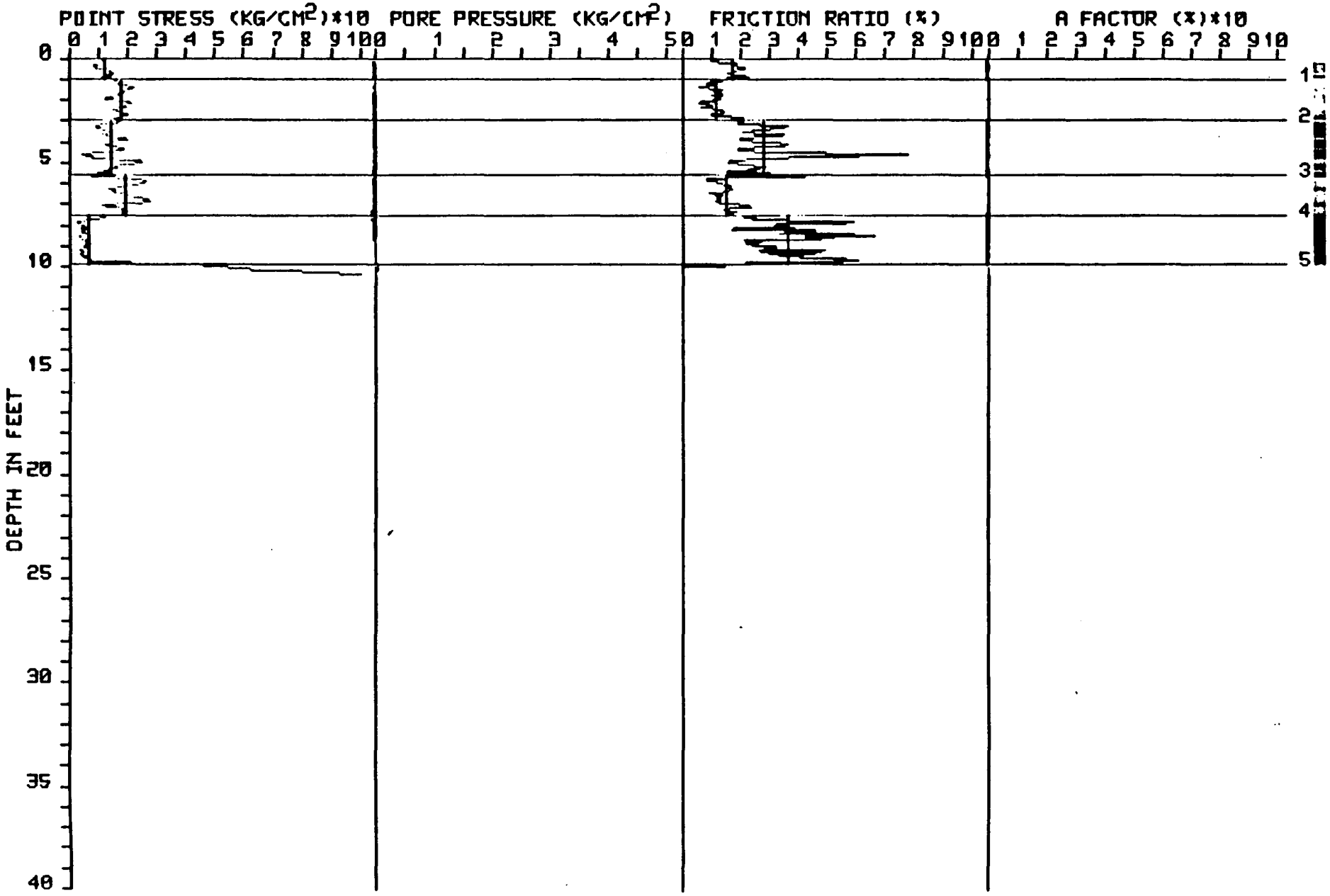


19

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 038

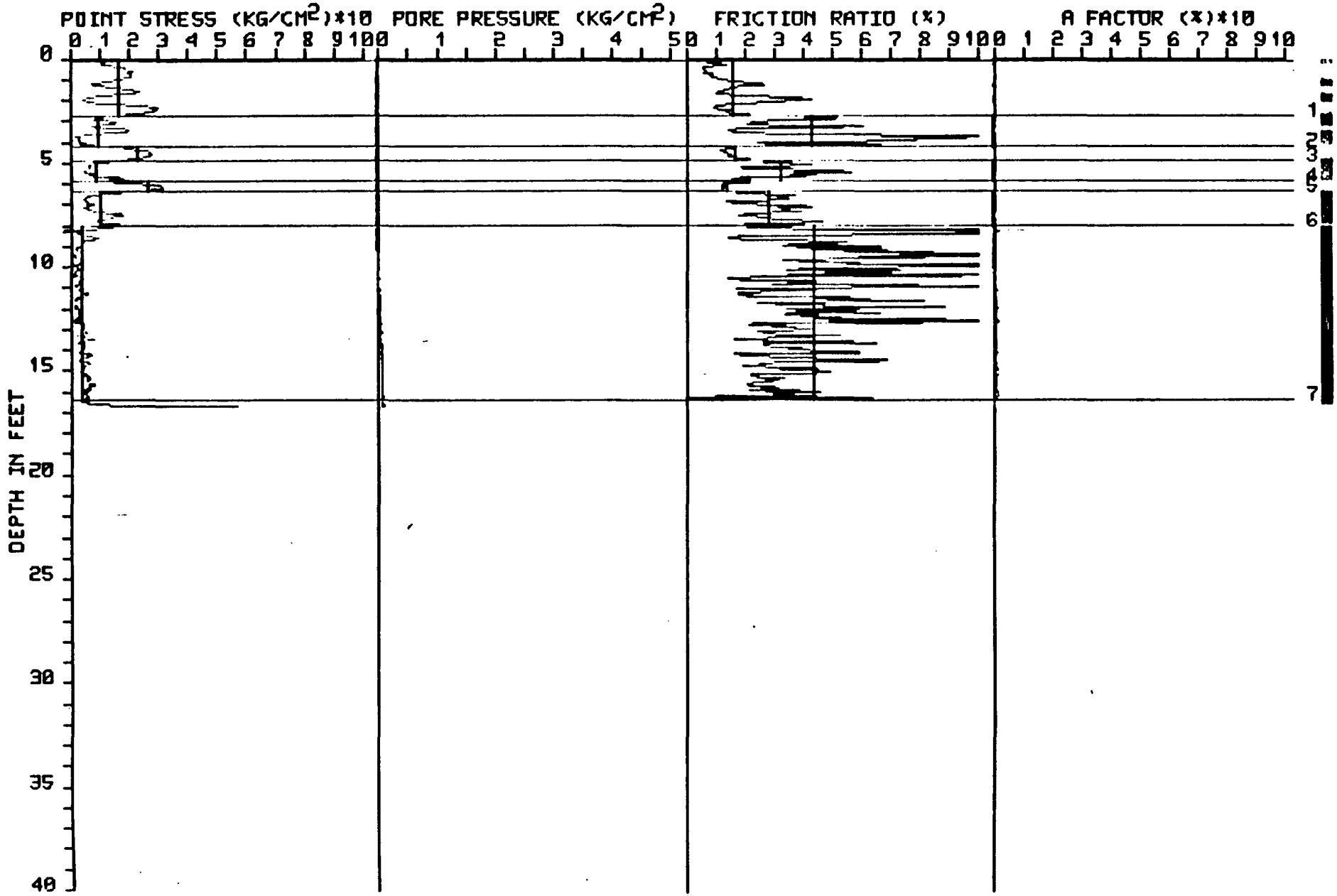


162

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 039

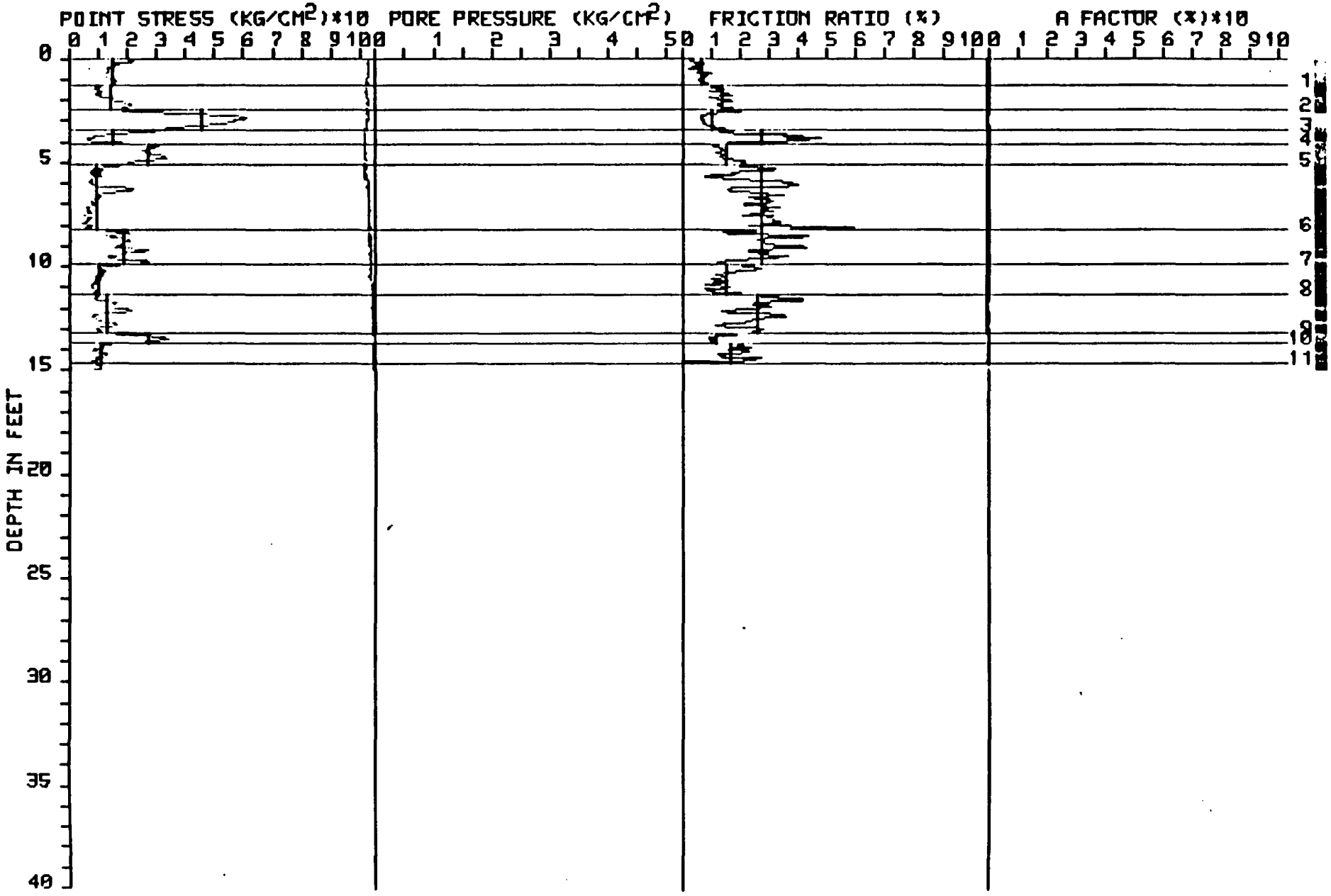


163

PIEZOCONE SOUNDING TEST

SITE ID: HAT01

LOCATION ID: 040



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SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 004
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.5	2.4	17.3	0.1	-0.0	0.6	S-SL*	5	41	30	61	2076	
2	2.5	10.8	8.3	7.6	0.2	0.0	2.5	SLIM	5			27	917	4.9
3	10.9	14.9	4.0	21.7	0.4	0.3	1.7	S-SL	7	37	29	76	2598	
4	14.9	17.7	2.8	8.4	0.3	0.6	3.5	SLIM	5			29	1007	1.9
5	17.8	19.2	1.4	40.7	0.6	1.2	1.4	S-SL*	13	47	31	142	4882	
% THK:		41	7.8	23.8	0.3	0.4	1.3	S-SL	7	40	30	83	2847	
% THK:		58	11.1	7.8	0.2	0.2	2.8	SLIM	5			27	939	4.1

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 005
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	2.7	2.6	13.8	0.1	-0.0	0.6	S-SL*	4	35	29	48	1661	
2	2.8	19.7	16.9	6.0	0.2	0.1	3.9	SLIM	3			21	718	2.5
% THK:		13	2.6	13.8	0.1	0.0	0.6	S-SL	4	35	29	48	1660	
% THK:		86	16.9	6.0	0.2	0.1	3.9	SLIM	3			21	718	2.5

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ADDENDUM D7

ADDITIONAL RADIOLOGICAL DATA

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Radon monitoring was performed at the Mexican Hat site from 08/27/85 until 09/22/86 in four separate quarterly periods: 08/27/85 to 11/21/85; 11/21/85 to 02/28/86; 02/28/86 to 06/06/86; and 06/06/86 to 09/22/86. Nineteen monitoring locations were established from the edge of the Mexican Hat site to 2500 meters away. Each monitoring location housed two to five film radon detectors. Multiple detectors were placed at each location to determine an average Rn-220 concentration and to avoid loss of data from a single damaged detector. The monitoring locations are illustrated in Figure D7.1. The mean radon concentration at each location for each quarterly period is given in Table D7.1.

Table D7.1 Background Ra-222 concentrations, Mexican Hat site, Utah

Location number	Concentration for the period (in pCi/l)			
	08/27/85 to 11/21/85	11/21/85 to 02/28/86	02/28/86 to 06/06/86	06/06/86 to 09/22/86
1	5.9	12	6.6	-
2	6.3	9.4	-	-
3	12	15	9.5	-
4	3.1	4.7	2.9	-
5	0.57	0.73	0.56	-
6	4.0	6.7	4.7	-
7	0.57	0.91	0.51	1.3
8	0.97	2.1	-	1.5
9	0.44	0.74	0.36	0.61
10	0.67	1.2	0.64	0.86
11	0.60	0.77	0.57	1.3
12	0.39	0.65	0.31	-
13	-[a]	0.47	0.27	0.48
14	-	0.64	0.40	-
15	0.84	1.3	0.76	1.2
16	0.45	0.98	-	-
17	1.1	2.0	0.97	-
19	0.20	0.37	0.30	0.36
20	0.62	0.94	0.48	0.51
Mean of nine background locations	0.50	0.78	0.42	0.74
Mean of four on site locations	6.8	10.3	6.3	-

[a]Indicates either damaged or stolen detector.

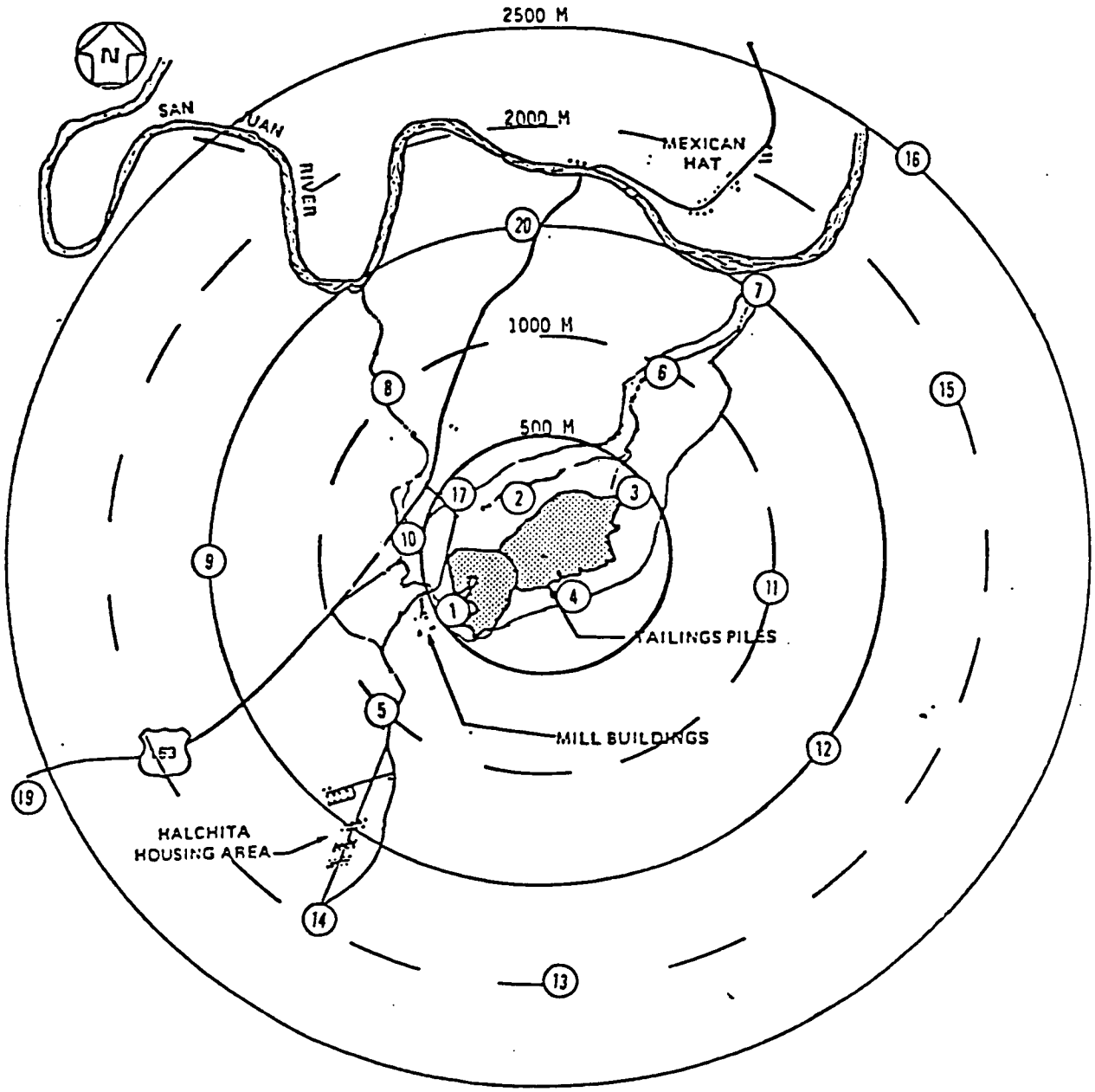

FIGURE D7.1
RADON MONITORING LOCATIONS
MEXICAN HAT, UTAH

Locations 1, 2, 3, and 4 are on the Mexican Hat uranium mill tailings site and may be used to determine the on-site radon concentration. The average radon concentration for the four sites ranged from 6.3 to 10.3 pCi/l for the four quarterly periods. Locations 5, 6, 8, 10, 11, and 17 are not on the site and are too close to the site to be considered background locations. Monitoring locations 7, 9, 12, 13, 14, 15, 16, 19, and 20 are 1500 meters or more from the site and may be considered background locations. The average background radon concentration over the nine background locations was 0.50 pCi/l for the period 08/27/85 to 11/21/85; 0.78 pCi/l for 11/21/85 to 02/28/86; 0.42 pCi/l for 02/28/86 to 06/06/86; and 0.74 pCi/l for 06/06/86 to 09/22/86. The background radon concentration in air shows a small seasonal variation with a range of 0.42 to 0.78 pCi/l.

Background gamma measurements were performed at four locations in the vicinity of the Mexican Hat site using a pressurized ionization chamber. Two measurements were performed at each location, giving an average gamma exposure rate of 11.6 μR/hr for the eight measurements. The locations of the background measurements were from 0.5 to five miles from the tailings site and are beyond the influence of the site. Gamma exposure rate is independent of the frequency and time of measurement for background measurements.

The arroyos extending beyond the 5 pCi/g windblown contamination limit are illustrated in Plate 1, Radiological Contamination Distribution Map. The contamination material was characterized using delta measurements and the data are summarized in Table D1.2 of Addendum D1. These data indicate that contamination may exist up to 2500 feet along the length of the four arroyos outside of the 5 pCi/g windblown boundary. Assuming a 100-foot width and a six-inch depth of contaminated material in the arroyos gives a volume estimate of 5500 cy. The average Ra-226 concentration is 10.4 pCi/g. This small volume of contaminated material will have a negligible impact on the final pile design.

Further characterization by the RAC will be necessary in the arroyos to determine the exact volume of contaminated materials since the contamination is largely associated with sandbars and probably does not cover the entire length and width of the arroyos. Zero- to six-inch soil samples may adequately characterize the materials in the arroyos north and east of the site. The arroyo at the northeast corner of the site will be characterized further downstream than is indicated on Plate 1 to a length of 1600 feet from the windblown border. This characterization will be performed by the RAC during remedial action.

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APPENDIX E

WATER RESOURCES PROTECTION STRATEGY

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E.1 SUMMARY

The performance of the Mexican Hat disposal cell will comply with the site-specific groundwater protection standards in 40 CFR 192.02(a)(3) as determined from an assessment of criteria established by the U.S. Nuclear Regulatory Commission (NRC) (NRC, 1988), which include an assessment of the hydrogeologic characteristics of the site, a design analysis of the disposal unit, and a performance assessment of the disposal site. The disposal cell will meet the concentration limits defined as the proposed U.S. Environmental Protection Agency (EPA) maximum concentration limits (MCL) or background water quality, whichever is higher, in the Honaker Trail Formation (the uppermost aquifer) at the point of compliance (POC). Seepage of tailings fluids into the Honaker Trail Formation is precluded by the strong upward hydraulic gradient between the Honaker Trail Formation and the Halgaito Shale Formation and the decrease in hydraulic conductivity with depth in the Halgaito Shale Formation in the area of the disposal cell. This upward hydraulic gradient is artesian in the vicinity of the tailings disposal cell. Because of the advantageous hydrogeologic setting, the remedial action will comply with the proposed EPA groundwater protection standards. In addition, the transient drainage of water added to suppress dust and compact relocated tailings, and tailings drainage that occurs prior to equilibration with the infiltration rate through the cover, will not cause the proposed EPA groundwater protection standards to be exceeded because of the advantageous hydrogeologic setting.

Several components of the cover design will provide additional conservatism for compliance with the proposed EPA groundwater protection standards. The proposed cover design is a three-component cover system that consists of a radon/infiltration barrier composed of highly compacted bentonite-amended soil, a bedding (filter) layer of sand, and a rock erosion layer. The combination of the filter layer and low-hydraulic conductivity radon/infiltration barrier will restrict infiltration through the tailings.

A hydrogeologic characterization of the Mexican Hat site is presented in Appendix D, Site Characterization. Further development of the water resources protection strategy is included in this appendix.

The combination of a low cover flux and arid climate will reduce the discharge of tailings fluids that created the perched water and the area of saturation within the Halgaito Shale Formation. The volume of water expelled from the cell due to transient drainage, consolidation, and construction water is minimal and is not expected to affect the design of the cell. Approximately 8600 acre-feet of water were used to slurry the tailings during mill operations. After operations had stopped, both the upper and lower piles continued to pond water periodically from precipitation and surface runoff; this would add to the amount of water that could infiltrate into the bedrock.

E.2 DISPOSAL SITE FEATURES THAT PROTECT WATER RESOURCES

The Mexican Hat disposal site lies within a geomorphically stable area of the Navajo Uplands section of the Colorado Plateau physiographic province (DOE, 1987). The lower pile at Mexican Hat will be left in place; the upper pile at Mexican Hat and contaminated materials from the Monument Valley site have been relocated and consolidated onto the lower pile. The base of the lower pile varies in elevation from 4240 feet to approximately 4300 feet, and overlies thin alluvial materials in pre-existing arroyos that were cut into sandstone bedrock. A diagrammatic cross section of the proposed disposal cell is shown in Figure E.2.1.

In terms of groundwater protection and long-term performance of the disposal cell at Mexican Hat, the following design considerations are important.

E.2.1 CLIMATE

The climate in the vicinity of the Mexican Hat disposal site is arid. Infrequent late summer and fall rainstorms furnish a large portion of the total annual precipitation. For a 30-year period of record, the average annual precipitation at Mexican Hat was 6.09 inches (DOE, 1987). Approximately 46 percent of the average annual precipitation occurs during July through October. Estimated pan evaporation is 84.41 inches annually (Stevens et al., 1983); thus, the ratio of pan evaporation to precipitation is 14 to one. This large evaporation rate would tend to minimize infiltration through the cover.

To estimate average annual recharge from precipitation at the Mexican Hat site, a comparison was made with the average annual recharge rate at another Uranium Mill Tailings Remedial Action (UMTRA) Project site in Green River, Utah, where a water balance survey was conducted by Rush et al. (1982). The climate at Green River is very similar to the Mexican Hat site; both have an average annual precipitation of six inches. An average annual recharge rate of one percent (or less) of the average annual precipitation was estimated by an empirical method developed for desert regions (Eakin et al., 1951; Rush et al., 1982). This would be a conservatively high estimate because it assumes a maximum potential for soil wetting depths. Because the soil at Green River is relatively coarse-textured, the moderately high permeability results in a high potential for infiltration from direct precipitation. It is reasonable to assume that the cover at the Mexican Hat disposal site would allow a similar rate of annual infiltration, or less, since the cover consists of a highly-compacted, bentonite-amended radon/infiltration barrier. Details of the cover design are presented in Section E.2.3.1. A more complete discussion of the performance of the cover for limiting infiltration is presented in Section E.2.3.2. One percent of six inches of precipitation at the Mexican Hat site per year is 0.06 inch (0.15 cm) per year, or an equivalent steady rate of 1.9×10^{-9} inch/second [5×10^{-9} centimeters per second (cm/s)].

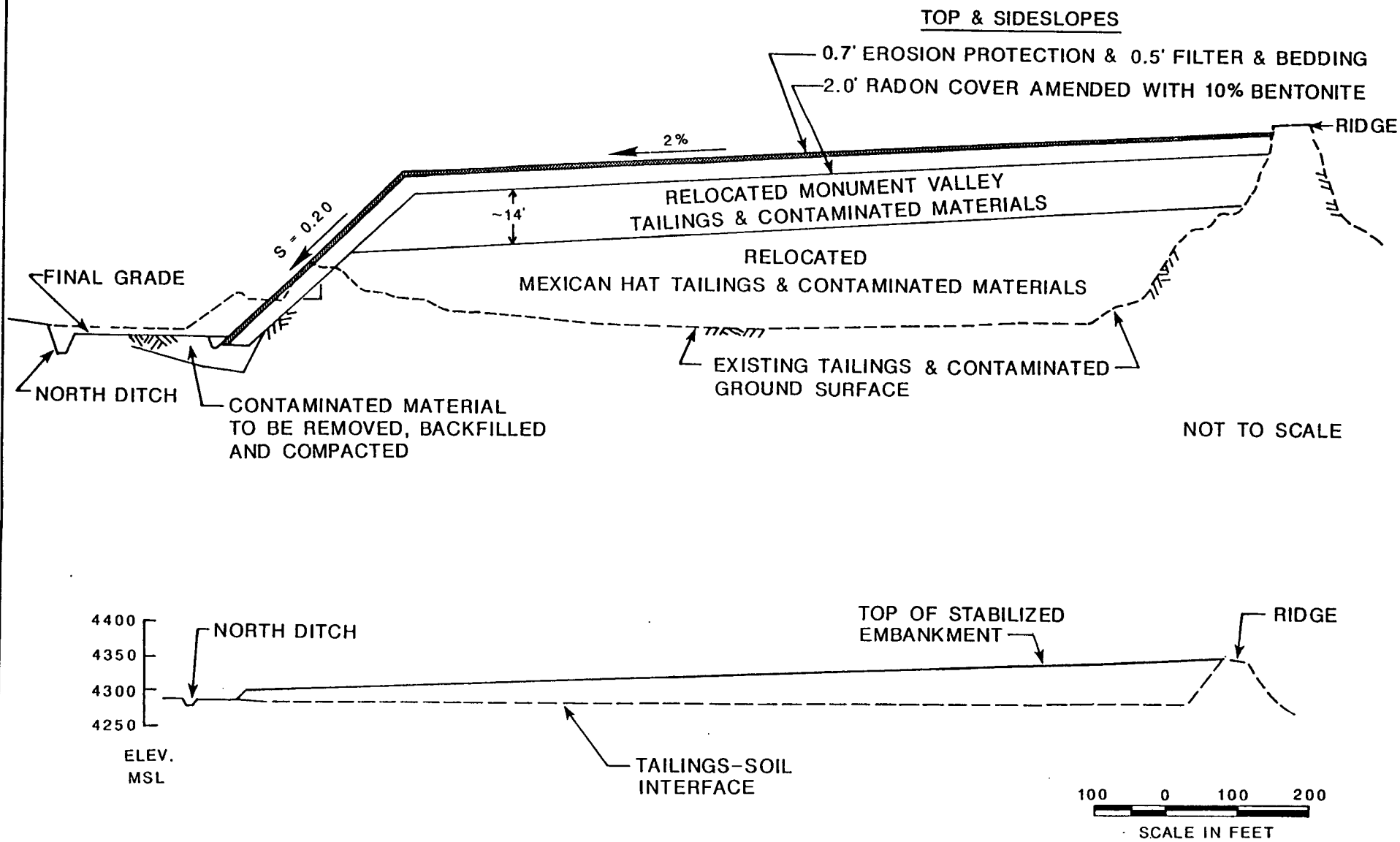

FIGURE E.2.1
TYPICAL CROSS SECTION OF THE DISPOSAL CELL
MEXICAN HAT SITE

E.2.2 TAILINGS SEEPAGE AND SUBSURFACE DRAINAGE

Drainage of tailings seepage into the cell foundation will occur as a result of percolation through the disposal cell. Because of this, tailings drainage or long-term infiltration through the cover of the disposal cell should not create perched water at the contact of the tailings with foundation materials, and neither the foundation nor the tailings should become saturated. The siltstone/sandstone bedrock of the Halgaito Shale Formation, which forms the foundation of the stabilized pile, has a hydraulic conductivity two to three orders of magnitude higher than the tailings materials and radon/infiltration barrier.

E.2.3 COVER DESIGN

The Mexican Hat disposal cell cover will consist of various layers intended to 1) prevent radon emanations to the atmosphere; 2) limit the amount of infiltration into the contaminated materials from direct precipitation over the pile; 3) limit or prevent erosion from surface flow; and 4) promote evaporation and runoff from the pile and prevent surface ponding.

The following section describes the cover design that will limit infiltration into the tailings. The reasons for incorporating the individual cover components, and the design specifications for each, are discussed in Section E.2.3.1. The performance of the cover with regards to longevity and infiltration is discussed in Section E.2.3.2. Figure E.2.1 shows a diagrammatic cross section through the disposal cell, and the details of the cover design on the top and the sideslopes.

E.2.3.1 Cover components

Radon/infiltration barrier

The compacted soil radon/infiltration barrier is a standard feature on UMTRA Project piles. It will be designed and placed in accordance with conventional and accepted UMTRA Project procedures. The soil will be mixed with 10 percent sodium bentonite (obtained from a commercial source). The estimated saturated hydraulic conductivity of the radon/infiltration barrier (from laboratory testing--Appendix B, Calculation 9-421-01-00) will be 5×10^{-8} cm/s to 3×10^{-7} cm/s, depending on the laboratory test method and the bentonite source. The radon/infiltration barrier will be placed in a two-foot-thick layer on the top and sideslopes and compacted to 100 percent standard Proctor density.

Bedding (filter) layer

The bedding/filter layer serves the following functions: 1) a filter to prevent erosion of the radon barrier by interstitial flow; 2) a bedding layer for the erosion barrier; 3) a

drain that sheds water laterally (downslope) off the pile. The bedding/filter layer will be six inches thick and will be constructed of clean sand.

Erosion barrier

An erosion barrier of rock will be designed and placed at the Mexican Hat site in accordance with conventional and accepted UMTRA Project procedures. The rock erosion protection is sized to withstand sheet erosion during a Probable Maximum Precipitation (PMP) event. The rock layer will also prevent burrowing animals and most plant roots from penetrating through to the radon/infiltration barrier. The erosion barrier will be placed in an eight-inch-thick layer and will consist of durable rock.

E.2.3.2 Cover performance

The performance of the cover must meet the longevity requirement of 40 CFR 192.02, which states that the design must be effective for up to one thousand years, to the extent reasonably achievable, and in any case, for at least 200 years. The cover will be constructed of durable earth materials that meet the longevity requirement. The materials will be placed so that geomorphic processes will not alter their performance with time.

Although long-term seepage of tailings fluids from the disposal facility is not a factor in meeting the concentration limits at the POC in the uppermost aquifer, the cover design will restrict infiltration to at least the ambient annual rate of recharge of 0.06 inch/year (5×10^{-9} cm/s) or to the unsaturated hydraulic conductivity of the radon/infiltration barrier. This will reduce the discharge of tailings fluids that created the perched water and the area of saturation within the Halgaito Shale Formation.

E.2.4 DISPOSAL CELL DESIGN AND GEOLOGIC SETTING

The tailings and other contaminated materials from the Mexican Hat and Monument Valley sites would be consolidated into a single embankment at the Mexican Hat site. The stabilized disposal cell would then be covered with a two-foot radon barrier, a six-inch layer of filter and bedding material, and an eight-inch-thick layer of small diameter rock on the topslopes and a 12-inch-thick layer of small diameter rock on the sideslopes for erosion protection.

The Mexican Hat disposal cell overlies the Halgaito Shale Formation, which unconformably overlies the Honaker Trail Formation in the site vicinity. The cell design favors the hydrogeologic isolation for moisture exiting the disposal cell. The design augments the natural setting by incorporating a low cover flux on the order of 10^{-9} cm/s and

controlling the use of construction water. The amount of transient drainage and water released during consolidation is minimal compared to the volume of water that infiltrated through the subsurface during milling operations.

E.2.4.1 Transient drainage

Transient drainage modeling for the Mexican Hat disposal cell was not performed. Based on a simple mass balance calculation, however, a maximum of 243 acre-feet of water may be expelled from the cell throughout its design life (see Calculation HAT-11-91-12-02, Appendix F). An assumption in the mass balance calculation is that because of arid conditions at the site, precipitation will contribute an insignificant amount of water to the total volume of pore fluid contained in the contaminated material matrix. The potential total volume of drainage from the disposal cell is small compared to the volume of water that infiltrated into the subsurface during milling operations (approximately 8500 acre-feet).

E.2.4.2 Water released during consolidation

Due to consolidation, tailings discharge water may have migrated from the saturated slimes in the lower tailings pile when the upper pile material was placed on top. Most of the lower tailings pile consists of sand-slime combinations or sands. Based on settlement readings, the lower tailings pile expelled approximately six acre-feet due to consolidation (DOE, 1990).

E.3 DISPOSAL AND CONTROL OF RADIOACTIVE MATERIALS AND NONRADIOACTIVE TOXICS

E.3.1 GROUNDWATER PROTECTION STANDARDS FOR DISPOSAL

The proposed groundwater standards (40 CFR 192.02) require three basic elements for setting the groundwater protection standards. These are 1) determination of hazardous constituents; 2) proposal of a concentration limit for each hazardous constituent found to exist in the tailings or leachate; and 3) specification of the POC. The groundwater protection standard applies to the uppermost aquifer hydraulically downgradient from the disposal unit (NRC, 1988). Definitions of the uppermost aquifer provided in 10 CFR 40, Appendix A, were used to implement the groundwater protection standards of 40 CFR 192, Subparts A-C. The Honaker Trail Formation is defined as the uppermost aquifer at the Mexican Hat disposal site. This is where the proposed EPA groundwater standards apply.

At the Mexican Hat disposal site, the Halgaito Shale Formation is not considered the uppermost aquifer because the groundwater found in this zone is saturation created by uranium recovery operations. Consequently, there is no native groundwater and, thus, no "background" water quality data for the Halgaito Shale Formation. Fluids derived from tailings seepage sampled in monitor wells completed within the Halgaito Shale Formation have a relatively high total dissolved solids (TDS) content, with a mean TDS concentration greater than 4000 milligrams per liter (mg/l). Maximum observed concentrations of chromium, molybdenum, uranium, and nitrate and the activities of net gross alpha exceed the EPA MCLs. After the tailings have been reconfigured into a disposal cell and covered with a low permeability radon/infiltration barrier, the tailings seepage to the Halgaito Shale Formation will become negligible.

Water discharges from seeps in the North Arroyo exhibit maximum observed concentrations or activities of molybdenum, net gross alpha, nitrate, and uranium above MCLs. Discharges from these seeps are from milling operations-related water. Water discharges from Gypsum Creek seep GS-3 (254) are also from milling operations-related water based on major cation/anion chemistry, elevated nitrate concentrations, and elevated uranium concentrations. Discharges from other seeps in Gypsum Creek have a similar water quality type to Honaker Trail Formation groundwater. However, five Gypsum Creek seeps exhibit concentrations of uranium elevated generally an order of magnitude above background for the Honaker Trail Formation. These seeps have a component of discharge derived from milling operations-related water. Gypsum Creek is dry most of the time, except for short periods after heavy rains or snow melts. Therefore, these seeps are discharging to a dry arroyo most of the time, and not to a surface water body.

Groundwater in the Halgaito Shale Formation and the Honaker Trail Formation in the vicinity of the Mexican Hat site is not used as a source of drinking water or for other domestic or beneficial purposes. Groundwater has not been developed in the Halgaito Shale Formation because of the limited areal extent of saturation in the site vicinity and the low hydraulic conductivity of the member, which results in low yields to wells. Once the disposal cell is constructed, transient

tailings seepage will decrease with time and will not contribute to existing levels of saturation. Because there will be no artificial source of recharge, the Halgaito Shale Formation will return to its former unsaturated condition.

E.3.1.1 Hazardous constituents

Hazardous constituents within the tailings at the Mexican Hat and Monument Valley sites have been identified based on characterization of the tailings materials. A description of the uranium recovery process and evaluation of groundwater quality data are discussed in Appendix D.

To be a hazardous constituent, a chemical should satisfy two criteria as follows: 1) it is present in or is reasonably expected to be present in, or derived from, the residual radioactive material stabilized at the disposal site; and 2) it is listed in Table 1 and Appendix I of 40 CFR 192. Dissolved constituents listed in Appendix IX of 40 CFR 264 are used to satisfy the analytical requirements for compounds listed in Appendix I of 40 CFR 192.

The chemical characteristics of the Mexican Hat tailings were evaluated by pore water sampling with suction lysimeters. Four suction lysimeters were installed in the tailings piles by the DOE in 1990 and sampled in 1990 and 1991 (Table D.7.6 and Section D.7.9). Some lysimeters produced water too turbid to be field filtered. In these cases, unfiltered samples were analyzed and the results were reported as total concentrations. Inorganic hazardous constituents with MCLs that exceed the laboratory method detection limits in tailings pore water are listed in Table E.3.1 and include arsenic, barium, cadmium, chromium, lead, molybdenum, mercury, net gross alpha, nitrate, silver, and uranium. As explained in Section D.7.9., radium-226 and -228 is assumed to exceed laboratory method detection limits in tailings pore water. For characterization purposes, mean or median tailings pore water quality were compared to MCLs. MCLs were exceeded for the mean or median observed concentrations or activities of arsenic, cadmium, net gross alpha, selenium, and uranium in tailings pore water. Concentrations of elements listed individually or included in compounds that are listed in Appendix I of 40 CFR 192 or in Appendix IX of 40 CFR 264 that exceed the laboratory method detection limit include aluminum, ammonium, antimony, beryllium, cobalt, copper, fluoride, nickel, strontium, tin, vanadium, and zinc.

The estimated source term concentrations for the Monument Valley tailings are the maximum values from the analyses of samples from the lysimeters emplaced in the tailings pile (Table E.3.1). These maximum values are conservative estimates of the pore fluid composition within the Monument Valley tailings.

There are an estimated 2,810,000 cubic yards of contaminated material at the Mexican Hat site and another 1,900,000

Table E.3.1 Estimated source term concentrations for the Mexican Hat disposal cell

Hazardous constituent	Proposed EPA MCL[a]	Maximum concentration in Mexican Hat tailings[b]	Maximum concentration in Monument Valley tailings[c]	Maximum source term concentration[d]
Antimony	NA	0.038	<0.003	0.04
Arsenic	0.05	5.4	<0.01	5.4
Barium	1.0	0.02	0.5	0.5
Beryllium	NA	0.009	ND	0.009[e]
Cadmium	0.01	0.111	<0.001	0.11
Chromium	0.05	0.13	0.05	0.13
Cobalt	NA	3.9	1.41	1.41
Copper	NA	14.1	0.14	14.1
Cyanide	NA	ND	ND	ND
Fluoride	NA	5.1	1.7	5.1
Net gross alpha	15.0 pCi/l	1843 pCi/l	ND	1843 pCi/l[e]
Lead	0.05	0.037	<0.01	0.04
Mercury	0.002	0.0003	<0.0002	0.0003
Molybdenum	0.1	0.18	0.32	0.32
Nickel	NA	2.6	1.10	2.6
Nitrate	44.0	6.5	570.0	570
Radium-226 and -228	5.0 pCi/l	ND	13.0[f]	13[e]
Selenium	0.01	0.015	<0.005	0.015
Silver	0.05	0.08	<0.01	0.08
Sulfide	NA	<0.8	ND	<0.8[e]
Thallium	NA	<0.03	ND	<0.03[e]
Tin	NA	0.025	<0.005	0.025
Uranium	0.044	1.53	1.08	1.53
Vanadium	NA	0.67	1.08	1.08
Zinc	NA	6.88	3.86	6.88

NOTE: <: Below detection limit.
NA: MCL presently not assigned.
ND: No data available.

[a]All concentrations mg/l except as noted.
[b]Maximum concentration analyzed from samples withdrawn from tailings lysimeters.
[c]Maximum concentration analyzed from samples withdrawn from lysimters completed within the Monument Valley tailings.
[d]Weighted average based on percent contaminated materials in the Mexican Hat and Monument Valley tailings.
[e]No data were available for this parameter at one of the tailings sites; therefore, the maximum concentration for either site was used for the maximum average concentration.
[f]Radium-226 only.

cubic yards at the Monument Valley site. The disposal cell will therefore contain 4,710,000 cubic yards of contaminated material. Tailings pore fluids in the disposal cell at Mexican Hat will be a mixture of fluids in the codisposal tailings. The expected source term concentration will be the maximum observed concentration of a particular constituent from either of the two sites. The source term concentration or activity is presented in Table E.3.1.

Sampling of the tailings and groundwater at both Monument Valley and Mexican Hat indicated that no Appendix IX 40 CFR 264 organic constituents related to uranium processing are present. Therefore, Appendix IX organic constituents were given no further consideration as hazardous constituents.

E.3.1.2 Proposed concentration limits

Pursuant to 40 CFR 192.02(a)(3) (ii and v) and 264.94, the proposed concentration limits for the hazardous constituents identified within the tailings at the Mexican Hat site must be met at the POC. The POC is discussed in Section E.3.1.3.

Concentration limits, where proposed, at the Mexican Hat disposal site are defined as the MCLs or background, whichever is higher for hazardous constituents that exceed laboratory method detection limits.

To achieve compliance with the proposed EPA groundwater protection standards at the Mexican Hat disposal site, the DOE proposes to meet MCLs or background concentrations in groundwater in the uppermost aquifer (Honaker Trail Formation) for the hazardous constituents listed in Table E.3.1. The statistical definition of background water quality and what constitutes an excursion of the concentration limits will be further defined in the long-term surveillance plan and reevaluated as groundwater sampling continues. Background water quality for the Honaker Trail Formation is discussed in Appendix D, Site Characterization.

E.3.1.3 Point of compliance

Seepage of tailings fluids into the Honaker Trail Formation is precluded by the upward gradient between the Honaker Trail Formation and the Halgaito Shale Formation and a decrease in hydraulic conductivity with depth in the area of the tailings pile. This upward hydraulic gradient is artesian in the vicinity of the tailings disposal cell. Because of the advantageous hydrogeologic setting, the Honaker Trail Formation groundwater will not be monitored. Therefore, there will not be a POC at this site. The performance monitoring is described in Section E.3.4.

E.3.2 PERFORMANCE ASSESSMENT

The performance of the disposal cell will comply with the groundwater protection standards in 40 CFR 192.02 as determined from an assessment of the hydrogeologic characteristics of the site, a design analysis of the disposal unit, and a performance assessment of the disposal site. There are two areas of concern: compliance with groundwater standards in the Honaker Trail Formation, and the risk associated with seeps. The disposal cell will meet the concentration limits defined as the proposed EPA MCLs or background water quality, whichever is higher, in the Honaker Trail Formation (the uppermost aquifer) at the POC.

Several components of the cover design will provide additional conservatism for compliance with the proposed EPA groundwater standards. The combination of the filter bedding and low-hydraulic conductivity radon/infiltration barrier will restrict infiltration through the tailings to at least the estimated ambient annual recharge rate of 0.06 inch/year (5×10^{-9} cm/s) (Rush et al., 1982). However, recent field studies at two UMTRA sites that have climate and cover design characteristics similar to the Mexican Hat disposal site have shown infiltration may be even less because the barriers at these two sites are unsaturated (DOE, 1989). Thus, the moisture conditions in the radon barrier at Mexican Hat should closely approximate the measured moisture conditions at these two sites and be unsaturated (DOE, 1989).

Water added to suppress dust and compact relocated tailings will be controlled; tailings drainage that occurs prior to equilibration with the infiltration rate through the cover will not cause the proposed EPA groundwater standards to be exceeded, as the seepage rate will be less than that which occurred from the tailings during processing activities. Seepage of tailings fluids into the Honaker Trail Formation is precluded by the upward gradient between the Honaker Trail Formation and the Halgaito Shale Formation and a decrease in hydraulic conductivity with depth in the area of the tailings pile. This upward hydraulic gradient is artesian in the vicinity of the tailings disposal cell. Because of the advantageous hydrogeologic setting, the remedial action is expected to comply with the EPA groundwater protection standards.

E.3.3 RISK ASSOCIATED WITH SEEPS

The risk assessment for the seeps at the Mexican Hat uranium mill tailings site near Mexican Hat, Utah, was undertaken to determine if exposures to chemical and radiological constituents in the seeps pose risks to humans, wildlife, and domestic animals.

The human health assessment was carried out for limited direct human exposure to seep water through seep water ingestion, and also for the indirect seep water-to-cattle-to-human pathways involving ingestion of homegrown meat and milk.

The ecological assessment focused upon freshwater aquatic organisms and domestic cattle, since sufficient data existed to quantify risks in these two cases. Risks to freshwater aquatic life were assessed using

Ambient Water Quality Criteria (AWQC) defined by the EPA, when these values were available. Cattle were assumed to be exposed to seep constituents via seep water ingestion and ingestion of seep-contaminated vegetation.

Five contaminants of concern were identified for the assessment of chemical risks: antimony, manganese, molybdenum, nickel, and uranium. Uranium was also analyzed as a radiological contaminant of concern.

The results of the assessment for potential chemical risks indicate that:

- Ingestion by humans of approximately 16 liters per year of seep water during occasional visits to Gypsum Wash or the North Arroyo is not expected to result in adverse noncarcinogenic health effects. The ingestion of meat and milk from cattle grazing at the seeps and drinking seep water is also not expected to result in adverse noncarcinogenic health effects.

- Based upon AWQC, the concentrations of antimony, cadmium, and nickel are below levels of concern for 95 percent of freshwater aquatic organisms. Based upon other toxicity data, concentrations of manganese and molybdenum are unlikely to cause significant adverse effects to aquatic life. Insufficient data on uranium precluded an assessment of its nonradiological effects on aquatic organisms.

- Cattle drinking seep water and browsing upon vegetation derived from seep water for approximately 160 days per year are not expected to suffer adverse noncarcinogenic health effects due to ingestion of the contaminants of concern.

The results of the radiological risk assessment indicate that a person who drinks 16 liters of seep water in one year from the North Arroyo, and who also consumes milk and meat from cattle that browse at the seeps, would ingest uranium sufficient to give an excess cancer risk of one in one million. The consumption of water from the seeps at Gypsum Wash would result in a lower risk from the ingestion of uranium because of the lower concentrations of uranium at the wash (JEG, 1990).

E.3.4 GROUNDWATER PERFORMANCE MONITORING PROGRAM

Pursuant to 40 CFR 192.020, this section addresses a monitoring plan to be carried out during the post-disposal period. Details of a performance monitoring plan will be supplied in a long-term surveillance plan. However, a conceptual plan for monitoring existing contamination in the Halgaito Shale is described here. Water quality impacts in the Honaker Trail Formation have not been observed, even though processing activities began over 30 years ago. Because of the hydrogeologic setting, water quality degradation should not occur in the future.

Seep water quality will be monitored in Gypsum Creek and the North Arroyo until a determination is made as to whether additional remedial action is necessary under Subpart B of 40 CFR 192. Groundwater

monitoring at these points would allow observation of seep flow and water quality changes with time. The volume of contaminated water in the Halgaito Shale is expected to diminish. This would be demonstrated by decreasing seep flow or decreasing contaminant concentrations in seep water.

This conceptual plan recommends seep monitoring instead of monitoring by point of compliance wells in the Honaker Trail Formation. If in the future, a disposal cell failure were to occur and contaminated water entered the Halgaito Shale, routine seep monitoring would allow for the observation of such an occurrence. This is because the only known flow path at the site is from the cell to the Halgaito Shale, then to either the North Arroyo seeps or Gypsum Creek seeps. A flow path from the Halgaito Shale to the Honaker Trail Formation is not expected to occur owing to the upward hydraulic gradient and aquitard between the two formations.

E.3.5 CORRECTIVE ACTION PLAN

Pursuant to 40 CFR 192.02, this section addresses a corrective action plan to bring the disposal site into compliance if the proposed EPA groundwater standards are found or projected to be exceeded. Proposing a specific, detailed action plan to clean up or control the movement of groundwater at this time is not possible; however, Table E.3.2 summarizes potential failure modes for the Mexican Hat disposal cell and potential remedial action for those modes. Should a failure of the cell occur or the site be found not to be in compliance, a corrective action plan shall be formulated and implemented within 18 months. The corrective action plan would probably involve an application of supplemental standards in the Honaker Trail Formation, because the groundwater in that aquifer is Class III.

E.3.6 GROUNDWATER CLEANUP

The need for and extent of groundwater cleanup at the Mexican Hat and Monument Valley processing sites will be determined based on the extent of the existing contamination, the potential for current or future use of the aquifer for drinking water supplies, and the technical practicability of restoring the aquifer from an engineering perspective. The relocation of the Monument Valley processing site tailings to the Mexican Hat disposal site will remove the source term and not affect the ability to perform groundwater cleanup at the Monument Valley site. Studies are currently underway to develop plans, guidance materials, and procedures for groundwater cleanup activities. The decision as to the need for and extent of groundwater cleanup, required to be addressed under 40 CFR 192 Subparts B and C, will be made as part of a separate process under the National Environmental Policy Act (NEPA). These investigations will be carried out during the Subpart B groundwater restoration phase.

Based on the present level of site characterization, no groundwater cleanup is anticipated at the Mexican Hat processing site. The uppermost aquifer, the Honaker Trail Formation, has not been and is not expected to

Table E.3.2 Corrective action plan summary for the Mexican Hat disposal site

Failure scenario	Remedial action
Contaminated seepage emerges in artificially induced springs below the pile.	Modify cover to eliminate excess infiltration
Groundwater quality deteriorates off-site due to tailings seepage.	Perform a risk assessment, then modify cover and apply institutional controls (groundwater restoration impractical) or apply for supplemental standards
Radon barrier cracks due to desiccation.	Replace high permeability filter layer with lower permeability filter layer
Erosion protection layer siltates.	No action needed unless it increases infiltration or induces vegetation
Vegetation threatens integrity of radon barrier.	Apply biointrusion barrier
Animals intrude into the pile.	Modify rock cover
Frost heave affects the cover.	Not realistic failure scenario[a]
Cover erodes.	Not realistic failure scenario (pile is designed for PMP and PMF[b] events)

[a]Frost heave is not anticipated to be a problem for the following reasons:
- Frost penetration in the area is shallow.
- Because of the arid climate, the radon barrier is not expected to be saturated, thereby reducing the potential and the effects of frost heaving.
- Currently, the radon barrier thickness is overdesigned by about six inches.

[b]PMF = Probable Maximum Flood.

be influenced by tailings seepage. The zone of saturation in the Halgaito Shale Member that was created as a result of uranium processing will eventually diminish as recharge through the tailings is limited by the consolidation of the tailings into a disposal cell with a cover that restricts infiltration. The seeps in the North Arroyo and in Gypsum Creek will continue to be monitored until the need for groundwater cleanup is assessed under the separate NEPA process.

REFERENCES

DOE (U.S. Department of Energy), 1990. "Assessment of Seeps in the Vicinity of the Mexican Hat Tailings Disposal Cell," DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

DOE (U.S. Department of Energy), 1989. "Moisture Contents and Unsaturated Conditions in UMTRA Project Radon Barriers," DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

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JEG (Jacobs Engineering Group Inc.), 1990. "Human Health and Ecological Risk Assessment for the Seeps Near the Mexican Hat Site," draft prepared for DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

NRC (U.S. Nuclear Regulatory Commission), 1988. "Information Needs to Demonstrate Compliance with EPA's Proposed Groundwater Protection Standards in 40 CFR Part 192, Subparts A-C," draft, NRC Division of Low-Level Waste Management and Decommissioning, Washington, D.C.

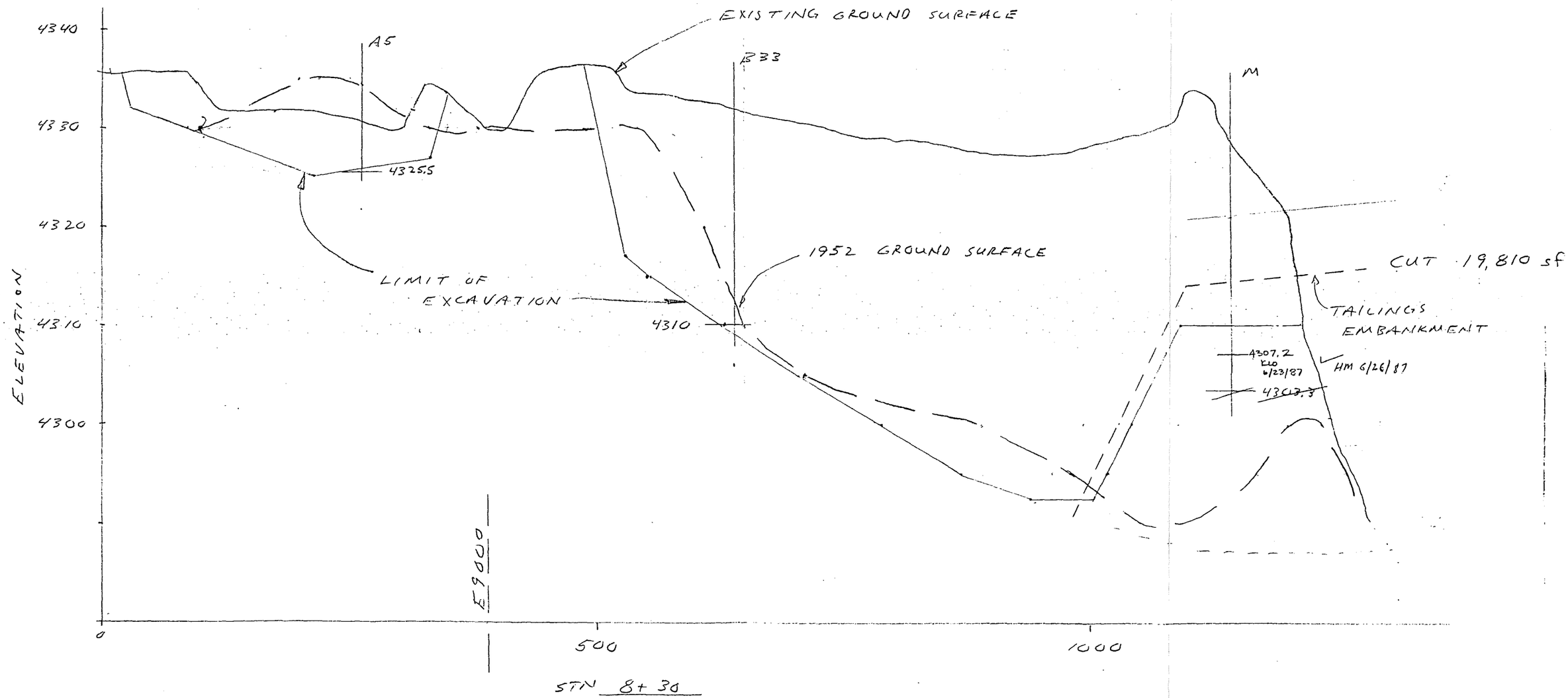
Rush et al. (F. E. Rush, M. S. Whitfield, and I. M. Hart), 1982. Regional Hydrology of the Green River-Moab Area, Northwestern Paradox Basin, Utah, U.S. Geological Survey Open File Report 82-107, U.S. Government Printing Office, Washington, D.C.

Stevens et al. (D. J. Stevens, R. C. Brough, R. D. Griffin, and E. A. Richardson), 1983. Utah Weather Guide, Society for Applied Climatology, West Jordan, Utah, and Department of Geography, Brigham Young University, Provo, Utah.

SHEET 18

UMTRA - HAT
UPPER PILE
EXCAVATION

GMB 1-27-87
KLO 6/23/87



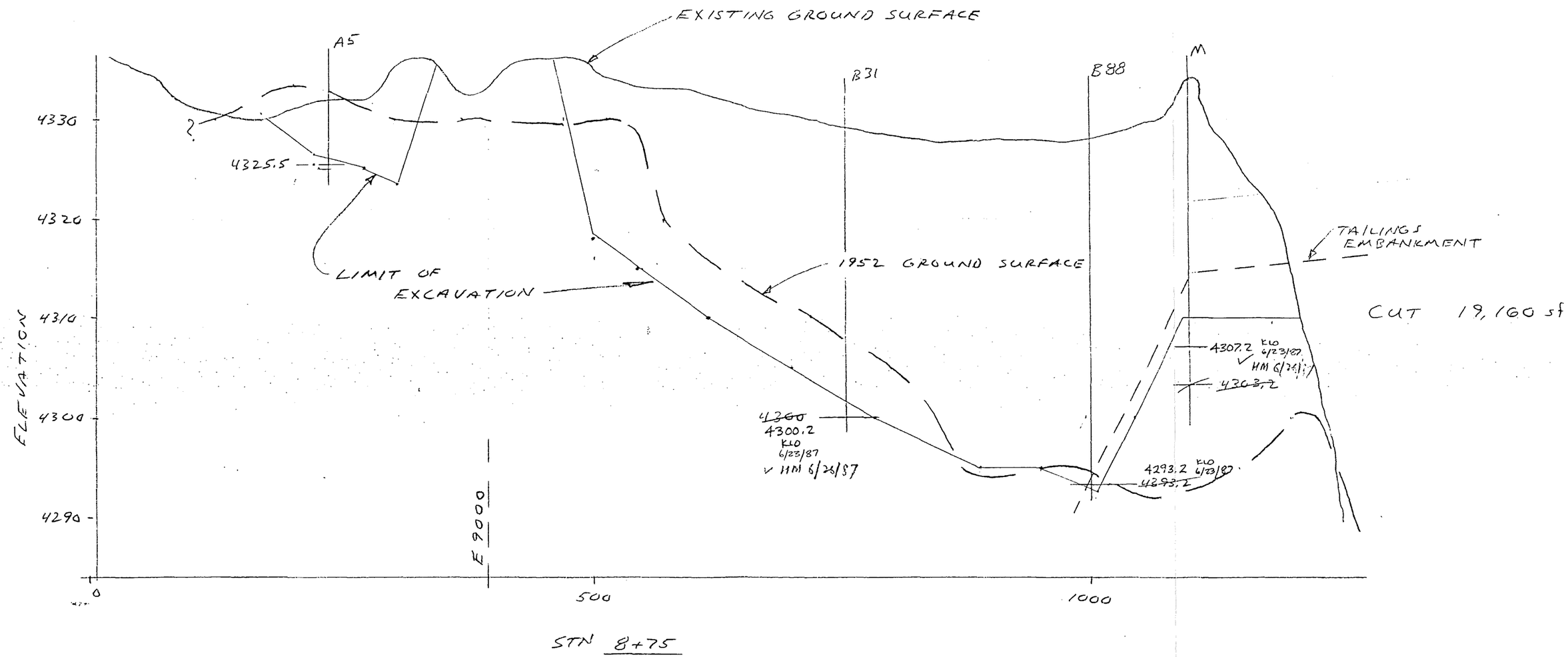
SCALE: HORIZ 1" = 100'
VERT 1" = 10'

STN 8+30

SHEET 19

UMTRA-HAT UPPER PILE EXCAVATION

GMB 1-27-87
KLO 6/23/87

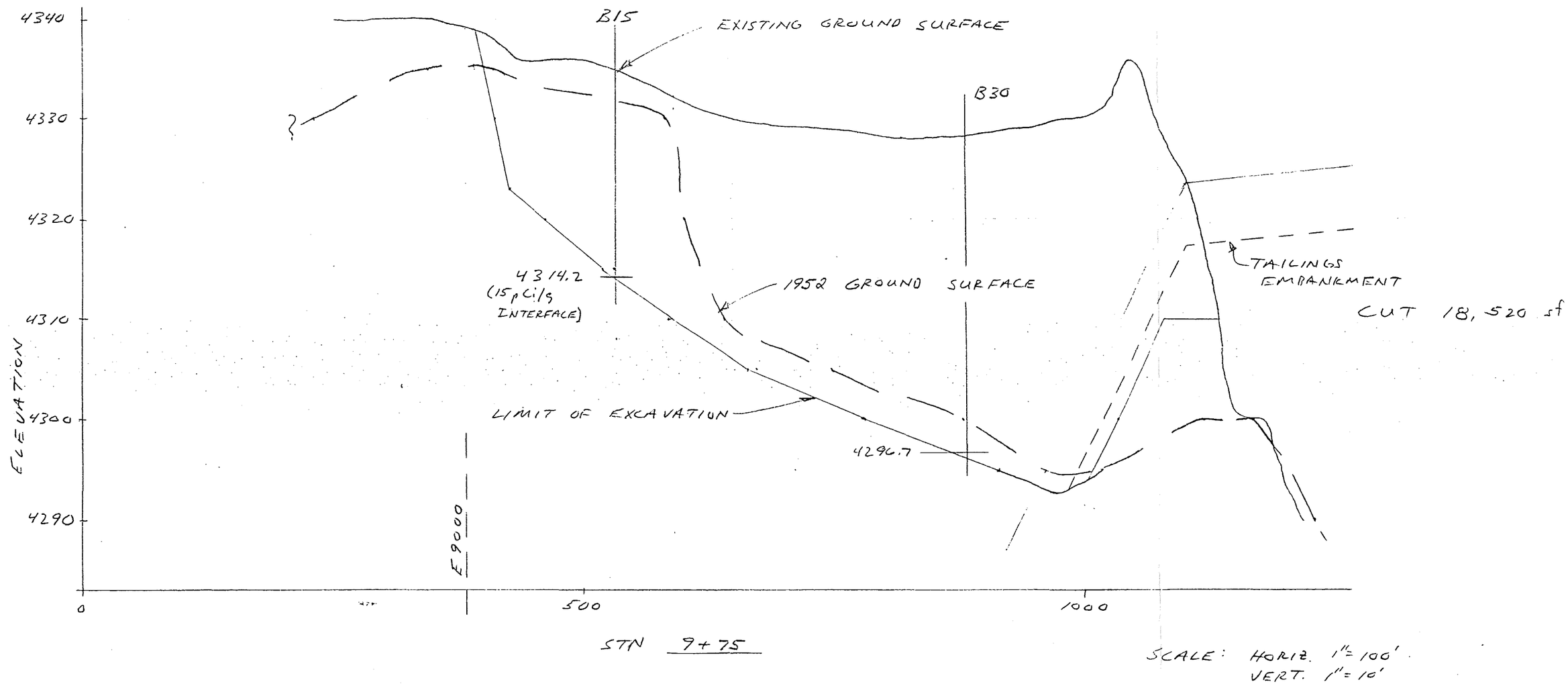


STN 8+75

SHEET 20

UMTRA-HAT
UPPER PILE
EXCAVATION

GMB 1-27-87
KWO 6/23/87

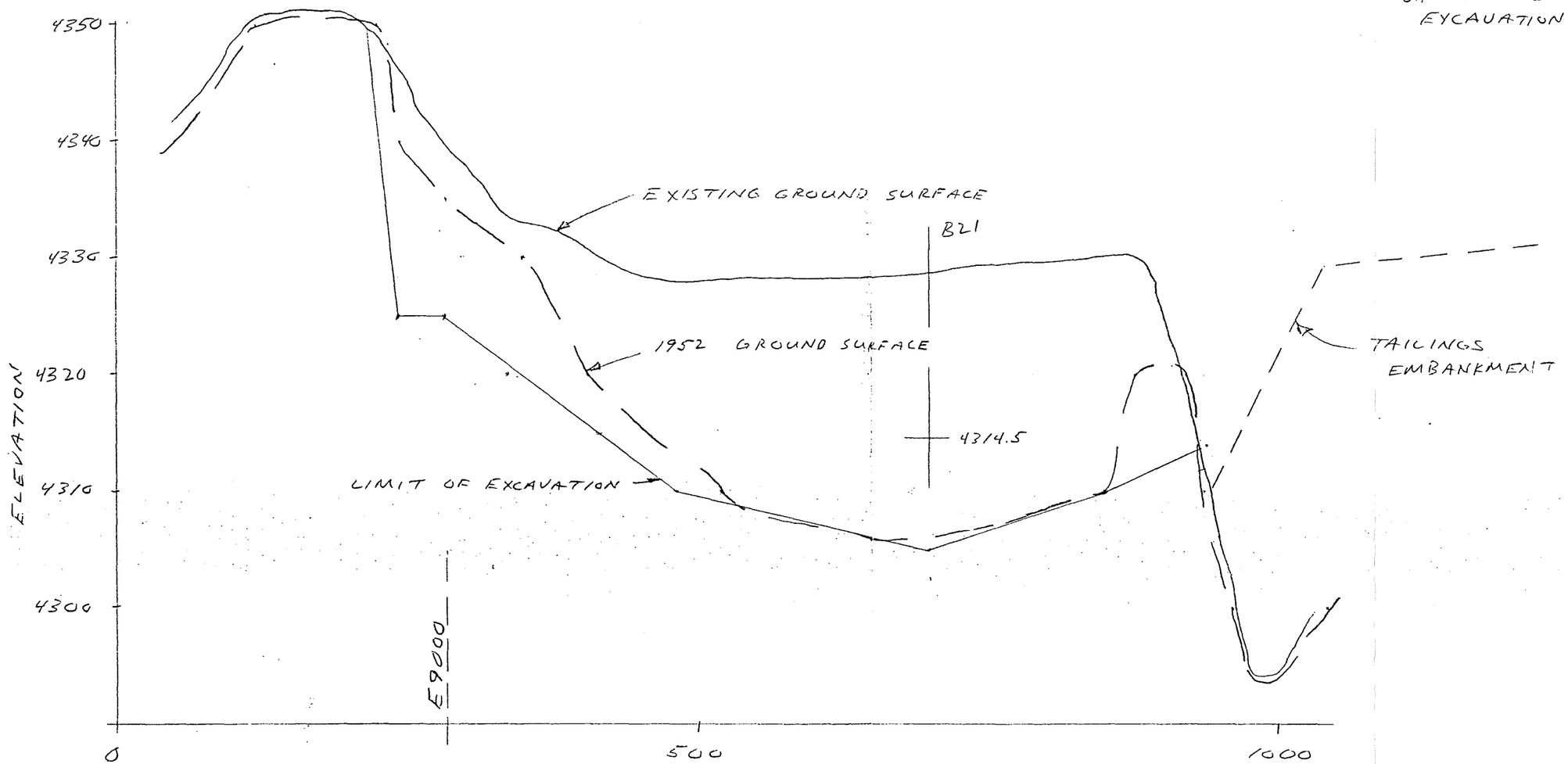


STN 9+75

SHEET 21

UMTRA - HAT
UPPER PILE
EXCAVATION

GMB 1-27-87
KLO 6/23/87



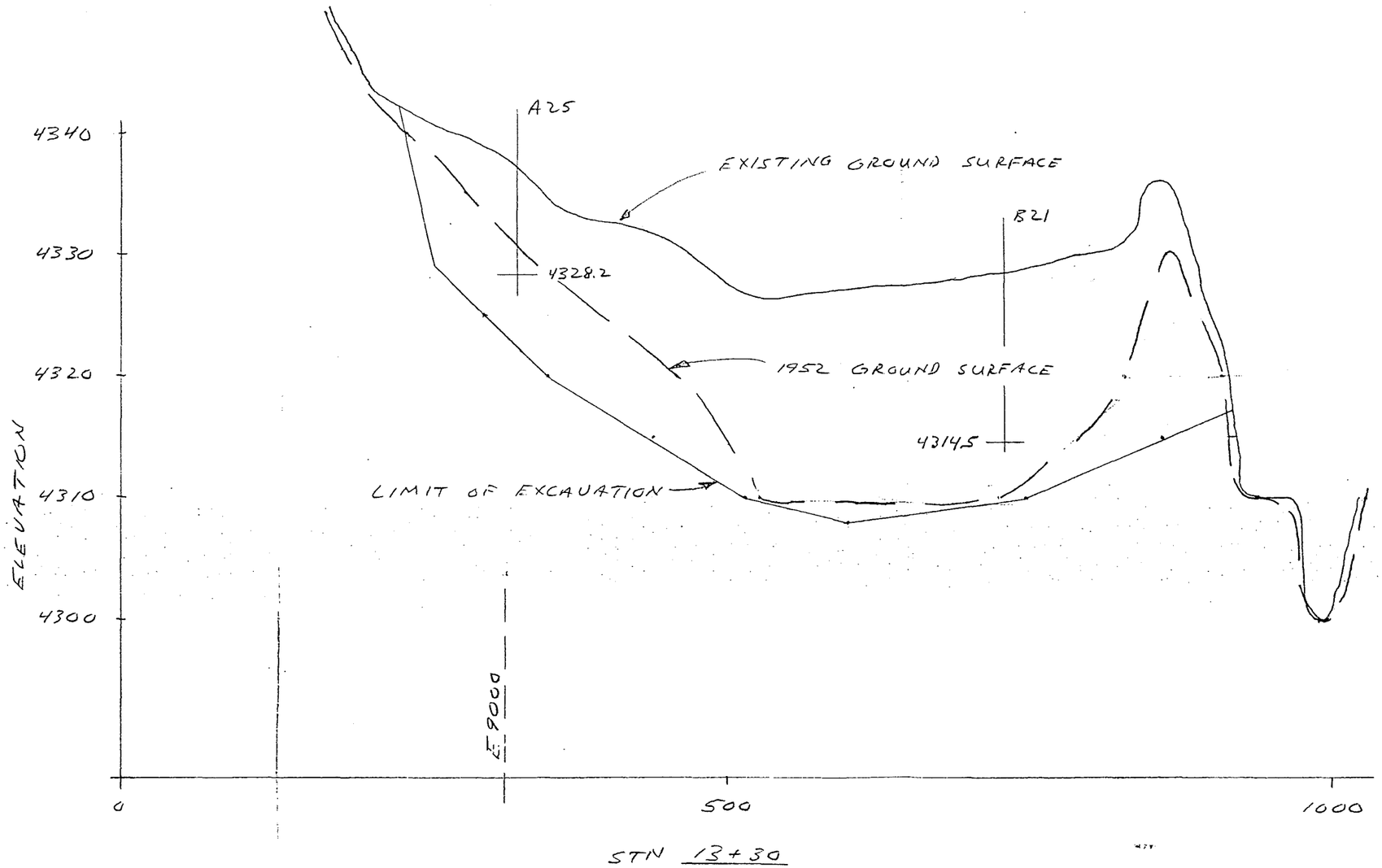
CUT 13,020 sf

SCALE: HORIZ 1" = 100'
VERT. 1" = 10'

STN 12+55

UMTA-HAT
UPPER PILE
EXCAVATION

SHEET 22
GMB 1-27-87
RLO 6/23/87



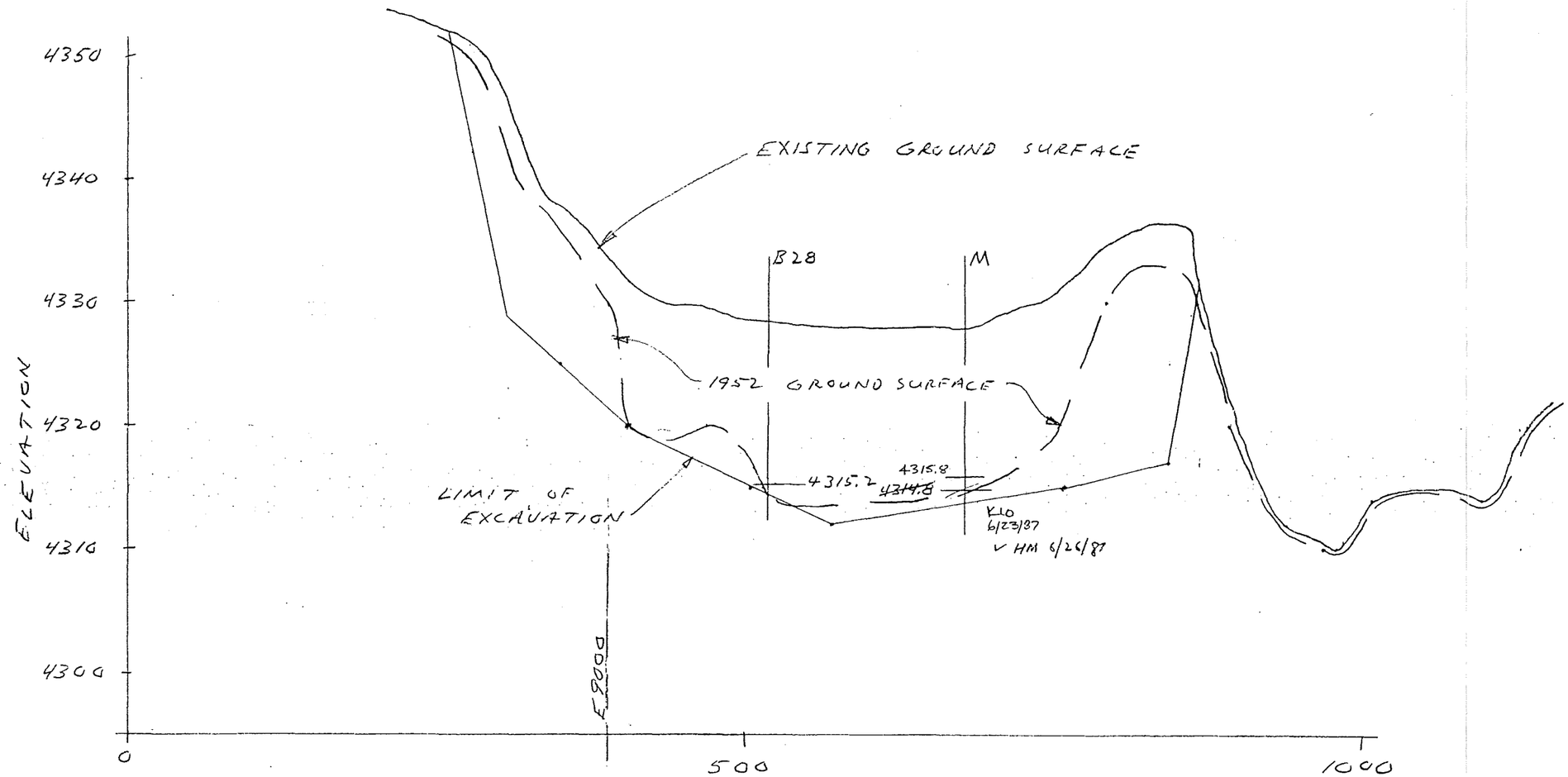
CUT 11,360 sf

SCALE HORIZ. 1" = 100'
VERT. 1" = 10'

STN 13+30

UMTRA-HAT
UPPER PILE
EXCAVATION

SHEET 23
GMB 1-27-87
KLO 6/23/87



CUT 8750 sf

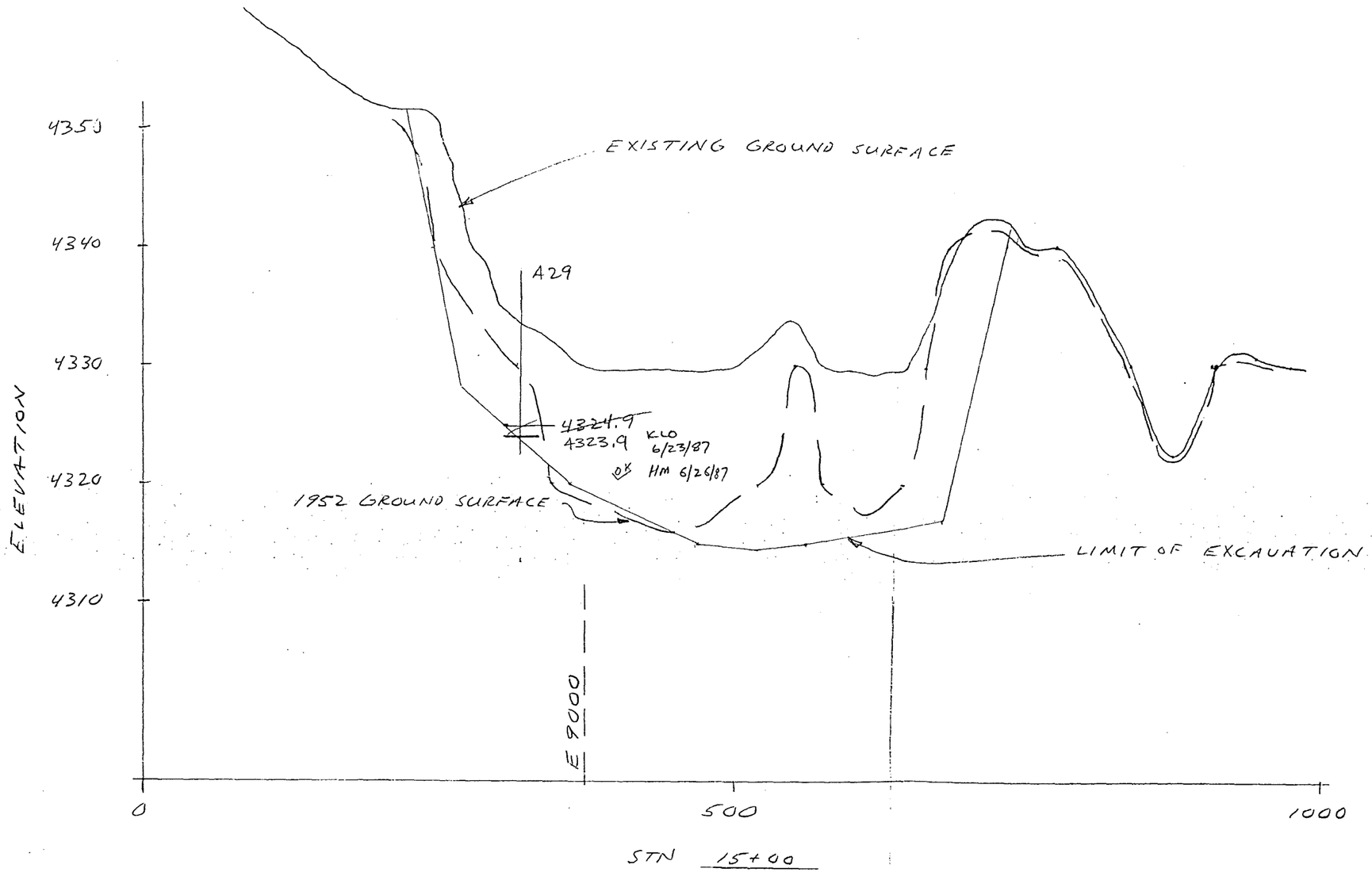
STN 14+10

SCALE HORIZ. 1" = 100'
VERT. 1" = 10'

STN 14+10

UMTRA-HAT
UPPER PILE
EXCAVATION

SHEET 24
GMB 1-27-87
KLO 6/23/87



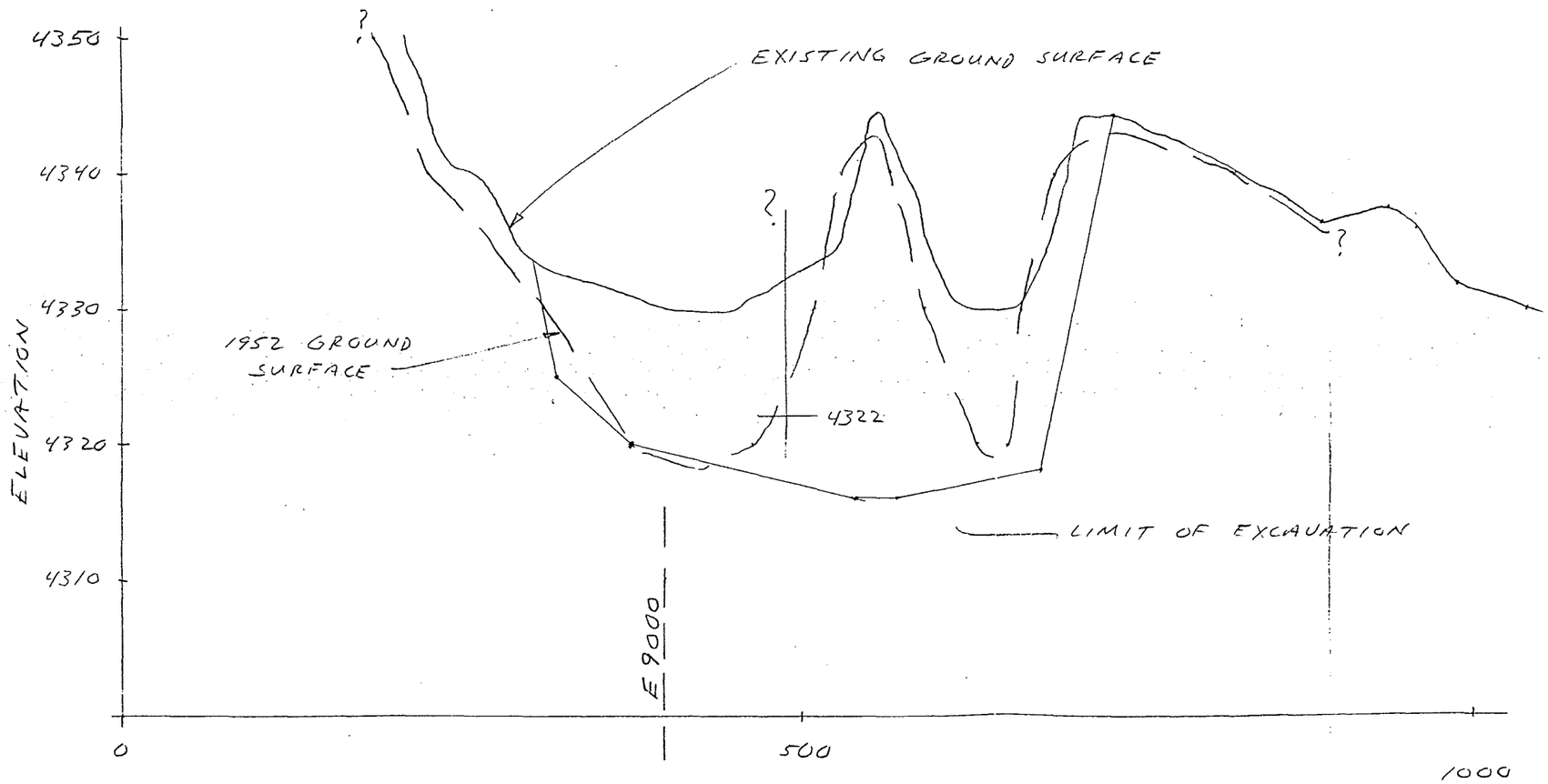
CUT 6730 sf

SCALE: HORIZ. 1" = 100'
VERT. 1" = 10'

STN 15+00

UMTRA-HAT
UPPER PILE
EXCAVATION

SHEET 23
GMB 1-27-87
RLO 6/23/87



CUT 5870 sf

STN 15+45

SCALE: HORIZ. 1" = 100'
VERT. 1" = 10'

STN 15+45

MKE Document No. 5025-HAT-C-01-01147-01

Calculation Cover Sheet

Calc. No. 9-226-02-01

Contract No. 5025 Discipline CIVIL No. of Sheets 14

Project

UMTRA, MEXICAN HAT

Feature

CONTAMINATED MATERIAL EXCAVATION

Item

WINDBLOWN & Waterborn Excavation Quantities

Sources of Data

1. Radiological characterization of the Mexican Hat, Utah, Uranium Mill Tailings Remedial Action Site, January 1985. DOC. NO. 5025-HAT-R-09-00086-00 (BENDIX REPORT)
2. Tailings MATERIAL EXCAVATION PLAN DRAWING NO. HAT-GE-10-~~0907~~ 0908 (Reduced size is attached) GMB 10-27-86

Sources of Formulae & References

3. Radiological Contamination Distribution map, Jacobs Engineering Group Inc. MKE DOC. NO. 5025-HAT-M-04-00132-00

Preliminary Calc. ☒ Final Calc. ☒ Supersedes Calc. No. _____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
01	QUANTITIES SEPARATED INTO WIND-BLOWN, WATER-BORNE, & TAILINGS SEE SHT. 2A	K. Quickel	7/17/87	R F Claire	7/21/87	A. Aufford	7/21/87
00		AS	10/2/86	G M Bleiger	10/27/86	A. Aufford	10/30/86

Form 42-110

PURPOSE

The purpose of this calculation is to estimate the quantity of windblown (and waterborne) contaminates to be excavated and placed on the embankment. The quantity is required to estimate the additional volume needed in the tailings embankment to accomodate off-pile contaminates as well as for economic analysis.

METHOD AND DISCUSSION

The depth of windblown (and waterborne) contaminates are estimated using the "Bendix" report (Ref 1). The contaminates must be excavated to a depth at which the Ra-226 readings are less than 5 pCi/g. The depth to the 5pCi/g interface can be found from the Radiometric Logs (on (micropiche) in the Bendix report.

An approximate average depth of excavation is determined for different areas of the off-pile contaminates (see sheet 14). It should

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Project UMTRA-HAT | Contract No. 5025 | Sheet 2
Feature CONTAMINATED MATERIAL EXCAV. | Designed GMB | File No.
Item WINDBLOWN MATERIAL EXCAV. | Checked AS | Date 10-27-86 | Date 10-28-86

Rev 01 { KLO 7/17/87 RFC 7/21/87

be noted that these depths are only averages and the actual depth of excavation will be determined in the field as the excavation is in progress. The contractor shall take Ra-226 readings to determine where excavation will terminate.

SUMMARY

Rev 01 [~~TOTAL EXCAVATION QUANTITY = 230,000 cy~~ Sheet 14

RECALCULATED
SEE SHEET 2A

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA-HAT	Contract No. 5025	Sheet 2A	File No.
Feature CONTAMINATED MATERIAL EXCAVATION	Designed K. OHSIEK	Date 7/17/87	
Item REV 01 SUMMARY/QUANTITY ESTIMATES	Checked RP Clair	Date 7/21/87	

THIS ENTIRE SHEET IS PART OF REV 01

REVISION 01 SUMMARY:*

DUE TO A DIFFERENCE IN UNIT PRICES FOR EXCAVATING WINDBLOWN CONTAMINATED MATERIAL AND WATER-BORNE CONTAMINATED MATERIAL, THE EXCAVATION AREAS AND QUANTITIES ARE REVISED. THE WATER-BORNE CONTAMINATED MATERIAL IS LOCATED IN SEVERAL ARROYOS. (SEE SHEET 14A .)

THESE REVISED AREAS AND QUANTITIES ALSO REFLECT MINOR REVISIONS TO THE EXCAVATION BOUNDARIES (COMPARE SHEETS 14 AND 14A.) BOTH THE AREA OF WINDBLOWN MATERIAL AND AREA OF WATER-BORNE MATERIAL HAVE BEEN DIVIDED INTO SUB-AREAS TO SIMPLIFY MEASURING AND CALCULATING. IT SHOULD BE NOTED THAT SUB-AREAS VIII THROUGH XI ARE NOT ACTUALLY WINDBLOWN MATERIALS. THEY ARE PORTIONS OF THE LOWER TAILINGS PILE WHICH HAVE NOT BEEN ACCOUNTED FOR IN OTHER QUANTITY CALCULATIONS. THEREFORE, THEY HAVE BEEN INCLUDED IN THIS CALCULATION SET.

EXCAVATION QUANTITIES:

WINDBLOWN CONTAMINATED MATERIAL = 191,000 CY
(FROM SHEET 2B)

WATERBORNE CONTAMINATED MATERIAL = 22,900 CY
(FROM SHEET 2C)

TAILINGS (Adjacent to lower pile) = 52,600 CY
(FROM SHEET 2D)

* REV 01 ADDS SHEETS 2A, 2B, 2C, 2D, AND 14A; SUPERSEDES

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA-HAT
Feature: CONTAMINATED MATERIAL EXCAVATION
Item: WINDBLOWN MATERIAL QUANTITIES

Contract No. 5025
Designed: K. OHSIER
Checked: R Claire

Sheet 2B
File No.
Date 7/17/87
Date 7/21/87

THIS ENTIRE SHEET IS PART OF REV 01

WINDBLOWN MATERIAL:

THE FOLLOWING REVISED AREAS AND QUANTITIES ARE MEASURED FROM AND CALCULATED BASED ON THE PARTIALLY REVISED EXCAVATION BOUNDARIES SHOWN ON SHEET 14A. WATER-BORNE MATERIAL IS EVALUATED ON A SEPARATE SHEET.

DEPTH OF EXCAVATION	SUB-AREA	AREA** (FT²)	QUANTITY (CY)	
0.5'	I	372,410	6896	
	II	544,980	10,092	
	III	922,560	17,084	
	IV	853,950	15,814	
	V	1,878,600	34,789	
	VII	221,550	4,103	
	XIII	18,190	337	
	XV	310,830	5,756	
			94,871	= TOTAL = 94,871
1.0'	XII	1,067,440	39,535	= TOTAL = 39,535
2.0'	XIV	763,220	56,535	= TOTAL = 56,535

GRAND TOTAL = 190,941 CY

SAY ≅ 191,000 CY

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA-HAT | Contract No. 5025 | Sheet 2C | File No.
Feature CONTAMINATED MATERIAL EXCAVATION | Designed K. OHSIEK | Date 7/17/87
Item WATER-BORNE MATERIAL QUANTITIES | Checked R. Claire | Date 7/21/87

THIS ENTIRE SHEET IS PART OF REV 01

WATER-BORNE MATERIAL:

THE FOLLOWING REVISED AREAS AND QUANTITIES ARE MEASURED FROM AND CALCULATED BASED UPON THE PARTIALLY REVISED EXCAVATION BOUNDARIES SHOWN ON SHEET 14A. WINDBLOWN MATERIAL IS EVALUATED ON A SEPARATE SHEET.

DEPTH OF EXCAVATION*	SUB-AREA	AREA** (FT²)	QUANTITY (CY)	
0.5'	A1	5,790	107	
	A2	60,140	1114	
	A4	126,500	2343	
	A5	176,700	3272	
			6836	= TOTAL = 6836
1.0'	A3	433,830+	16,068	= TOTAL = 16068

GRAND TOTAL = 22,904 CY
SAY ≅ 22,900 CY

+ SUB-AREA A-3:
CONTAMINATION EXTENDS AN ADDITIONAL 1600' DOWNSTREAM OFF THE DRAWING (SHEET 14A). ADDITIONAL AREA IS:

$$(1600')(100') = 160{,}000 \text{ FT}^2$$

* DEPTH IS ESTIMATED FROM SHEET 13.

** BY PLANIMETER

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: TEA-HAT | Contract No. 5025 | Sheet 3D | File No.
Feature: CONTAMINATED MATERIAL EXCAVATION | Designed K. OHSIEK | Date 7/17/87
Item: TAILINGS QUANTITIES | Checked R. Claire | Date 7/21/87

THIS ENTIRE SHEET IS PART OF REV 01

TAILINGS:

THE FOLLOWING REVISED AREAS AND QUANTITIES ARE MEASURED FROM AND CALCULATED BASED UPON THE PARTIALLY REVISED EXCAVATION BOUNDARIES SHOWN ON SHEET 14A. THESE TAILINGS QUANTITIES INCLUDE SUB-AREAS (VIII THROUGH XI) WHICH ARE PART OF THE LOWER TAILINGS PILE, AND SUB-AREA VI WHICH WILL BE EXCAVATED TO A DEPTH OF 7 FEET. WINDBLOWN AND WATER-BORNE MATERIALS ARE EVALUATED ON SEPARATE SHEETS.

DEPTH OF EXCAVATION	SUB-AREA	AREA (FT²)*	QUANTITY (CY)	
~6.0'	X	30,790	6842	
	XI	57,660	12,813	
	VIII	22,530	5,007	
			24,662	= TOTAL = 24,662
7.0'	VI	26,250	6,806	= TOTAL = 6,806
~12.0'	IX	47,530	21,124	= TOTAL = 21,124

GRAND TOTAL = 52,592 CY

SAY ≅ 52,600 CY

* BY PLANIMETER

INTERNATIONAL ENGINEERING COMPANY, INC.

Sheet 3

Project UHTRA – MEXICAN HAT | Contract No. 5025 | File No.
Feature EXCAVATIONS | Designed AS | Date 9/21/86
Item WINDBLOWN CONT. MATERIALS | Checked GMB | Date 10-27-86

→ QUANTITIES RECALCULATED IN REV01. SEE SHEETS 2A-2D.
KLO 7/17/87
RFC 7/21/87

TAILING MATERIAL EXCAVATION QUANTITIES

I. EXCAVATE TO 0.5 Ft Depth.

AREA 1 301,320 S.F. AS 10-28-86

AREA 5 615,750 - ~~117,200~~ = ~~498,550~~ S.F. GMB 10-27-86

AREA 6 416,950 - (110 x 280) = 386,150 S.F.

AREA 7 744,000 S.F.

AREA 8 2,411,800 S.F.

AREA 9 1,218,600 S.F.

AREA 11 65 x 275 = 17,875 S.F.

~~5,678,295~~ 5,675,515 S.F

5,675,515

(~~5,678~~)(0.5)(1/27) = ~~103,302~~ 105,472 c.y. GMB 10-27-86 AS 10-28-8

II. EXCAVATE TO 1.0 Ft Depth

AREA 2 725,710 S.F.

AREA 4 343,000 S.F.

1,068,710 S.F.

(1,068,710)(1)(1/27) = 39,582 c.y.

INTERNATIONAL ENGINEERING COMPANY, INC.

Project UMTRA, MEXICAN HAT | Contract No. 5025 | Sheet 4
Feature EXCAVATIONS | Designed AS | File No.
Item WINDBLOWN CONT. MATERIALS | Checked GMB | Date 9/2/86 | Date 10-27-86

→ QUANTITIES RECALCULATED IN REV 01. SEE SHEETS 2A-2D.
KLO 7/7/87
RPC 7/21/87

III. EXCAVATE TO 2.0 Ft. DEPTH.

AREA 3 756,100 S.F.

(756,100)(2)(1/27) = 56,007 c.y.

IV. EXCAVATE TO 7.0 Ft. Depth

AREA 10 (110)(280) = 30,800 S.F.

(30,800)(7)(1/27) = 7,985 c.y.

V. EXCAVATE TO 6.0 Ft. Depth

AREA 12 (200)(100) = 20,000 S.F.

(20,000)(6)(1/27) = 4,444 c.y.

VI. EXCAVATE TO 12 Ft Depth

AREA 13 (420)(100) = 42,000 S.F.

(42,000)(12)(1/27) = 18,666 c.y.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 5

Project UMTRA MEXICAN HAT | Contract No. 5025 | File No.
Feature EXCAVATIONS | Designed AS | Date 9/5/86
Item WIND BLOWN CONTAMINATED MAT. | Checked GMB | Date 10-27-86

[QUANTITIES RECALCULATED IN REV 01. SEE SHEETS 2A-2D
KLO 7/17/87
RFC 7/21/87]

SUMMARY OF EXCAVATIONS

Depth (ft)	C.Y.
0.5	105,280 ~~103,302~~
1	39,582
2	56,007
6	4,444
7	7,985
12	18,666
Total	~~229,986~~ ≃ 230,000 C.Y.
	231,955 ≃ 232,000 C.Y.

GMB 10-27-86
AS 10-28-86

GMB 10-27-86
AS 10-28-86

34.6
AS 8/29/86
GMB 10-27-86

APPENDIX E

BENDIX REPORT

windblown

Areas

Table E-1

Borehole Data from Spectral System

EQUIPMENT DATA

INSTRUMENT	COMPULOGGER	CASING THICKNESS	0.1875 in.
GJO NUMBER	1815	CASING FACTOR	1.238 ± 0.012
SERIAL NUMBER	231-03	FLUID FACTOR	1.220 ± 0.154
DETECTOR	NaI(Tl)	MOISTURE FACTOR	1.069 ± 0.007
DETECTOR SIZE	2 in. x 6 in.	K FACTOR	7.00 ± 0.18 g-cps/pCi(eRa-226)
PROBE DIAMETER	2.5 in.	BACKGROUND	21.04 ± 3.24 cps
HOLE DIAMETER	6.87 in.	ALPHA FACTOR	3.0 ± 0.3
		CALIBRATION DATE	4 September 1984

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)	Depth to 5 pCi/gr (1)
HAT-014	9200	8500	4335.1	7.5	0.5
HAT-021	8900	8200	4345.5	3.5	—
HAT-022	8900	8400	4339.7	6.0	5.0
HAT-023	8800	7900	4347.6	3.5	—
HAT-026	8800	8500	4340.4	4.0	1.0
HAT-029	8700	7300	4332.8	3.5	—
HAT-031	8700	8200	4342.1	3.5	0.5
HAT-035	8600	8500	4350.3	4.0	2.5
HAT-045	8300	7500	4340.1	5.5	—
HAT-047	8200	7900	4353.4	4.0	1.5
HAT-071	10350	8150	4313.8	4.0	3.5
HAT-073	10000	8100	4315.0	3.0	0.5
HAT-074	9900	8000	4316.8	8.0	—
HAT-075	9900	8100	4318.4	9.5	2.0
HAT-080	9700	8200	4321.0	7.5	0.5
HAT-081	9700	8300	4323.6	11.0	0.5
HAT-083	9600	8200	4322.4	8.0	1.0
HAT-086	9400	8200	4328.3	18.5	1.5
HAT-088	9300	7500	4330.8	4.5	—
o HAT-102	9807	9148	4312.1	5.0	
o HAT-103	9762	9321	4305.1	4.0	
o HAT-105	9530	9647	4315.6	8.5	
o HAT-110	8642	9559	4336.0	27.5	
o HAT-120	9014	8836	4331.3	8.5	
o HAT-121	9163	8789	4331.2	14.0	
o HAT-151	9801	9637	4305.6	5.5	
o HAT-153	9999	10095	4292.2	8.0	
o HAT-157	10320	10788	4268.3	9.0	
o HAT-159	10223	11088	4267.7	7.0	
o HAT-161	10108	11630	4233.5	12.5	
o HAT-166	9199	11424	4300.7	9.0	
o HAT-169	8922	11004	4295.6	9.0	

o Boreholes located at prephery of the upper & Lower piles.

All Corr

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Table E-2

Borehole Data from Total-Count System

EQUIPMENT DATA

INSTRUMENT	PRS-1 RASCAL	CASING THICKNESS	0.1875 in.
GJO NUMBER	C-3572S	CASING FACTOR	1.555 ± 0.095
SERIAL NUMBER	753	FLUID FACTOR	1.112 ± 0.078
DETECTOR	NaI(Tl)	MOISTURE FACTOR	1.069 ± 0.007
DETECTOR SIZE	2 in. x 2 in.	K FACTOR	77.14 ± 2.24 g-cps/pCi(eRa-226)
PROBE DIAMETER	2.5 in.	BACKGROUND	135.51 ± 94.20 cps
HOLE DIAMETER	6.87 in.	ALPHA FACTOR	3.0 ± 0.3
		CALIBRATION DATE	04 September 1984

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)	Depth to 5 pCi/gr.
HAT-011	9200	7900	4331.6	1.5	~~1.0~~ 1.5
HAT-012	9200	8100	4343.6	1.3	—
HAT-013	9200	8300	4337.6	2.9	0.5
HAT-015	9000	7900	4342.1	3.8	—
HAT-016	9000	8100	4348.9	4.4	1.0
HAT-017	9000	8300	4342.1	2.8	0.5
HAT-018	9000	8500	4335.2	4.2	~~2.0~~ 3
HAT-019	9000	8700	4330.3	2.5	~~1.5~~ 2.
HAT-020	8900	8100	4348.3	3.6	—
HAT-021	8900	8200	4345.5	4.4	—
HAT-024	8800	8100	4346.1	3.6	—
HAT-025	8800	8200	4343.4	1.0	~~0.5~~ [illegible]
HAT-027	8800	8700	4344.2	1.5	1.5 [illegible]
HAT-028	8800	8900	4338.7	1.0	0.5
HAT-030	8700	7700	4355.0	4.1	—
HAT-032	8600	7900	4350.6	2.7	~~1.0~~ 1.5
HAT-033	8600	8100	4344.6	1.0	1.5
HAT-034	8600	8400	4342.6	3.7	~~1.5~~ 2
HAT-036	8600	8700	4345.1	1.6	0.5
HAT-037	8590	8900	4.41.7	3.8	1.0
HAT-038	8500	7700	4351.5	2.2	—
HAT-039	8500	8200	4343.8	2.0	~~2.0~~ [illegible]
HAT-040	8400	7900	4350.8	1.3	~~0.5~~ 1.0
HAT-041	8400	8100	4348.1	3.9	0.5
HAT-042	8400	8300	4347.4	2.8	2.0
HAT-043	8400	8500	4352.1	2.4	0.5
HAT-044	8400	8700	4359.3	0.7	0.5
HAT-046	8300	7700	4351.6	3.2	0.5
HAT-048	8185	8100	4351.6	2.8	0.5
HAT-049	8200	8300	4354.9	0.8	1.0
HAT-050	8200	8500	4357.4	0.3	0.5
HAT-051	8200	8750	4352.9	1.9	1.5
HAT-052	8000	7900	4353.2	3.5	~~0.5~~ [illegible]

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Table E-2 (continued)

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)	Depth to 5 pCi/g.
HAT-053	8000	8100	4358.7	1.4	0.5
HAT-054	8000	8300	4357.6	3.5	1.0 ✓
HAT-055	7800	7900	4353.2	3.5	1.5 ✓
HAT-056	7800	8100	4360.1	2.0	0.5
HAT-072	10200	8100	4312.5	1.0	—
HAT-076	9800	7700	4328.4	4.3	—
HAT-078	9800	8200	4321.7	4.0	—
HAT-079	9700	8100	4318.6	1.4	—
HAT-082	9700	8600	4332.1	2.9	0.5
*HAT-085	9500	8200	4332.5	2.7	0.5
HAT-087	9400	8300	4336.8	0.8	—
○ HAT-101	9800	8990	4332.6	2.9	
○ HAT-104	9652	9489	4315.0	4.0	
○ HAT-106	9400	9769	4312.3	1.8	
○ HAT-107	9208	9849	4300.0	14.5	
○ *HAT-108	9023	9802	4315.0	2.7	
○ *HAT-109	8825	9720	4296.8	2.0	
○ *HAT-112	8299	9223	4329.5	2.8	
○ *HAT-113	8388	9135	4332.2	7.5	
○ *HAT-114	8241	8895	4329.1	3.5	
○ HAT-115	8442	8964	4332.9	9.5	
○ HAT-116	8600	9008	4336.4	1.9	
○ HAT-117	8734	9097	4334.5	0.8	
○ HAT-118	8852	8979	4338.4	0.8	
○ HAT-119	9003	9074	4334.9	2.8	GMB 10-27-86
○ HAT-122	9373	8783	4330.1	2.0	
○ HAT-123	9642	8775	4332.7	3.2	AS 10-28-86
HAT-124	9960	9246	4313.7	7.1	~~7.0~~ 7.1
HAT-125	10151	9290	4317.3	7.0	5.5 ✓
○ HAT-152	9907	9847	4295.7	4.7	
○ HAT-154	10109	10340	4282.0	3.4	
○ HAT-155	10159	10478	4287.3	0.9	
○ HAT-156	10263	10614	4268.0	2.5	
○ HAT-158	10446	11062	4257.3	4.5	
○ HAT-160	10107	11416	4236.8	3.0	
○ *HAT-163	9818	11533	4245.8	7.9	
○ HAT-164	9697	11614	4272.7	2.7	
○ HAT-165	9538	11662	4271.8	11.8	
○ HAT-167	9103	11372	4304.3	3.3	
○ HAT-168	8978	11269	4300.5	1.6	
○ HAT-171	8944	10732	4293.5	4.5	
○ *HAT-173	8903	10319	4284.5	1.3	
○ *HAT-174	8898	10249	4280.2	5.3	

*Boreholes logged without casing. Data were reduced for these boreholes using a hole diameter of 5.5 in., a casing thickness of 0 in., and a casing factor of 1.000 ± 0.000. All other equipment data were the same for all boreholes.

○ Boreholes Located at prephery of the upper & Lower piles.

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Table E-2 (continued)

Hole No.	Grid Coordinates North	Grid Coordinates East	Elevation (ft)	Log Depth (ft)
○ *HAT-175	8876	10100	4281.9	1.9
○ *HAT-176	8728	9768	4289.7	2.1
○ *HAT-177	10105	11302	4242.0	2.5
○ *HAT-178	9998	11407	4239.9	9.5
○ HAT-179	10011	11622	4230.7	2.7
○ *HAT-180	9957	11511	4237.2	4.6

*Boreholes logged without casing. Data were reduced for these boreholes using a hole diameter of 5.5 in., a casing thickness of 0 in., and a casing factor of 1.000 ± 0.000. All other equipment data were the same for all boreholes.

○ Boreholes located at prephery of the upper & lower piles.

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Appendix D

DELTA-GAMMA RADIUM MEASUREMENT DATA

Table D-1 presents results of the in-situ delta-gamma radium measurements. The two-standard-deviation (2σ) error reported in this table reflects only the uncertainty in the counting statistics; it does not include errors introduced through the use of a calibration factor and three correction factors. These data were generated using the computer program DELTCALC.BAS, Version 1.1. Radium values represent equivalent concentrations.

Table D-1

In-Situ Delta-Gamma Radium Measurement Results

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)	Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
11600	11600	0	2.3 ± 0.8	10800	12000	0	10.8 ± 1.5
11600	11600	6	0.3 ± 0.6	10800	12000	6	* 0.6
11600	12000	6	0.9 ± 0.8	10800	12400	6	0.4 ± 0.7
11400	12450	0	95.8 ± 3.0	10800	12800	6	0.6 ± 0.7
11400	12450	6	131.5 ± 4.0	10775	11100	0	45.3 ± 1.9
11400	12450	12	65.8 ± 3.6	10775	11100	6	41.3 ± 2.7
11400	12450	15	28.1 ± 4.5	10775	11100	12	5.4 ± 1.9
11275	12325	0	39.3 ± 1.8	10775	11100	14	1.8 ± 2.1
11275	12325	6	2.4 ± 1.4	10775	12125	0	69.7 ± 3.0
11202	11600	6	1.7 ± 0.7	10775	12125	6	4.6 ± 2.2
11200	10800	6	0.6 ± 0.7	10725	10750	0	59.6 ± 2.3
11200	11200	6	0.4 ± 0.7	10725	10750	6	38.8 ± 2.9
11200	12000	6	2.3 ± 1.0	10725	10750	12	2.1 ± 1.7
11090	12225	0	6.1 ± 1.4	10700	10575	0	55.4 ± 2.5
11090	12225	6	1.1 ± 0.9	10700	10575	6	4.5 ± 1.9
11000	10400	0	3.7 ± 0.8	10700	10575	12	2.2 ± 1.2
11000	10400	6	0.7 ± 0.8	10700	10925	0	20.1 ± 1.5
10925	12125	0	37.1 ± 2.4	10700	10925	6	1.5 ± 0.9
10925	12125	6	4.2 ± 1.8	10650	12050	0	68.4 ± 3.1
10900	11650	0	3.8 ± 1.2	10650	12050	6	32.0 ± 3.1
10850	11475	0	31.4 ± 2.2	10600	8200	2	3.1 ± 0.9
10850	11475	6	4.0 ± 1.7	10600	9000	6	2.6 ± 0.8
10825	11825	0	22.8 ± 1.4	10600	9600	6	1.6 ± 0.9
10825	11825	6	31.0 ± 1.9	10600	10400	6	15.8 ± 3.5
10825	11825	12	39.8 ± 2.4	10600	10400	8	11.1 ± 3.3
10825	11825	18	11.1 ± 2.3	10600	11200	6	0.7 ± 1.3
10800	9400	6	0.5 ± 0.6	10550	10050	0	41.4 ± 2.1
10800	10000	6	0.9 ± 0.8	10550	10050	4	6.7 ± 1.8
10800	10800	6	0.3 ± 0.7	10525	9875	0	35.6 ± 2.2
10800	11300	0	41.3 ± 2.7	10525	9875	6	16.0 ± 2.1
10800	11300	6	2.9 ± 1.6	10525	9875	12	* 1.5
10800	11600	6	2.4 ± 1.3	10525	11950	0	135.1 ± 3.9
				10525	11950	6	78.4 ± 3.1

*There is at least 95 percent confidence that the true value is less than the measurement reported.

NOTE: when Ra-226 Measurements are not below 5 pCi/gr, add

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Table D-1 (continued)

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
10525	11950	10	10.8 ± 2.7
10500	10200	0	240.2 ± 4.5
10500	10200	6	278.1 ± 6.0
10500	10200	12	2.2 ± 4.1
10450	9700	0	12.8 ± 1.6
10450	9700	4	1.1 ± 1.2
10400	8000	6	0.7 ± 0.6
10400	8200	6	45.4 ± 2.1
10400	8200	12	24.1 ± 2.5
10400	8200	18	15.9 ± 2.6
10400	8200	24	4.1 ± 1.9
10400	8400	6	0.9 ± 0.8
10400	8800	6	0.7 ± 0.8
10400	9400	6	0.9 ± 0.7
10400	10400	6	1.5 ± 0.9
10400	10800	6	2.3 ± 1.3
10400	11600	6	3.6 ± 1.4
10325	11925	0	44.2 ± 2.5
10325	11925	6	59.0 ± 2.0
10325	11925	10	9.4 ± 2.3
10275	9650	0	143.6 ± 3.5
10275	9650	4	19.1 ± 2.5
10200	8000	6	0.8 ± 0.7
10200	8400	6	1.8 ± 0.9
10200	9000	6	1.0 ± 0.8
10200	10000	6	0.9 ± 1.0
10200	11600	6	2.3 ± 1.5
10200	11800	0	124.8 ± 3.8
10200	11800	6	224.1 ± 4.2
10200	11800	12	194.4 ± 5.4
10200	11800	15	115.8 ± 5.7
10200	12200	6	1.9 ± 1.0
10200	12600	4	* 0.3
10125	9575	0	155.9 ± 3.8
10125	9575	6	8.2 ± 2.4
10125	9575	10	5.4 ± 1.9
10059	12775	0	5.9 ± 1.1
10059	12775	6	0.7 ± 0.7
10010	12565	0	5.5 ± 1.2
10010	12565	3	0.6 ± 0.8
10000	7800	6	0.9 ± 0.7
10000	8300	6	2.2 ± 0.7
10000	8500	6	1.3 ± 0.8
10000	8700	6	1.1 ± 0.9
10000	8900	6	1.7 ± 0.9
10000	9200	6	510.8 ± 8.2
10000	9200	12	491.0 ± 7.2
10000	9200	18	493.3 ± 9.7
10000	9400	6	2.4 ± 0.8
10000	9600	6	2.7 ± 1.3
10000	9800	6	3.7 ± 1.4
9967	12390	0	16.6 ± 1.7
9967	12390	1	1.3 ± 1.3
9950	12150	0	13.5 ± 2.0
9950	12150	4	2.1 ± 1.2
9866	11994	0	19.1 ± 1.7
9866	11994	3	3.9 ± 1.5
9800	8500	6	1.8 ± 0.9
9800	8700	6	1.7 ± 0.9
9800	11800	0	11.2 ± 1.9
9800	11800	5	1.5 ± 1.1
9800	12200	5	0.5 ± 1.0
9800	12200	6	1.2 ± 1.0
9600	8300	2	1.2 ± 0.9
9600	8500	6	0.7 ± 0.7
9600	8700	6	0.4 ± 0.8
9600	12000	6	2.2 ± 1.2
9580	12580	0	23.3 ± 1.8
9580	12580	6	5.6 ± 1.4
9580	12580	8	2.0 ± 1.3
9450	12480	0	9.5 ± 1.3
9450	12480	6	1.8 ± 0.9
9400	8600	6	1.0 ± 0.9
9400	12000	6	1.0 ± 1.0
9400	12600	4	2.5 ± 0.8
9350	12350	0	6.3 ± 1.3
9350	12350	6	1.4 ± 0.8
9300	12175	0	13.7 ± 1.4
9300	12175	6	2.3 ± 1.2
9280	11980	0	20.4 ± 1.9
9280	11980	5	5.7 ± 1.3
9275	11800	0	4.0 ± 1.5
9240	7400	6	0.6 ± 0.7
9200	12000	6	* 0.2
9200	12400	6	3.0 ± 1.0
9000	7600	6	0.8 ± 0.7
9000	7800	6	0.7 ± 0.8
9000	11600	6	1.2 ± 0.8
9000	12200	6	0.3 ± 0.7
8800	7200	6	1.3 ± 0.7
8800	7600	6	2.0 ± 0.7
8800	7800	2	1.4 ± 0.7

*There is at least 95 percent confidence that the true value is less than the measurement reported.

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Table D-1 (continued)

Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)	Coordinates North	Coordinates East	Depth (in.)	eRa-226 (pCi/g)
8800	11000	6	1.8 ± 0.9	8200	10000	6	1.0 ± 0.8
8800	11400	6	2.4 ± 0.9	8200	10400	6	3.0 ± 0.8
8800	11800	6	1.7 ± 0.9	8000	7200	6	1.0 ± 0.7
8790	7400	6	1.4 ± 0.9	8000	7400	6	0.4 ± 0.6
8600	7200	6	1.1 ± 0.7	8000	7600	6	21.6 ± 2.1
8600	7400	6	1.0 ± 0.8	8000	7600	12	3.1 ± 1.7
8600	7600	6	1.8 ± 0.9	8000	7800	6	2.5 ± 0.9
8600	7800	6	0.7 ± 0.7	8000	8400	6	3.5 ± 2.2
8600	10400	6	2.3 ± 1.3	8000	8600	6	2.9 ± 1.3
8600	10800	6	2.9 ± 1.0	8000	9000	6	0.1 ± 0.7
8600	11200	6	0.7 ± 0.7	8000	9600	6	1.1 ± 0.8
8400	7200	6	1.0 ± 0.7	7800	7400	6	1.0 ± 0.8
8400	7200	6	1.0 ± 0.8	7800	7600	6	14.0 ± 2.1
8400	7400	6	1.8 ± 1.3	7800	7600	12	3.3 ± 1.6
8400	7600	6	1.2 ± 0.8	7800	7800	6	5.7 ± 1.8
8400	7800	6	1.8 ± 0.9	7800	7800	12	1.3 ± 1.5
8400	8800	6	8.3 ± 1.7	7800	8000	6	0.2 ± 0.7
8400	8800	8	1.9 ± 1.5	7800	8200	6	4.2 ± 1.7
8400	9600	6	2.1 ± 1.0	7800	8200	12	2.7 ± 1.2
8400	10000	6	4.2 ± 0.9	7800	8400	6	2.7 ± 1.3
8400	10400	6	1.9 ± 0.7	7800	8800	6	1.7 ± 0.8
8200	7200	6	2.0 ± 0.8	7800	9200	6	3.1 ± 0.8
8200	7400	6	1.5 ± 0.9	7600	7635	6	13.7 ± 1.1
8200	7600	6	* 0.1	7600	7635	12	5.0 ± 1.4
8200	7800	6	1.3 ± 0.9	7600	7635	18	2.8 ± 1.4
8200	8600	4	1.4 ± 0.8	7600	7800	6	0.7 ± 0.6
8200	8800	6	14.3 ± 1.6	7600	8000	6	0.9 ± 0.8
8200	8800	12	13.2 ± 1.6	7600	8200	6	0.5 ± 0.7
8200	8800	18	1.6 ± 1.2	7600	8400	6	16.4 ± 4.2
8200	9200	6	2.2 ± 1.0	7600	8400	12	* 0.1

*There is at least 95 percent confidence that the true value is less than the measurement reported.

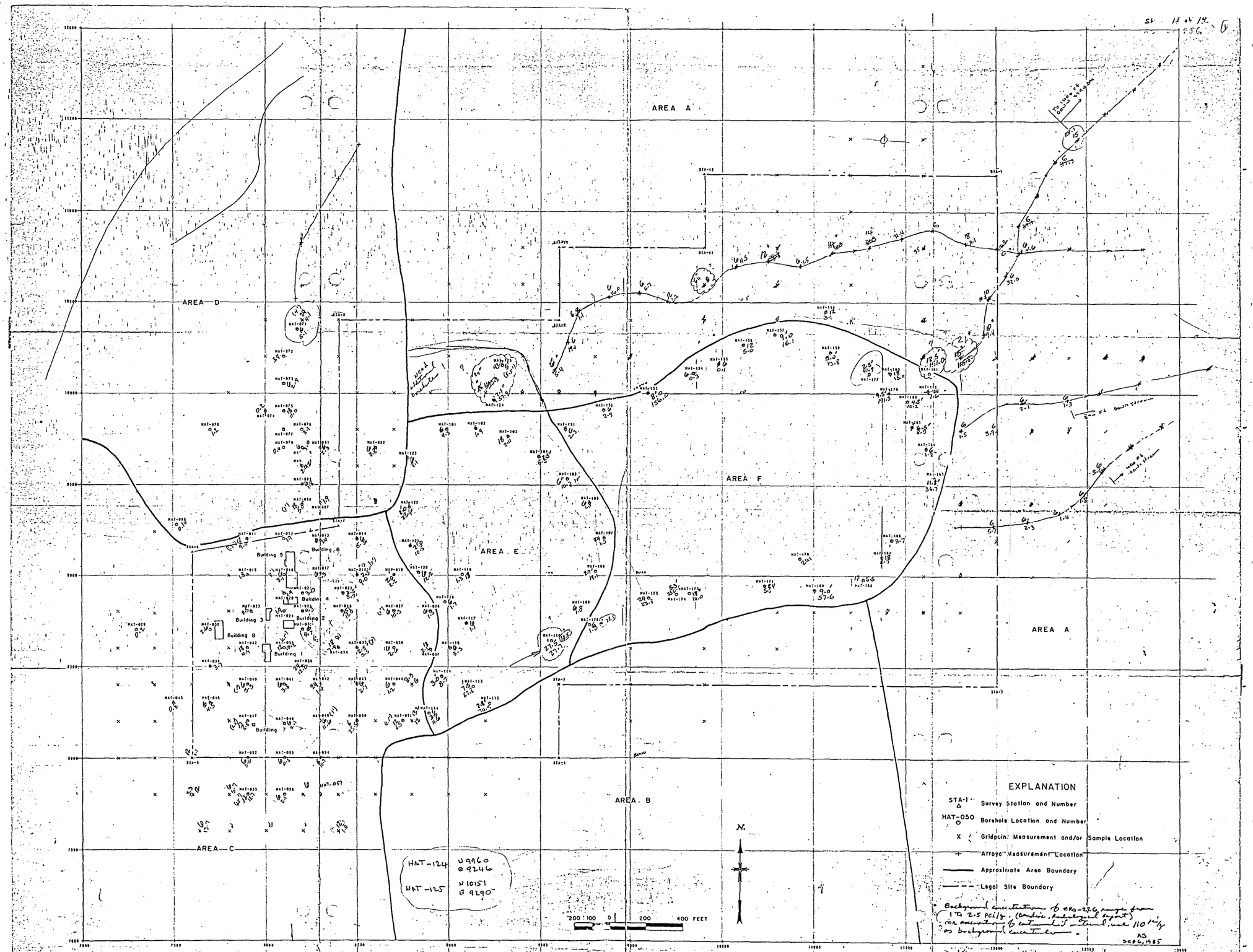

Plate I. Base Map for the Mexican Hat, Utah, Site

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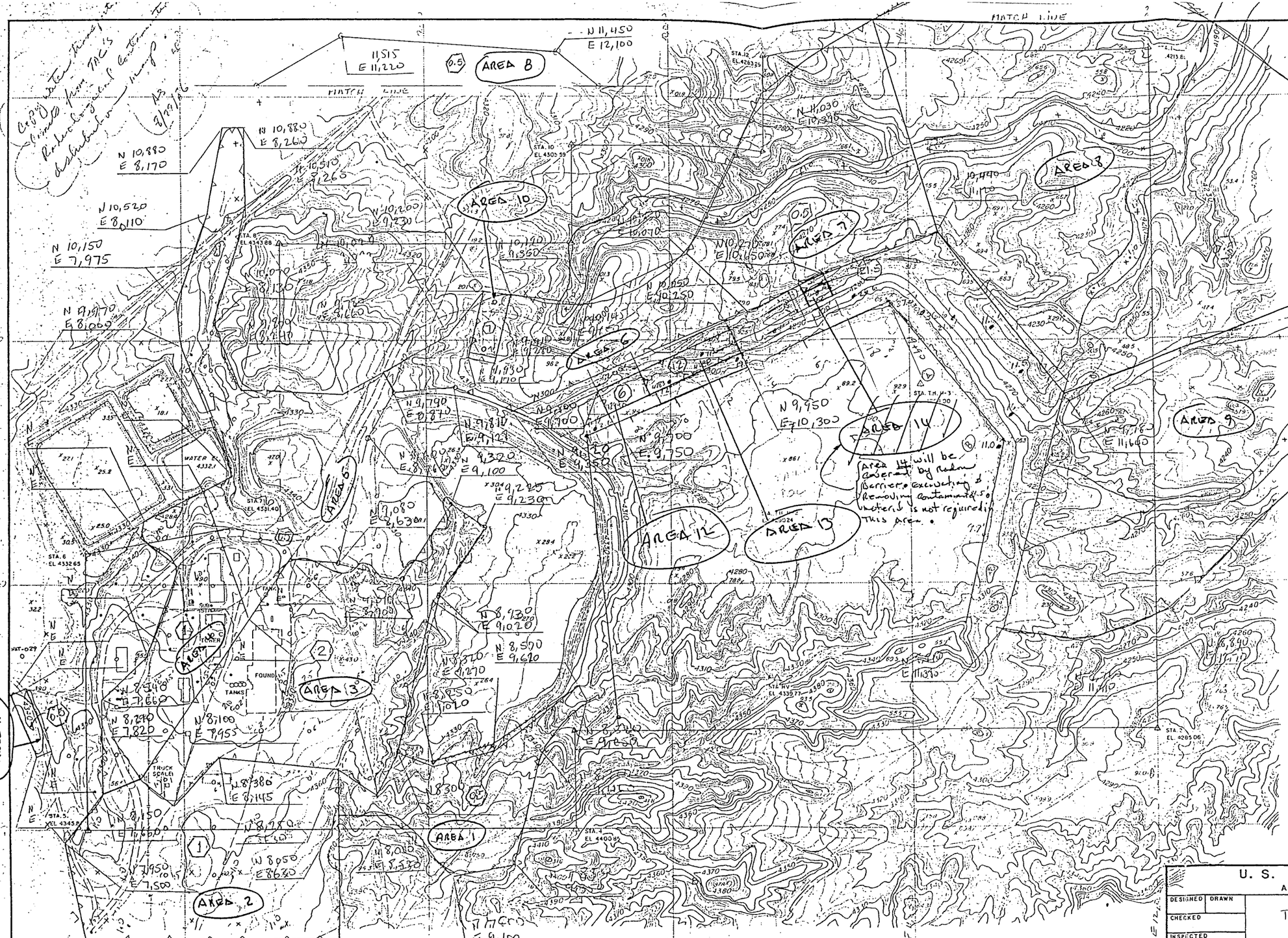

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NO.	DATE	REVISIONS	BY	CK	EBD MGR	CHIEF ENG	T&C REV	DOE APP

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED | DRAWN
CHECKED
INSPECTED
RECOMMENDED
APPROVED | DATE | DOE PROJECT ENGINEER | DATE

TAILINGS MATERIAL EXCAVATION PLAN

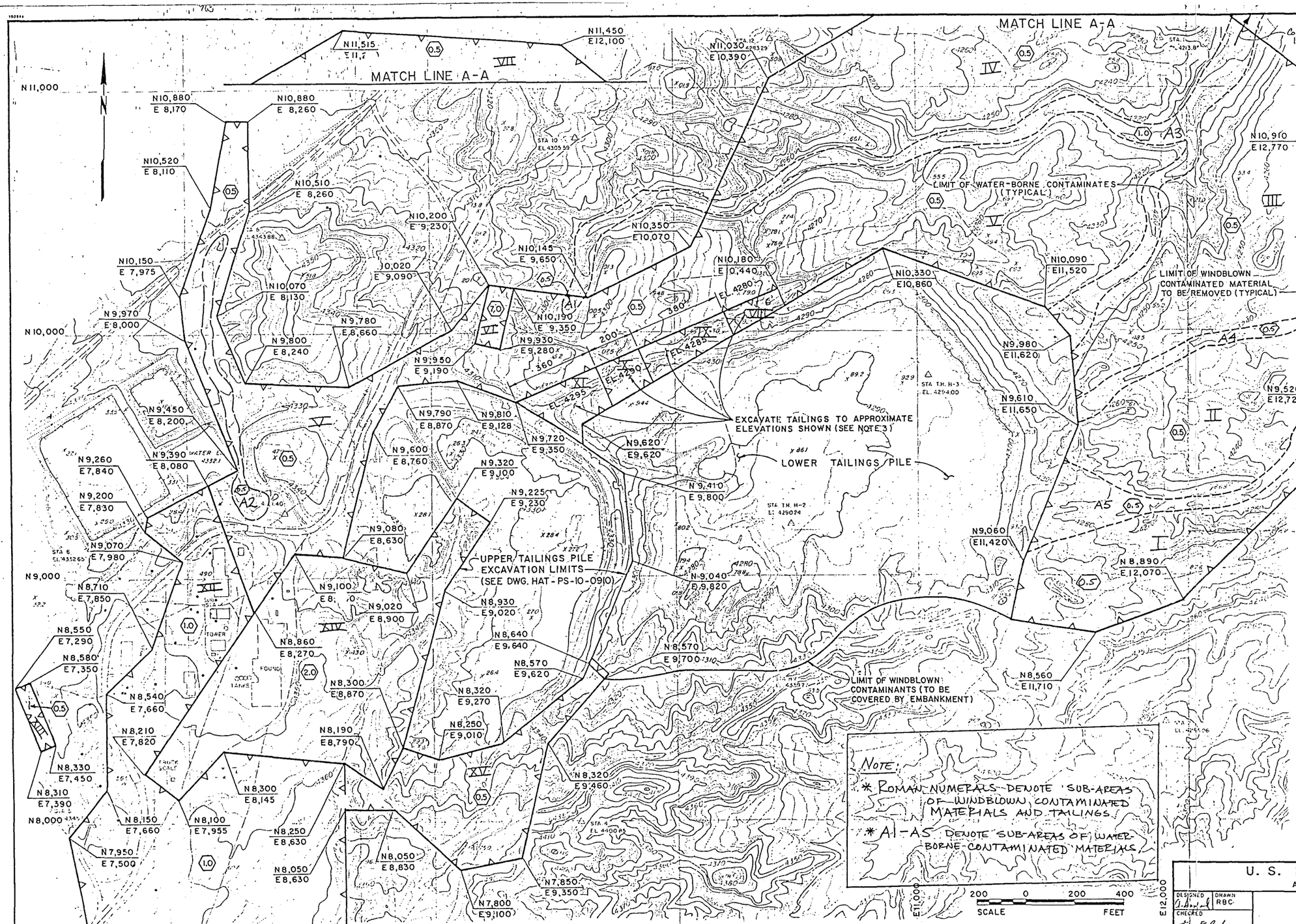
PROJECT NO. DE-AC04-83AL18796

DRAWING NO. HAT-C-10-5707

REV.

SHEET 14A
K. Ohsier 7/17/87
R. Clase 7/21/87

CONTAMINATION EXTENDS ANOTHER 1600' DOWNSTREAM OFF DRAWING. SEE PLATE 1 (SHEET 13)



REFERENCE DRAWINGS:

HAT-PS-10-0910 UPPER TAILINGS PILE EXCAVATION PLAN.

HAT-PS-10-0916 FINAL SITE GRADING AND DRAINAGE PLAN.

THIS ENTIRE SHEET IS PART OF REV 01

NOTES:

1. ALL EXCAVATED CUT SLOPES SHALL BE 2(H):1(V) MAXIMUM.
2. SUBCONTRACTOR SHALL REMOVE WINDBLOWN MATERIAL FROM THE STAGING AND MONITORING AREA PRIOR TO THE LAYOUT OF ANY CONSTRUCTION FACILITIES IN THAT AREA.
3. SUBCONTRACTOR SHALL EXCAVATE TAILINGS NORTH OF LOWER TAILINGS PILE TO ELEVATIONS SHOWN. THE TAILINGS SHALL BE PLACED ON THE EMBANKMENT PRIOR TO THE PLACEMENT OF WINDBLOWN MATERIAL. EXCAVATED AREAS SHALL BE BACKFILLED WITH UNCONTAMINATED MATERIAL TO THE GRADES SHOWN ON DWG. HAT-PS-10-0916
4. DEPTHS AND LIMITS OF WIND BLOWN CONTAMINATED MATERIALS ARE APPROXIMATE AND WILL BE CONFIRMED BY THE CONTRACTOP DURING CONSTRUCTION.
5. DEPTHS AND LIMITS OF WATER-BORNE CONTAMINATES WILL BE DETERMINED BY THE CONTRACTOR DURING CONSTRUCTION.
6. WORK IN ALL OR PORTIONS OF THE ARROYO AREAS MAY BE QUALIFIED UNDER SUPPLEMENTAL STANDARDS. EXTENT OF REMOVAL OF CONTAMINATED MATERIALS MAY BE MODIFIED AS APPLICABLE.

LEGEND:

------ WATER TRANSPORT LIMITS

N 9,000 CONSTRUCTION GRID COORDINATES

(1.0) DEPTH OF EXCAVATION IN FEET

△ △ LIMIT OF EXCAVATION

NOTE:
* ROMAN NUMERALS DENOTE SUB-AREAS OF WINDBLOWN CONTAMINATED MATERIALS AND TAILINGS.
* A1-A5 DENOTE SUB-AREAS OF WATER-BORNE-CONTAMINATED MATERIALS.

PRELIMINARY REVIEW

E&D MANAGER	CHIEF ENGINEER	QA MANAGER

QA MK-F	NO.	DATE	REVISIONS	BY	CK	E&D MGR	CHIEF ENG	TAC REV	DOE APP
	A	116-87	ISSUED FOR PRELIMINARY REVIEW	—	—	—	—	—	—

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DESIGNED / DRAWN RBC / CHECKED / INSPECTED / RECOMMENDED / APPROVED / DATE / DOE PROJECT ENGINEER / DATE

MEXICAN HAT SITE
MEXICAN HAT, UTAH

WINDBLOWN MATERIALS EXCAVATION PLAN

MORRISON-KNUDSEN ENGINEERS, INC.
MORRISON-KNUDSEN COMPANY
UMTRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO DE-AC04-83AL18796

DRAWING NO ~~HAT-PS-10-0912~~ REV A

MKE Document No. 5025-HAT-C-01-01153-00

Calculation Cover Sheet

Calc. No. 9-239-11-00

Contract No. 5025 Discipline Esci No. of Sheets 34

Project

UMTRA – MEXICAN HAT

Feature

EMBANKMENT DESIGN

Item

PIEZOCONE INTERPRETATION

Sources of Data

Sources of Formulae & References

(see pp. 34)

Preliminary Calc. ☒ Final Calc. ☒ Supersedes Calc. No. _____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	_____	E.C. Tre	10/29/86	PS	10/31/86	A. Aufed	11/6/86

Form 42-110

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA - HAT	Contract No. 5025	Sheet 1
Feature	Embankment Design	Designed EC7	File No.
Item	Piezocone Interpretation	Checked PS	Date 9/23/86
			Date 10/30/86

1. INTRODUCTION

The purpose of this exercise is to check and verify the piezocone data interpretation by the Technical Assistance Contractor (TAC) for the Mexican Hat Processing Site, Utah.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - HAT
Feature: Embankment Design
Item: Piezocone Interpretation

Contract No. 5025
Designed: ECT
Checked: PS

Sheet 2
File No.
Date 9/23/86
Date 10/30/86

SUMMARY OF PIEZOCONE INTERPRETATION

	Parameter	Approach Accepted by Most Geotechnical Engineers (based on Ref. 1)	TAC's Approach
1.	Classification	Use Douglas & Olsen's chart (Fig. 5.1 on p. 53 of Ref. 1) for natural deposits. No classification chart are available for tailings, except the one developed by TAC.	Use a modified Douglas & Olsen's classification chart, developed by the TAC, for tailings classification (Fig. on sh. 12)
2.	Equivalent SPT blowcount N-value	Use (q_c/N) vs. mean grain size curve developed by Robertson and Campanella (see fig. on sh. 17)	Based on Robertson & Campanella's chart, and for the mean grain sizes of each tailings type, determine the (q_c/N) ratio for each tailings type, and use the ratios for estimating N from q_c. Sand: (q_c/N) = 5.0 Sand-slime: 3.0 Slime: 1.5
3.	Relative Density D_r	Use Baldi et al.'s chart (see fig. on sh. 21)	Use Baldi et al.'s chart
4.	Effective Friction Angle, ϕ'	Use Robertson & Campanella's chart (see Fig. on sh. 23)	Use Robertson & Campanella's chart. Then correct ϕ' value according to correlations with lab tests

SUMMARY OF PIEZOCONE INTERPRETATION (continued)

Parameters	Approach Accepted by Most Geotechnical Engineers (based on Ref. 1)	TAC's Approach
5. Modulus of Elasticity, E_s	Use $E_s = \beta q_c$, where β is a function of soil type & problem geometry.	Use $E_s = 3.5\, q_c$ based on Schmertmann's (Ref. 2) recommendation for sands under a plane-strain condition.
6. Undrained Shear Strength, s_u	$s_u = (q_c - \sigma_{vo})/N_k$ where N_k = cone factor, value backfigured from lab. tests &/or local experience.	$s_u = q_c/N_c$ where N_c was shown to be 17 based on previous experience with uranium mill tailings at other UMTRA sites.
7. Overconsolidation Ratio, OCR	1. Estimate $(s_u/\sigma_{vo}')_{N.C.}$ by lab. tests or empirical correlations. 2. Estimate OCR using Ladd & Foott's (Ref. 3) chart (see Fig. on sh. 30) Ladd & Foott's chart can be expressed as: $OCR \cong \left[\frac{(s_u/\sigma_{vo}')_{measured}}{(s_u/\sigma_{vo}')_{N.C.}}\right]^{1.25}$	1. Assume $(s_u/\sigma_{vo}')_{N.C.} = 0.33$* based on previous experience at other UMTRA sites. (* where drainage) 2. Estimate OCR using the following equation $OCR \cong 1.03685 \left[\frac{(s_u/\sigma_{vo}')_{measured}}{(s_u/\sigma_{vo}')_{N.C.}}\right]^{0.745194}$ * given in TAC's computer code. ECT 10/31/86

A total of 41 piezocone holes were made at the Mexican Hat site; 28 on the lower pile, and 13 on the upper pile. In order to correlate laboratory classification tests and piezocone soundings, 13 boreholes were made adjacent to the piezocone holes; 9 on the lower pile and 4 on the upper pile. These boreholes and the adjacent piezocone holes are listed on sh. 6.

The approach taken in this correlation is to spot check the data and the inferred ~~values of~~ parameter values from several piezocone holes. It was decided that the spot-check should be made on 10% ± - of the piezocone holes. It was decided that 4 piezocone holes w/ adjacent boreholes at the lower pile be used for spot-checking. These piezocone holes are: HAT01-220, 215, 217, and 223.

Why no piezocones for upper pile evaluated?
→ upper pile will be moved to the lower pile area
Therefore, no need to evaluate data at upper pile

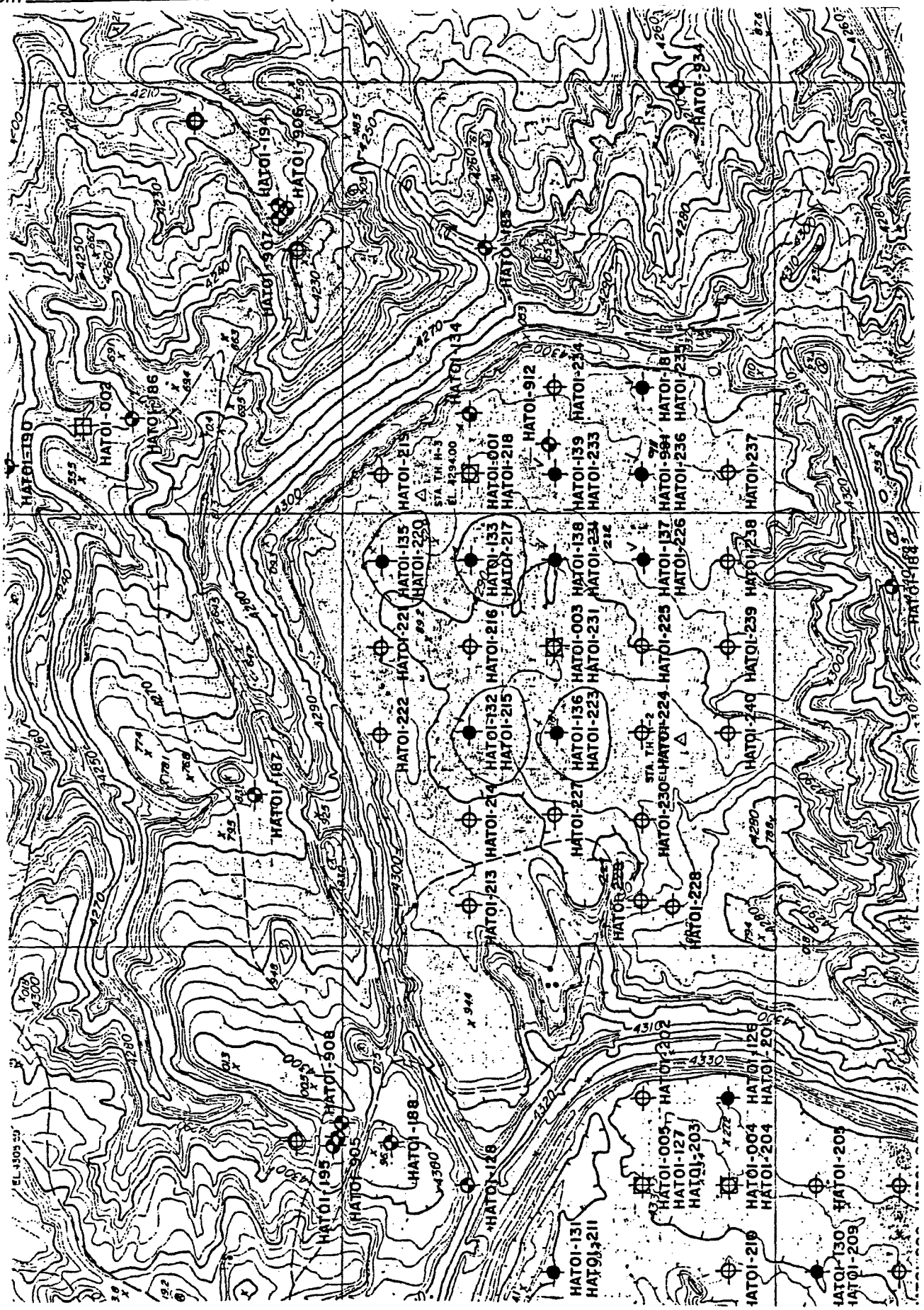
ECT 10/31/86

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UNTRA - HAT
Feature: Embankment Design
Item: Piezocone Interpretation

Contract No. 5025
Designed: ECT
Checked: PS

Sheet: 5
File No.:
Date: 9-16-86
Date: 10-30-86



MORRISON-KNUDSEN ENGINEERS, INC.
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Project	UMTRA - HAT	Contract No.	5025
Feature	Embankment Design	Designed	ECT
Item	Piezocone Interpretation	Checked	DJ

Sheet 6
File No.
Date 9-16-86
Date 10/30/86

Borehole - Piezocone Correlation

Borehole	Piezocone	
HAT-01-135	HAT-01-220	Lower Pile
132	215	
133	217	
136	223	
138	232	
139	233	
137	220	
911*	236	
181	235	
HAT-01-131	HAT-01-211	Upper Pile
126	201	
130	209	
129	207	

Used for correlation checks

* monitoring well

PIEZOCONE NO. HAT01-220

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 020 ⇒ BORING HAT-01-135 (HAT01-20)
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	1.0	1.0	15.2	0.1	-0.2	0.8	S-SL*	5	37	30	53	1827	
2	1.0	2.0	1.0	6.7	0.1	-0.1	1.8	SLIM	4			23	798	13.9
3	2.0	3.1	1.1	15.9	0.2	-0.1	1.4	S-SL*	5	38	30	56	1905	
4	3.2	6.5	3.3	10.1	0.2	-0.1	2.4	SLIM	6			35	1208	7.9
5	6.5	9.3	2.8	27.2	0.2	0.0	0.7	S-SL*	9	53	32	95	3265	
6	9.4	10.3	0.9	13.3	0.2	0.0	1.4	S-SL	4	29	29	47	1599	
7	10.3	11.3	1.0	31.7	0.2	0.0	0.6	S-SL*	10	51	32	111	3800	
% THK:		61	6.8	22.4	0.2	-0.0	0.9	S-SL	7	44	31	78	2691	
% THK:		38	4.3	9.3	0.2	-0.1	2.3	SLIM	5			32	1112	9.3

USCOE - HAT 5005
Earthquake Design
Piezocone Interpretation
ECT 9/16/86
PS 10/30/86

Pb.7

PIEZOCONE NO. HAT01-215

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 015 ⇒ BORING HAT-01-132 (HAT01-15)
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.2	2.4	2.2	7.1	0.2	0.0	2.9	SLIM	4			25	846	16.2
2	2.4	3.1	0.7	25.2	0.4	0.1	1.6	S-SL*	8	52	32	88	3021	
3	3.1	5.7	2.6	8.9	0.2	0.1	2.3	SLIM	5			31	1071	7.6
4	5.8	7.2	1.4	27.5	0.3	0.2	1.3	S-SL*	9	54	32	96	3294	
5	7.2	9.1	1.9	14.1	0.3	0.2	2.1	SLIM	9			49	1697	6.6
6	9.1	10.6	1.4	28.8	0.2	0.3	0.8	S-SL*	9	50	32	101	3456	
7	10.6	11.7	1.1	16.8	0.3	0.3	1.9	SLIM	11			59	2015	5.0
8	11.8	16.5	4.8	27.3	0.4	0.3	1.3	S-SL*	9	41	30	95	3270	
9	16.6	18.4	1.9	49.0	0.5	0.3	1.0	SAND*	9	54	32	172		
10	18.5	19.9	1.4	28.0	0.4	0.3	1.5	S-SL*	9	36	29	98	3355	
11	19.9	22.0	2.1	42.6	0.5	0.4	1.1	S-SL*	14	46	31	149	5109	
12	22.0	22.7	0.7	17.5	0.3	0.3	1.9	S-SL	5	23	28	61	2101	
13	22.8	25.1	2.4	16.9	0.2	0.4	0.9	S-SL*	5	21	28	59	2024	
% THK:		7	1.9	49.0	0.5	0.3	1.0	SAND	9	54	32	172		
% THK:		60	14.9	27.4	0.3	0.3	1.2	S-SL	8	39	30	95	3289	
% THK:		31	7.8	10.8	0.2	0.1	2.4	SLIM	6			37	1293	9.4

UMTRA-HAT SOIL
Supplemental Design
Piezocone Interpretation
ECT 9/16/86
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Att. 8

PIEZOCONE NO. HAT01-217

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 017 ⇒ BORING HAT-01-133 (HAT01-17)
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.1	5.5	5.4	8.2	0.3	-0.0	3.1	SLIM	5			29	989	10.1
2	5.6	7.0	1.4	26.2	0.3	0.1	1.3	S-SL*	8	53	32	92	3139	
3	7.0	9.3	2.4	13.1	0.4	0.1	2.7	SLIM	8			46	1575	6.2
4	9.4	11.5	2.1	40.7	0.4	0.1	0.9	SAND*	8	60	33	143		
5	11.5	12.5	0.9	36.5	0.6	0.1	1.6	S-SL*	12	53	32	128	4376	
6	12.5	13.0	0.5	13.8	0.5	0.1	3.3	SLIM	9			48	1660	3.7
7	13.0	17.3	4.3	31.8	0.4	0.1	1.1	S-SL*	10	44	31	111	3812	
8	17.3	19.4	2.1	17.5	0.4	0.1	2.5	SLIM	11			61	2094	2.8
9	19.4	20.1	0.7	35.6	0.5	0.2	1.4	S-SL*	11	42	30	124	4268	
10	20.1	21.8	1.6	12.8	0.5	0.2	4.0	SLIM	8			45	1536	1.9
11	21.8	23.2	1.4	24.4	0.5	0.2	2.0	SLIM	16			85	2923	2.7
12	23.3	30.4	7.1	8.4	0.2	2.5	2.9	SLIM	5			29	1006	1.0
13	30.4	31.3	0.9	28.6	0.4	1.8	1.3	S-SL*	9	29	29	100	3426	
14	31.4	31.8	0.5	15.0	0.1	1.6	1.0	S-SL*	4	16	26	52	1797	
% THK:		6	2.1	40.7	0.4	0.1	0.9	SAND	8	60	33	143		
% THK:		27	8.7	30.4	0.4	0.4	1.2	S-SL	9	43	31	106	3643	
% THK:		65	20.5	11.4	0.3	0.9	2.9	SLIM	7			39	1367	4.4

UMTRA HAT 5025
Embankment Design
Piezocone Interpretation
ECT 9/16/96
PS 10/3/96

pg. 9

PIEZOCONE NO. HAT01-223

SITE ID: HAT01
GROUND WATER DEPTH: 50.0 (FT.)

LOCATION ID: 023 → BORING HAT-01-136 (HAT01-23)
AVERAGE SOIL WEIGHT: 100.0 (PSF)

LY	DEPTH FROM	DEPTH TO	THK.	AVG. POINT	AVG. SLEEVE	AVG. PORE PRESS.	AVG. FRICT. RATIO	SOIL CLASS	BC	DEN	FA	ELAS.	UND. SHEAR STREN	OCR
1	0.0	7.2	7.2	6.4	0.2	0.3	3.1	SLIM	4			22	769	7.0
2	7.2	8.2	1.0	16.6	0.3	0.5	1.6	S-SL	5	39	30	58	1987	
3	8.2	14.1	5.8	6.6	0.2	0.7	2.5	SLIM	4			23	792	2.6
4	14.1	16.0	1.9	27.7	0.3	1.0	1.2	S-SL*	9	41	30	97	3330	
5	16.0	23.6	7.6	4.5	0.2	2.1	3.5	SLIM	2			16	537	0.9
% THK:		12	2.9	23.9	0.3	0.8	1.3	S-SL	7	40	30	83	2866	
% THK:		87	20.6	5.8	0.2	1.1	3.1	SLIM	3			20	689	3.5

CMTRA - HAT 5025
Embankment Design
Piezocone Interpretation
ECT 9/16/86
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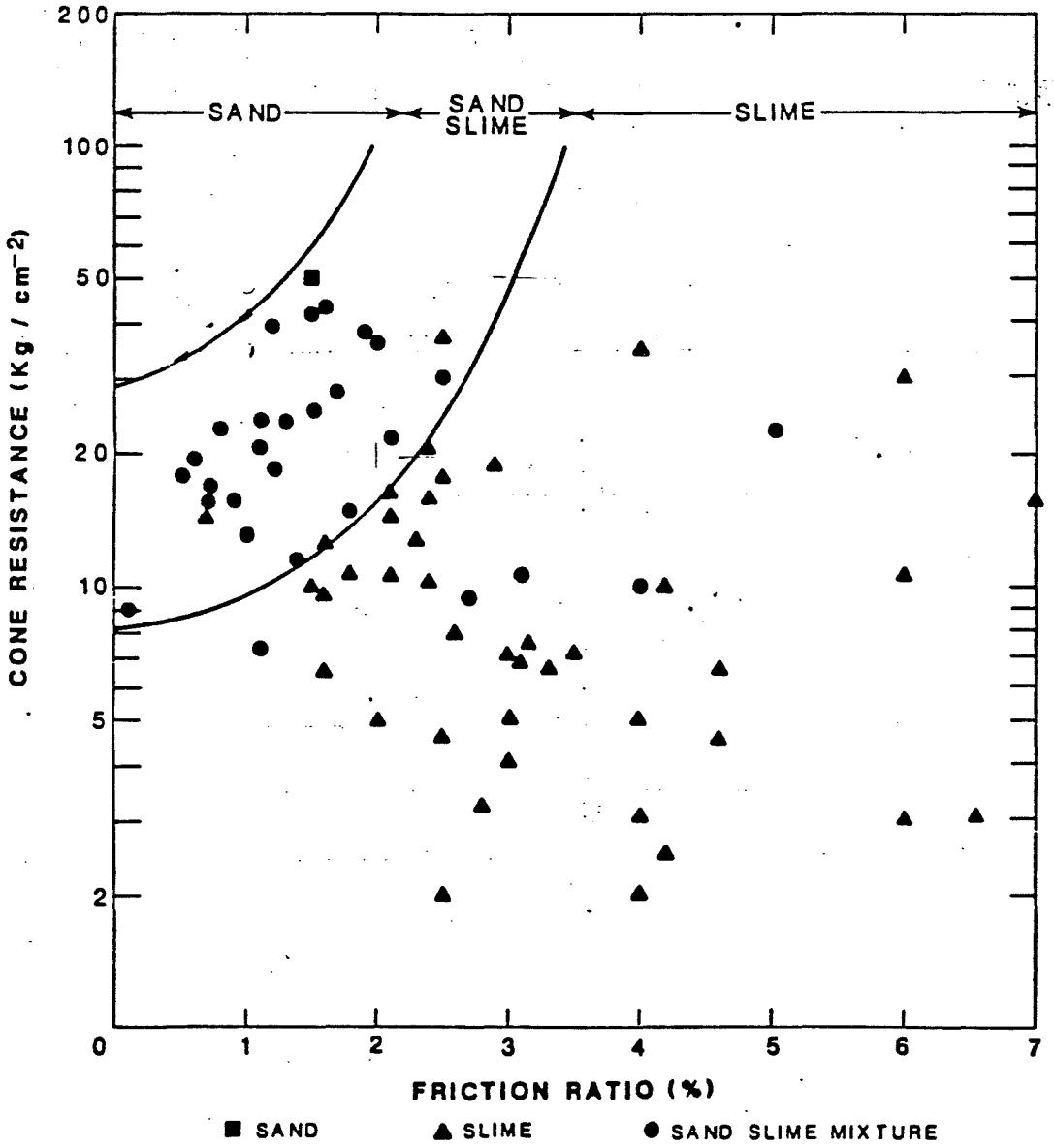
ab. 10

CLASSIFICATION

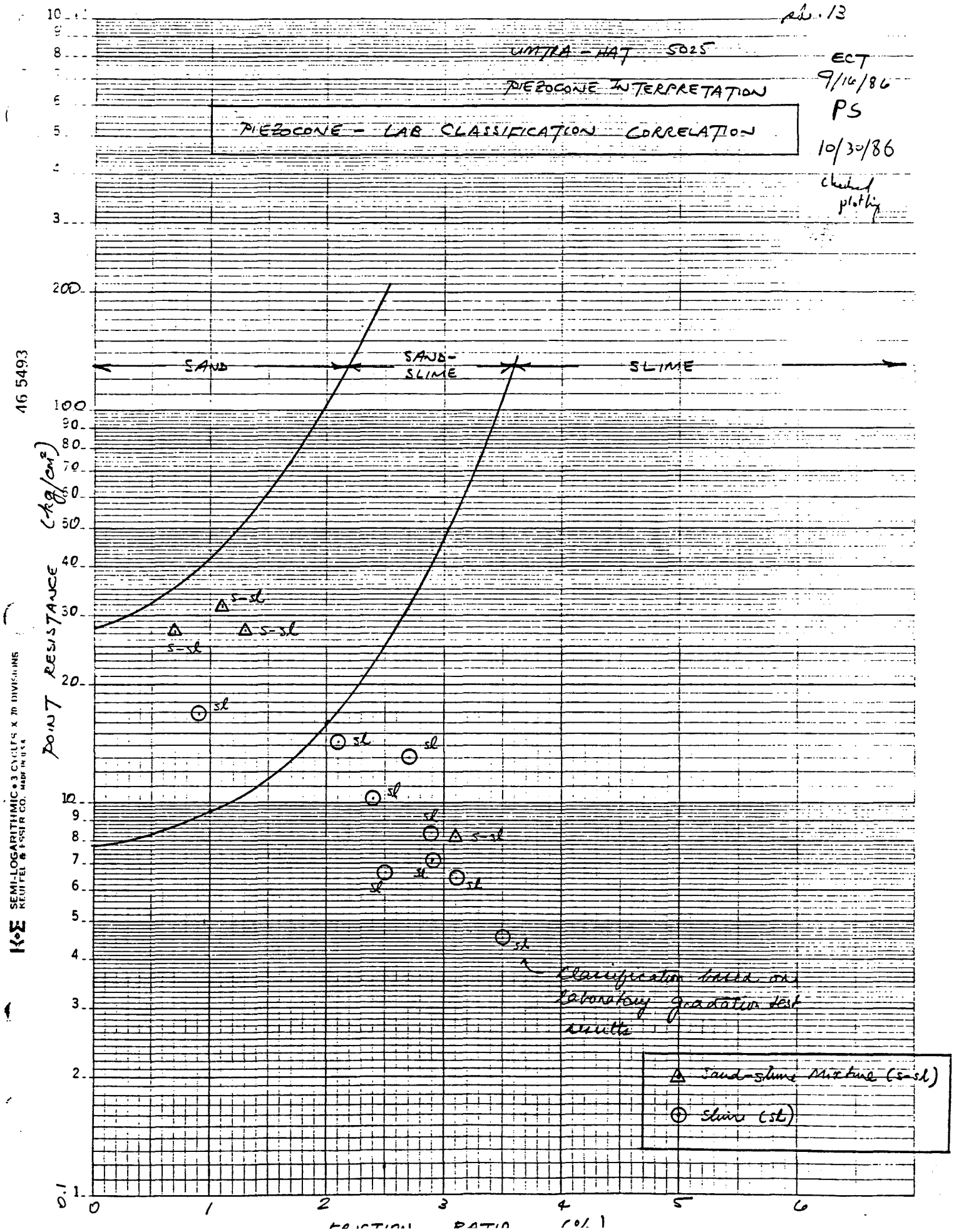
The chart shown on sh. 13 was used for classifying tailings into sands (s), sand-slimes (s-sl), and slimes (sl). The definition of these three tailings types is given at the bottom of sh. 14. TAC plotted data from Tuba City, Ambrosia Lake and Mexican Hat on this chart. There is a good agreement between the data and the classification using this chart. I plotted the Mexican Hat data, based on my interpretation of the laboratory gradation test results (sh. 14) on the same chart (sh. 13). Although the chosen data did not include sands, there is, by and large, a good agreement between the classification based on lab. gradation tests, and that using the TAC's classification chart. This is in line with the conclusions made for piezocone interpretation for Tuba City, and Ambrosia Lake (Ref. 4). In conclusion, this chart is acceptable as a tool for tailings classification for Mexican Hat.

UNTRA-HAT 5025 Ab. 12
Embankment design
Piezocone Interpretation
ECT 9/16/86
PS 10/30/86



(From Ref. 5)

FIGURE D6.1
PIEZOCONE CLASSIFICATION CHART USED FOR TAILINGS


ab. 13
UMTRA - HAT 5025
PIEZOCONE INTERPRETATION
PIEZOCONE - LAB CLASSIFICATION CORRELATION
ECT 9/16/86
PS 10/30/86
checked plotting
SAND
SAND-SLIME
SLIME
CONE RESISTANCE (kg/cm²)
FRICTION RATIO (%)
s-sl
sl
Classification based on laboratory gradation test results
Sand-slime mixture (s-sl)
Slime (sl)
46 5493
K+E SEMI-LOGARITHMIC 3 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A.

MORRISON-KNUDSEN ENGINEERS, INC.
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Project	UMTRA - MAT	Contract No.	5025	Sheet	14
Feature	Embankment Design	Designed	ECT	File No.	
Item	Piezocone Interpretation	Checked	PS	Date	9-16-86 / 10-30-86

Soil Classification Comparison (Data plotted on sh. 13)

Lab. Tests (1)				Piezocone (2)			
Boring	Depth (ft)	Unified Soil Classification (3)	Tailings Classification (4)	Piezocone	Depth (ft)	Point	Friction Ratio
132	1.5-4	CL	sl	215	0.2-2.4	7.1	2.9
	7-8.5	?	sl		7.2-9.1	14.1	2.1
	11.5-14	?	S-sl		11.8-16.5	27.3	1.3
	24.5-26.5	CL-ML	sl		22.8-25.1	16.9	0.9
133	1.5-4	?	S-sl	217	0.1-5.5	8.2	3.1
					7.0-9.3	13.1	2.7
	8.5-11	?	sl		9.4-11.5	40.7	0.9
	15.5-17	?	S-sl		13.0-17.3	31.8	1.1
	27-28.5	CL	sl		23.3-30.4	8.4	2.9
135	3-5.5	?	sl	220	3.2-6.5	10.1	2.4
					6.5-9.3	27.2	0.7
	8.5-10	?	S-sl		9.4-10.3	13.3	1.4
	20-22.5	CL	sl		-	-	-
	30-32.5	SM	S-sl		-	-	-
136	3-5.5	CL	sl	223	0-7.2	6.4	3.1
	13-15.5	CH	sl		8.2-14.1	6.6	2.5
	20-22.5	CL	sl		16.0-23.6	4.5	3.5

(1) Data from Table D.5.3, pp. D-168 ~ D-169, draft RAP, Appendix D (Ref. 5).
(2) Data from sh. 7 - 10.
(3) Based on lab gradation and Atterberg limit tests
(4) Based on lab gradation tests:
- Sands: 0% to 30% passing the no. 200 sieve (S)
- Sand-slime mixture: between 30% to 70% passing the no. 200 sieve (S-sl)
- Slimes: more than 70% passing the no. 200 sieve (sl)

Checked all data

q_c - N CORRELATION

The piezocone data showed consistent values of (q_c/N) ratios with respect to different materials (see next sheet).

	(q_c/N)
Sand	5 ±
Sand-slime	3 ±
Slime	1.5 ±

The above q_c/N ratios are in agreement with the average values suggested by Robertson & Campanella (Ref. 1) (see sh. 17).

MORRISON-KNUDSEN ENGINEERS, INC.
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Sheet 16

Project UMTRA - HAT | Contract No. 5025 | File No.
Feature Embankment Design | Designed ECT | Date 9/16/86
Item Piezocone Interpretation | Checked PS | Date 10/31/86

q_c - N CORRELATION

MATERIAL TYPE	PIEZOCONE NO.	DEPTH (ft)	POINT RESISTANCE q_c (kg/cm²)	REPORTED EQUIVALENT SPT B.C. N	q_c/N	$(q_c/N)_{average}$
Sand	215	16.6 - 18.4	49.0	9	5.4	5.3
	217	9.4 - 11.5	40.7	8	5.1	
Sand-Silime	215	2.4 - 3.1	25.2	8	3.2	3.1
		5.8 - 7.2	27.5	9	3.1	
	217	5.6 - 7.0	26.2	8	3.3	
		11.5 - 12.5	36.5	12	3.0	
	220	0.0 - 1.0	15.2	5	3.0	
Silime	215	0.2 - 2.4	7.1	4	1.8	1.7
		3.1 - 5.7	8.9	5	1.8	
	217	0.1 - 5.5	8.2	5	1.6	
		7.0 - 9.3	13.1	8	1.6	
	220	1.0 - 2.0	6.7	4	1.7	

Note: The computer computes the integer nearest to $\frac{q_c}{N}$ but lower than $\frac{q_c}{N}$

OK ECT 10/31/86

UMTRA-HAT 5025
Embankment Design
Piezocone Interpretation
ECT 9/16/86

~~110~~
pb. 17
PS. 10/30/86

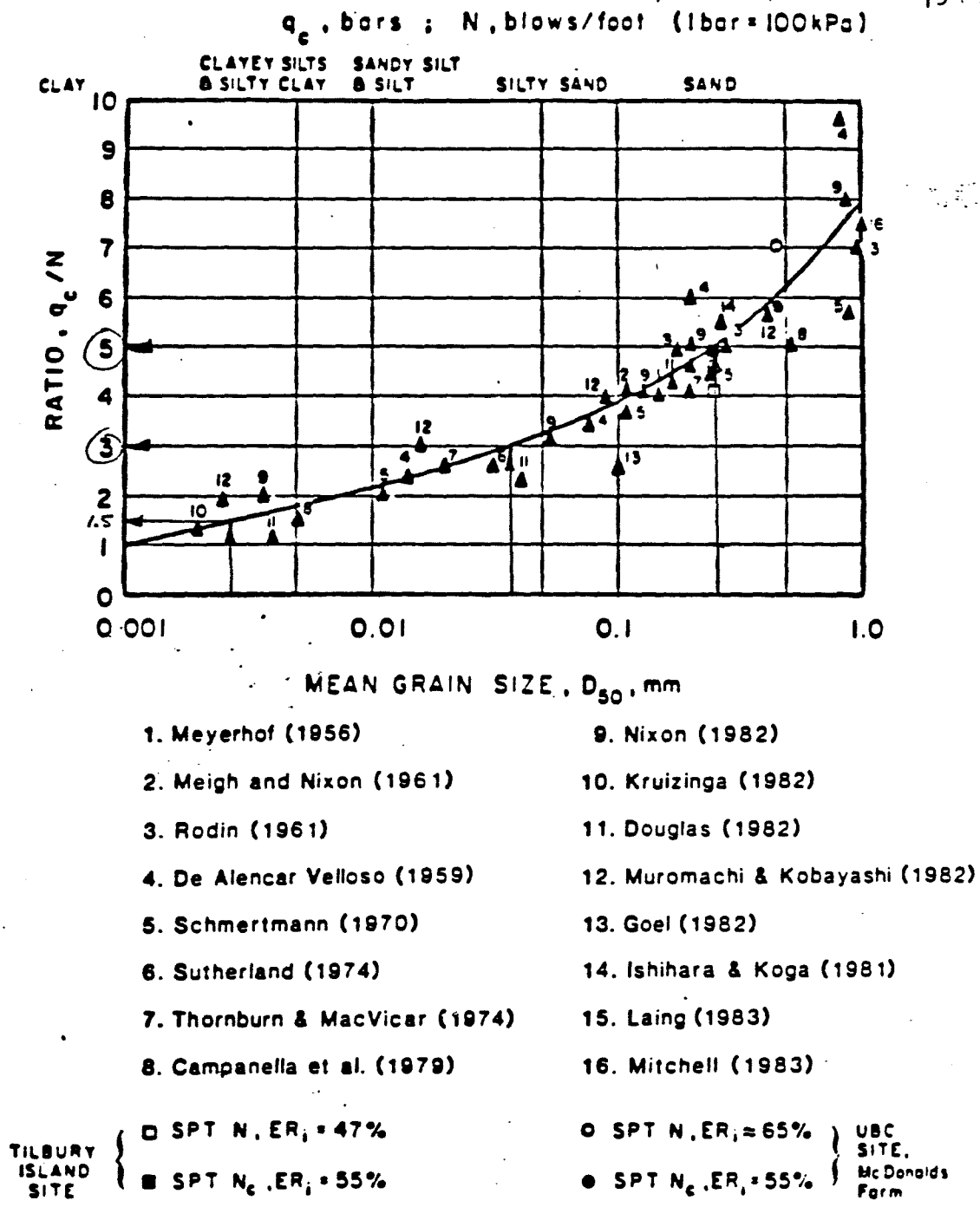

Fig. 5.14. Variation of q_c/N Ratio with Mean Grain Size (After Robertson et al., 1983)

(FROM REF. 1)

RELATIVE DENSITY D_r

The relative density D_r of coarse-grained materials (sands and sand-silt mixture) should be determined using Baldi et al.'s chart (ch. 21). This chart, strictly speaking, is applicable only for 'uncemented and unaged quartz sands'; however, it is frequently used for estimating D_r of other coarse-grained materials. This chart was used in D_r estimates for Tuba City & Ambrosia Lake. At these two sites, the TAC normalized the σ_v' to 1 bar, and then used the normalized stresses to find D_r. They did not digitize the whole Baldi et al.'s chart, and no "correlation-with-laboratory-test" factor was applied. At Ambrosia Lake, it was found that the TAC's D_r values are generally 20% to 50% higher than those from Baldi et al.'s chart (Ref. 1)

To check the D_r values for Mexican Hat, the table on the next sheet was prepared. The R_g factor, which is defined as:

$$R_g = \frac{D_r \text{ reported by TAC}}{D_r \text{ obtained from Baldi et al's chart}}$$

ranged from 1.3 to 1.5. In other words, the D_r values reported by the TAC are about 30% to 50% higher than those from Baldi et al.'s chart.

The reason for the discrepancy is probably due to the normalization procedure mentioned above. I would, therefore, caution the use of TAC's D_r values directly. I would recommend that TAC's D_r values be reduced by 30% to 50% if they are to be used in design.

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Project: CRA TRA - HAT
Feature: Embankment Design
Item: Piezocone Interpretation

Contract No. 5065
Designed: ECT
Checked: PY

Sheet 20
File No. 9/16/30
Date 10/30/86

SPOT CHECK ON RELATIVE DENSITY

Piezocone Hole	Depth (ft)	Point Resist. (kg/cm²)	q_c (bars)	σ_{vo}' (bars)	(1) D_r from Baldi's Chart	(2) D_r reported by TAC	R_D = (2)/(1)	Material Type
215	16.6 – 18.4	49.0	48.0	0.89	39 %	54%	1.4	Sand
217	9.4 – 11.5	40.7	39.9	0.53	47 %	60%	1.3	Sand
220	10.3 – 11.3	31.7	31.1	0.55	~~40~~ 38	51	1.3	S-sl
215	19.9 – 22.0	42.6	41.7	1.07	30	46	1.5	S-sl

I think 40 is closer, but whether it is 38 or 40, it does not matter.

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pb. 21

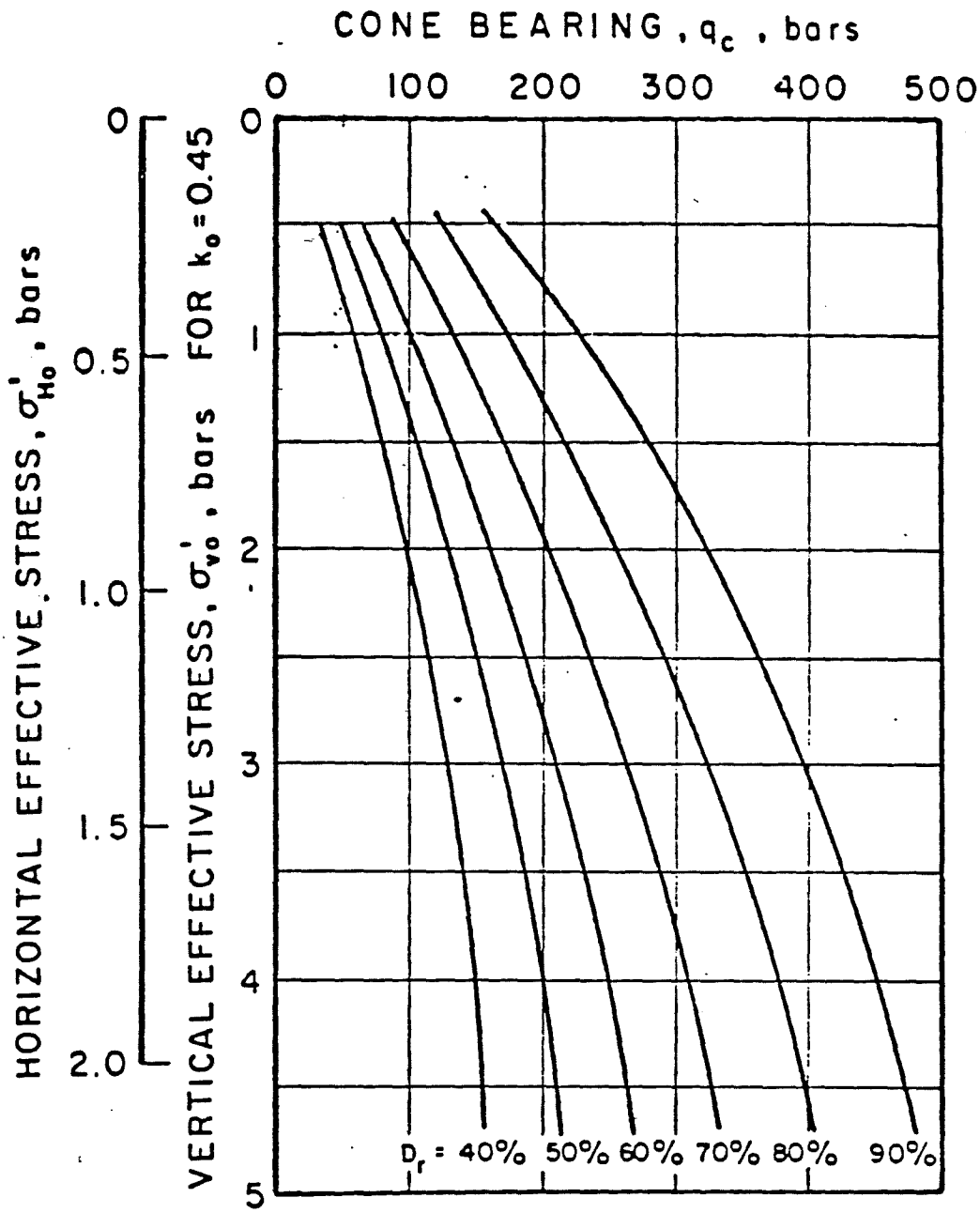

Fig. 5.3. Relative Density Relationship for Uncemented and Unaged Quartz Sands
(Adapted from Baldi et al. 1982)

(From Ref. 1)

EFFECTIVE FRICTION ANGLE, ϕ'

Based on the piezocone data, the TAC computed ϕ' values for coarse-grained materials including sands, and sand-slimes ~~and slimes~~. Slimes are not coarse grained. Also, some sand-slimes are not!

The TAC's approach is to: OK ECT 10/31/86

1. Determine ϕ' from q_c and σ_{vo}' (from Robertson & Campanella's chart, sh. 23)
2. Multiply ϕ' by a factor, R_ϕ, based on correlations with laboratory test results. R_ϕ was about 0.80 based on data from previous UMTRA sites.

The reported ϕ' values from piezocone data ranged from 26° to 32° ✓ for sand-slime mixture and 32° to 33° (two ✓ data) for sands (see sh. 7 - 10). These values seem to be reasonable for these materials.

✓ ECT 10/31/86

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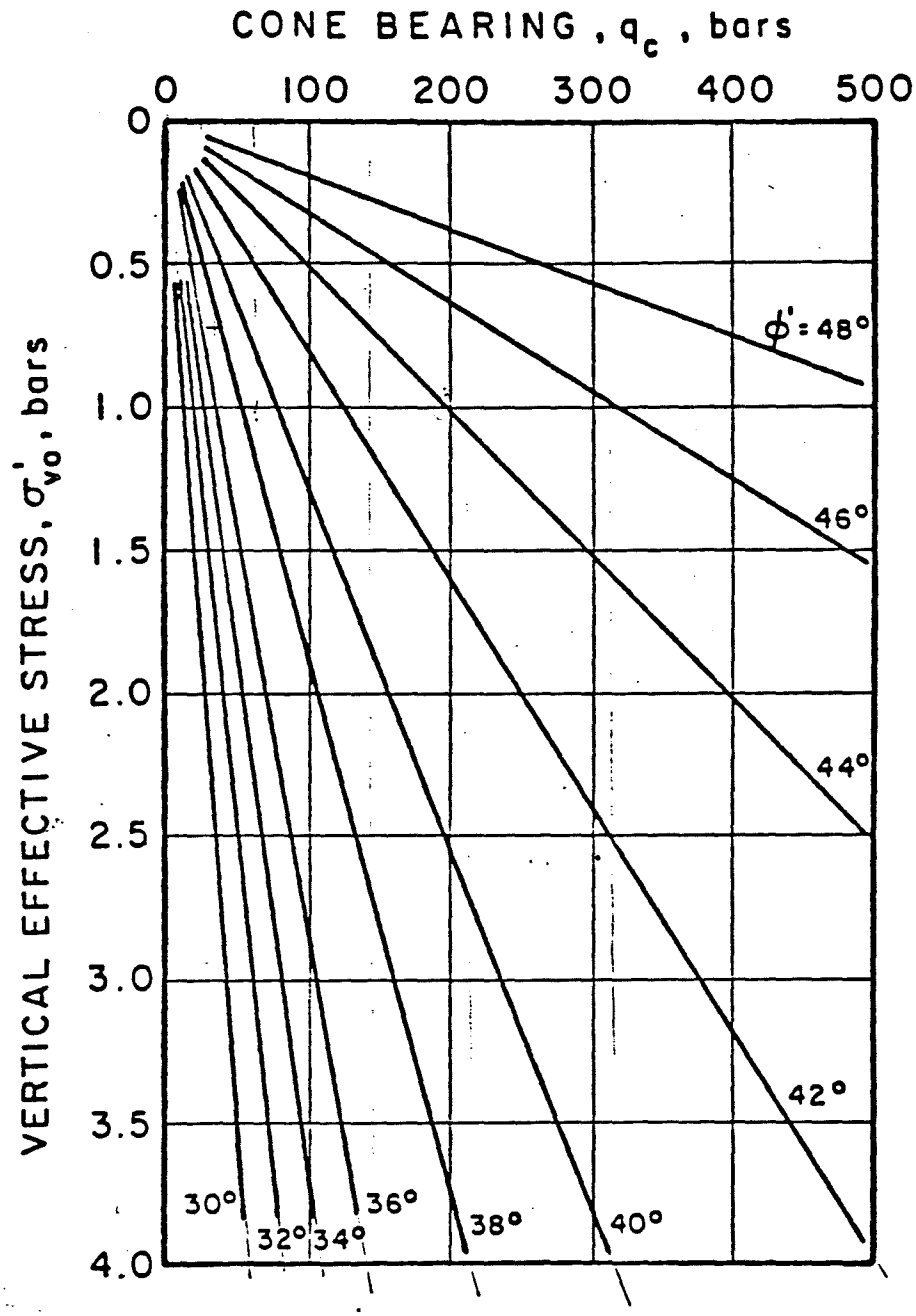

Fig. 5.5. Proposed Correlation between Cone Bearing and Peak Friction Angle for Uncemented, Quartz Sands (After Robertson and Campanella, 1983)

(From Ref. 1)

MODULUS OF ELASTICITY, E_s

The TAC suggested that $E_s = 3.5 q_c$. The computations were checked to be correct.

UNDRAINED SHEAR STRENGTH s_u

In the draft RAP (Ref. 5), the TAC indicated that the following approach was used for estimating s_u from the piezocone:

(1) $$s_u = \frac{q_c}{N_c} \Longrightarrow N_c = \frac{q_c}{s_u}$$

$$= \frac{q_c\,(kg/cm^2)}{s_u\,(psf)} \times 2126.96$$

The TAC also indicated that $N_c = 17$ was used for Mexican Hat. (Pg D-114)

CHECK

Piezocone Hole	Depth (ft)	(1) Point, q_c (kg/cm^2)	(2) Undrained Strength s_u (psf)	Computed N_c = (1) × 2126.96
215	0.2 - 2.4	7.1	846	17.9
	7.2 - 9.1	14.1	1697	17.7
	18.5 - 19.9	28.0	3355	17.8
	22.8 - 25.1	16.9	2024	17.8
			average	17.8

(1) Average computed N_c, is 17.8 and is close to 17 as report

(2) There was no site-specific correlation made for the N_c val for this site. Site-specific correlations at Ambrosia Lak showed a N_c factor of about 18. Ref. 1 (p.85) sho that N_c typically varies between 9 to 20. Therefore, a N_c value of 17 should be a reasonable value to use for this case.

Note: Perhaps a N_c value of 18 was used in TAC for Nin. they used $N_c = 17$; ECT 10/31/86

There are two common approaches to determine s_u:

(1) $$s_u = \frac{q_c}{N_c} \longrightarrow N_c = \frac{q_c}{s_u}$$

(2) $$s_u = \frac{q_c - \sigma_{vo}}{N_k} \longrightarrow N_k = \frac{q_c - \sigma_{vo}}{s_u}$$

The use of Approach (1) to determine s_u does not account for the depth effect on the measured point stress and shear strength of soils. Approach (2) is thus more appropriate.

Analysis done in Ref. 4 for Ambrosia Lake showed that the use of Approach (1) may lead to overestimation of s_u up to a maximum of about 30%. The overestimation is most significant for deep tailings. The same conclusion may also apply to Mexican Hat.

OVERCONSOLIDATION RATIO, OCR

From Ref. 1 and Ref. 3,

The following relationship is recommended to be used to compute OCR from measured s_u, and estimated (s_u/σ'_{vo}) for a normally consolidated state.

$$\underbrace{\left(\frac{s_u}{\sigma'_{vo}}\right)_{meas.}}_{\text{measured } \left(\frac{s_u}{\sigma'_{vo}}\right)} \cong \underbrace{\left(\frac{s_u}{\sigma'_{vo}}\right)_{N.C.}}_{\left(\frac{s_u}{\sigma'_{vo}}\right) \text{ for normally consolidated state}} (OCR)^{0.6}$$

$$\Rightarrow \quad OCR \cong \left[\frac{(s_u/\sigma'_{vo})_{meas.}}{(s_u/\sigma'_{vo})_{N.C.}}\right]^{1.25} \text{ ------ } (1)$$

Equation (1) should be used for estimating OCR.

As pointed out in my review of the Ambrosia Lake data the TAC used the following Equation (2) for estimating OCR

$$OCR \cong 1.03685 \left[\frac{(s_u/\sigma'_{vo})_{meas}}{(s_u/\sigma'_{vo})_{N.C.}}\right]^{0.745194} \text{ ---- } (2)$$

Should be 1.0 ?* Equation from TAC's computer code ECT 10/31/86

Note: The OCR results in TAC don't check out. Discussed with ELT OK ECT 10/31/86

It is not clear whether the coefficient 1.03685 and the exponent 0.745194 of the above equation are site-specific. However, based on a telephone conversation w/ the TAC (9/24/86), an equation of similar form as Equation (2) was used for estimating OCR.

The difference in the OCR profiles determined from Equation (1) and (2) are shown on pl. 30.

From sh. 30, TAC's OCR curve -

$\frac{(S_u/\sigma_{vo}')_{measured}}{(S_u/\sigma_{vo}')_{N.C.}} = SR$	OCR	$m = \frac{\log SR}{\log OCR}$
1.7	1.5	1.31
2.5	2	1.32
4.2	3	1.31
6.0	4	1.29

average $m = 1.31$

$$\therefore \quad SR \cong (\text{TAC's OCR})^{1.31}$$

Substituting into Eq. (1),

$$OCR \cong (\text{TAC's OCR})^{1.31 \times 1.25}$$

$$\Rightarrow \quad OCR \cong (\text{TAC's OCR})^{1.63} \quad \text{------ (3)}$$

We can use Equation (3) to correct the TAC's OCR values.

TAC's OCR values are shown on sh. 31. Using Equation (3), the TAC's values were corrected and shown on sh. 32. The OCR values were then transformed to preconsolidation stress σ_{vp}' on sh. 33, and compared with the σ_{vp}' obtained from lab. consolidation tests.

The piezocone σ_{vp}' values are higher than the lab. σ_{vp}' values. It is not clear what was the reason for this discrepancy. Since the piezocone interpretation of OCR involves indirect inference, and are not yet well-proven and supported by field performance (for uranium mill tailings), I would think that the lab. values are [illegible] reliable. In addition, using the lab.

- may be. But the slimes are classified as CL, CH in terms of plasticity. ECT 10/31/86

σ_{vp}' values would lead to larger consolidation settlement, and should, therefore, be more conservative. It would seem preferable to use the lab σ_{vp}' values for preliminary design unless further data, if any, prove otherwise.

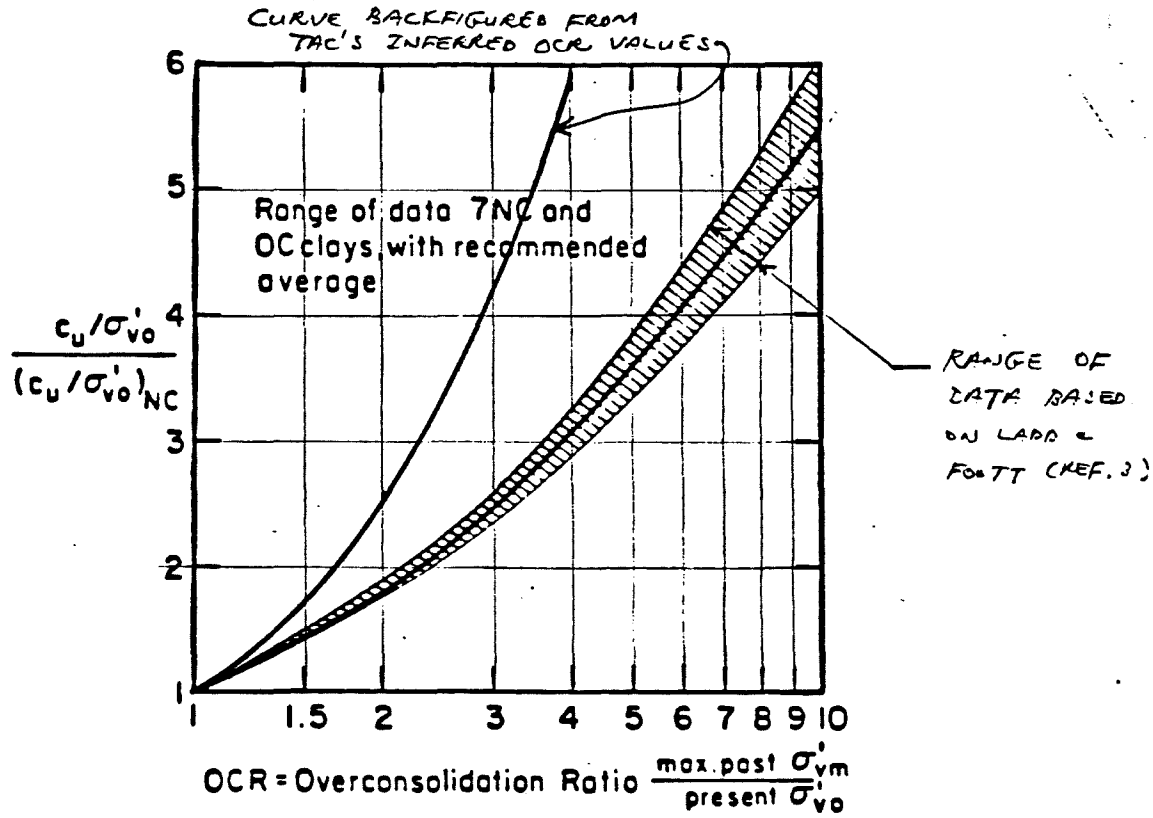

FIG.5.12(a) NORMALIZED c_u/σ'_{vo} RATIO VS. OCR FOR USE IN ESTIMATING OCR.

(From Ref. 1)

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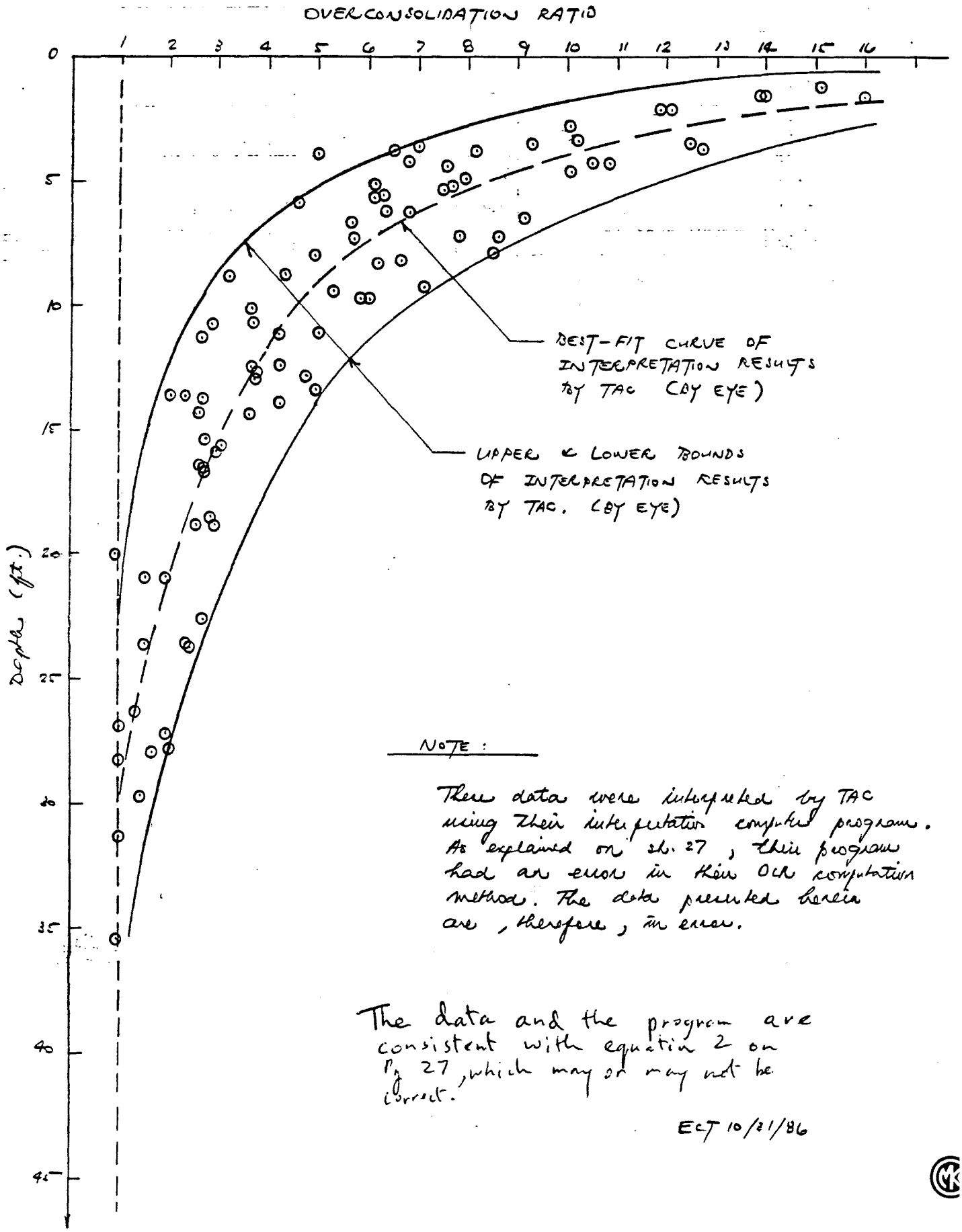
Project: UMTRA – HAT | Contract No. 5025 | Sheet 31
Feature: Embankment Design | Designed: ECT | File No.
Item: Piezocone Interpretation | Checked: PG | Date: 10/28/86 | Date: 10/31/86



NOTE:

These data were interpreted by TAC using their interpretation computer program. As explained on sh. 27, their program had an error in their OCR computation method. The data presented herein are, therefore, in error.

The data and the program are consistent with equation 2 on Pg 27, which may or may not be correct.

ECT 10/31/86

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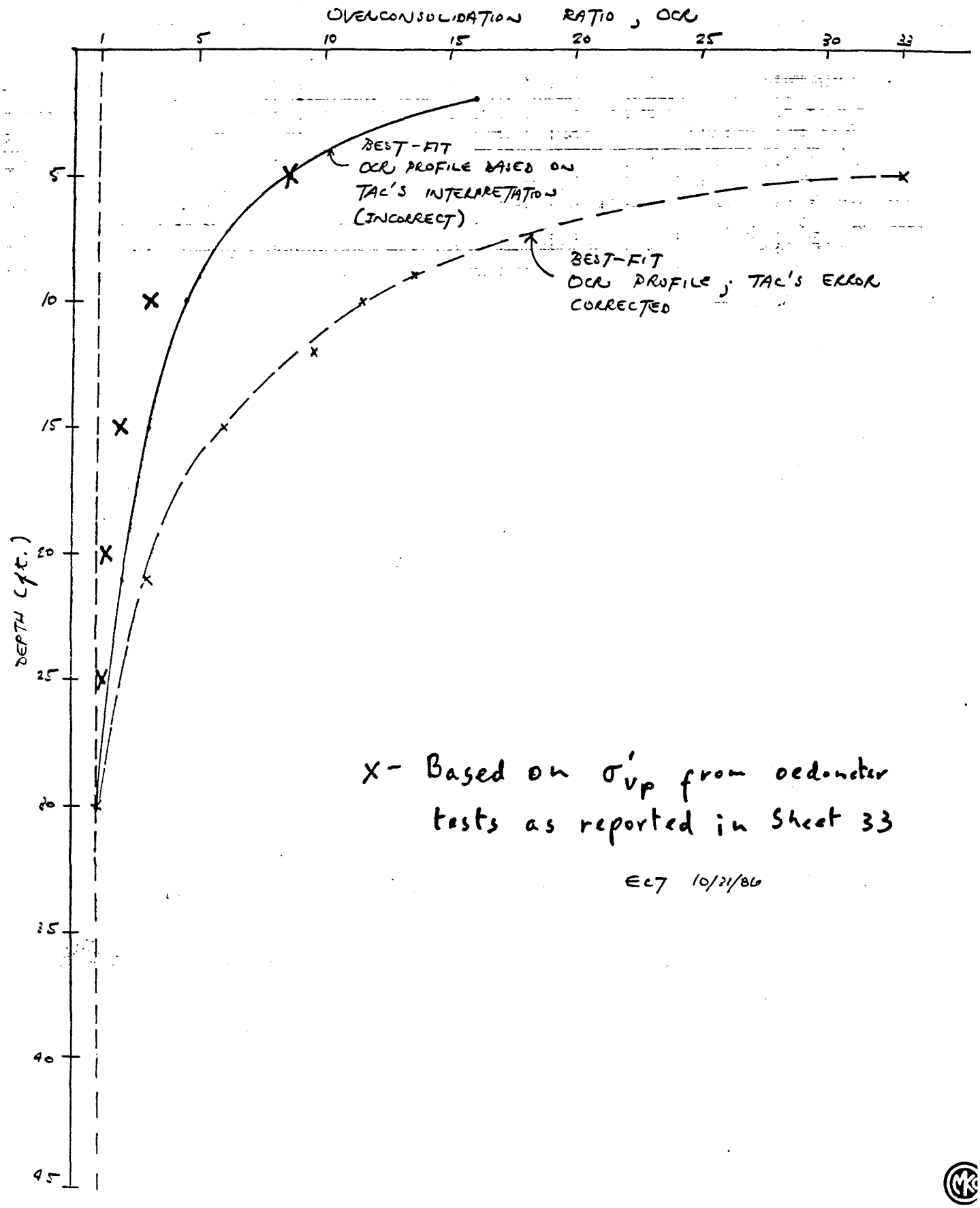
Project	UMTRA - HAT	Contract No.	5025	Sheet	32
Feature	Embankment Design	Designed	ECT	File No.	
Item	Piezocone Interpretation	Checked	PS	Date	10/28/86
				Date	10/31/86



X - Based on σ'_{vp} from oedometer tests as reported in Sheet 33

ECT 10/31/86

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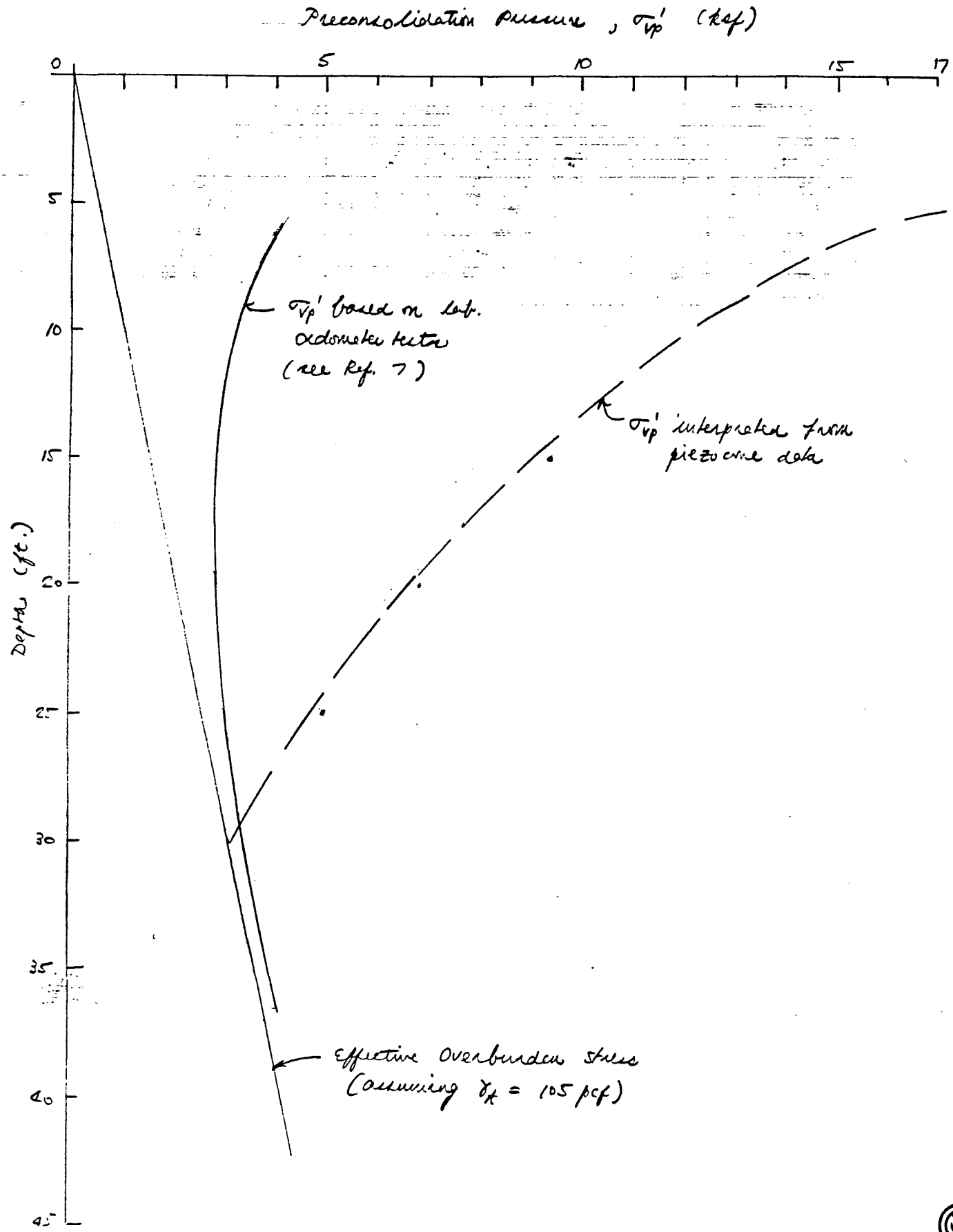
Project	UMTRA - HAT	Contract No.	5025	Sheet	33
Feature	Embankment Design	Designed	ECT	File No.	
Item	Piezo cone Interpretation	Checked	PS	Date	10/28/86
				Date	10/31/8



REFERENCES

1. Robertson, P.K. and Campanella, R.G., "Guidelines for Use & Interpretation of the Electronic Cone Penetration Test," Dept. of Civil Engineering, University of British Columbia, February 1984.

2. Schmertmann, J.H., "Guidelines for Cone Penetration Test, Performance and Design," Federal Highways Administration, Report FHWA - TS - 78 - 209, Washington, July 1978.

3. Ladd, C.C. and Foott, R., "New Design Procedure for Stability of Soft Clays," JGED, ASCE, Vol. 100, NO. GT7, pp. 763 - 786, 1974.

4. Morrison - Knudsen Engineers, Inc., "UMTRA - Ambrosia Lake Embankment Design, Piezocone Interpretation," Calculation NO. 5025 - AMB - C - 01 - 00256 - 00, April 1986.

5. Technical Assistance Contractor (TAC), "Appendix D to draft Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Mexican Hat, Utah," February 1986.

6. Technical Assistance Contractor (TAC), "Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Mexican Hat, Utah," Draft, February 1986

7. Morrison - Knudsen Engineers, "UMTRA, Mexican Hat, Materials Evaluation, Tailings - Design Parameters," October 1986, Calc. No. 9-239-01-00

Calculation Cover Sheet

Contract No. 5025 Discipline Elci/UMTRA Calc. No. 9-228-03-01 No. of Sheets 28

Project: UMTRA - Mexican Hat

Feature: Site Drainage

Item: North Ditch

Sources of Data: See Sheet 28

Sources of Formulae & References: See Sheet 28

Preliminary Calc. ☒ Final Calc. ☒ Supersedes Calc. No. _____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
01	Time-intensity curve revised (See Sheet 12 & 13)	R.F. Claire	5/6/87	H. Mojumder	7/17/87	A. Dayal	7/17/87
00	—	BWV / HM	12/4/86	G.M. Bletgo	1-8-87	A. Dayal	1/9/87

Form 42-110

Contents

		Sheet
1.	Purpose	1
2.	Method	2
3.	Summary of Design Values	3
4.	Description of "RIPRAP SFDI"	4
5.	Time of Concentration Calculation	9
6.	Input Parameters Calculation	9
7.	Computer Input	20
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I. PURPOSE AND SCOPE:

The purpose of the following calculations is to design the North ditch which is located on the north side of the tailings embankment. The North Ditch will intercept the runoff from the MW side and a portion of the runoff from the embankment.

II. METHOD:

Stable rock sizes and ditch dimensions were calculated using the MKE computer program "RIPRAP SFDI", a description of which is given on sheets 4 thru 8. The following assumptions were used in the design:

A. The design storm is the PMP;

B. The computer program uses the RATIONAL METHOD with a conservative coefficient of runoff C=1 for calculation of the design flow;

C: A trapezoidal ditch is assumed with side slopes of 2(H):1(V), since the ditch is in bedrock. A bottom width of 10 feet is also assumed, with a flared apron at end width equal to 50 feet;

D. The computer program uses MANNING'S EQUATION to size the ditches. No flow is assumed in the riprap voids (due to silting), which is a conservative assumption.

II. METHOD: (cont.)

E. The computer program uses the SAFETY FACTOR METHOD to size the riprap. The ditches are divided into several reaches with the $D_{50(min)}$ calculated at the upstream and downstream section of each reach. The largest D_{50} for each reach was used throughout that reach.

F. The intensity - duration curve used is from MKE UMTRA - Mexican Hat Calculation No. 9-223-01-00, "Site Hydrology."

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Project: UMTRA-HAT
Feature: Site Drainage
Item: North Ditch

Contract No.: 5025
Designed: RWJ
Checked: GMB

Sheet: 3
File No.:
Date: 12-4-86
Date: 1-8-87

Summary of Values:

North Ditch

STA	Bottom Width (ft)	Invert Slope (%)	Design Flow (CFS)	Flow Depth (ft)	Flow Velocity (fps)	Computed D_{50} (min) (in)
0+00	10.0	1.0	—	—	—	—
2+50	10.0	1.0	238	2.4	6.7	6.3
5+10	10.0	1.0	435	3.4	7.6	8.3
6+38	10.0	1.0	487	3.6	7.9	8.7
8+50	50.0	1.0	501	1.6	5.9	5.5

Description of "RIPRAP - SFDI" -- Ref (6)

The MKE computer program "RIPRAP SFDI" is used to calculate stable rock sizes for the riprap erosion protection of vee- or trapezoidal-shaped ditches. It also determines flow velocities and depths. The program utilizes the Safety Factors Method and other design procedures described in the MKE UMTRA Design Procedures Manual (Ref. 1, sec 5).

Design Method Summary:

a) The design flow rate is determined using the Rational Method ($Q = CiA$ with $C = 1.0$) for a reach

b) Incremental time of concentration is determined using average flow velocity calculated for the channel section at the end of the reach.

c) The flow velocity (and flow depth) is estimated using Manning's Equation.

d) Manning's N is estimated using the COE formula. (Ref 2)

e) Flow in the riprap voids may be deducted from the total flow. For this purpose the rock layer thickness is assumed to be the thicker of $2 \times D_{50(min)}$ or 12". In this calculation, the ditch riprap is assumed to be filled with silt and therefore no flow in the voids is assumed.

f) A maximum local boundary shear stress on the channel sideslope is used in the program. The initial shear coefficient, based on estimated flow depths, is checked with calculated flow depths.

g) A stable rock size is calculated for the ditch side slopes using the Safety Factors Method. A safety factor of 1.0 is used, with failure defined as movement of the minimum mean rock size ($D_{50(min)}$)

A flow chart follows, showing the actual equations used in "RIPRAP SFDI"; the sequence indicates the factors which are checked to ensure compatible results for flowrate, rock size, Manning's N, and flow depth.

Definition of Terms:

L = ditch length for reach (ft)
G, H, E = curve fitting parameters for site specific rainfall intensity vs duration.
F_s = Factor of Safety
TE = time of concentration for embankment (or overland) flow (min)
B = drainage area (acres)
D = ditch bottom width (ft)
IR = intensity corresponding to QD (by Q = CIA) (in/hr)
IV = intensity corresponding to QV (by Q = CIA) (in/hr)
QD = ditch flowrate (cfs)
QV = flow rate through riprap voids (cfs)
Q = total flow rate (= QD + QV) (cfs)
τ = shear stress (lb/ft^2)
F = shear stress factor
γ_w = unit weight of water (lb/ft^3)
y = flow depth (ft)
S = invert slope (ft/ft) ($\alpha = \tan^{-1} S$)
D_{50} = rock size that 50% by weight is smaller or larger than (ft)
T_c = time of concentration (min.)
A = cross-sectional area (ft^2)
V = flow velocity (ft/sec)
n = Manning's coefficient
ϕ = angle of friction of riprap (degrees)
G_s = specific gravity of rock
η = stability factor for rock on a horizontal surface
K = rock size (D_{50} (min)) (ft.)
P = porosity
W_m = throughflow factor ($= 3.266 K^{0.5}$) (ft/sec)
I = rainfall intensity (in/hr)
I_r = rainfall intensity that will cause a given runoff flowrate.
I_v = rainfall intensity that will cause a given throughflow rate.
θ = ditch side slope angle (degrees)
R = hydraulic radius
QR = flow across the rock
I_{MAP} = rainfall intensity

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Project	UMTRA - HAT	Contract No.	[illegible]	Sheet	1
Feature	Site Drainage	Designed	RWW	File No.	
Item	North Ditch	Checked	GMB	Date	12/4/86
				Date	1-8-87

EROSION PROTECTION FOR DITCH

SAFETY FACTORS METHOD

FLOW CHART

WYL 1/22/86
FBG 2-12-86

Source: MKE Lakeview Calc
No. 13-727-01-02

READ INPUT : DITCH, SECTION, TE, B, L, S, θ, D, F, K_{smooth}, $K_{increment}$, φ, G_s, P, G, H, I

CASE = DITCHES

CASE = SECTIONS

$K = K_{smooth} + K_{increment}$

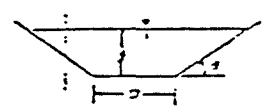
$\eta = \frac{(\tan\lambda/\tan\theta)^2 - 1}{(\tan\phi/\tan\theta)^2} \cdot \cos\theta$

CALCULATE λ

$\alpha = \tan^{-1} S$, $a = 1/\sin\alpha$, $b = 1/\sin\lambda$, $c = 1/\sin\theta$, $d = 1/\tan\theta$, $e = (b^2 - d^2)^{1/2}$

$\lambda = \cos^{-1} \frac{a^2 + e^2 - c^2}{2 \cdot a \cdot e}$

Notes:

1. IPMP = 10 $[G - 4 \cdot (L_g T)^{1/2}]$
2. 

FOR TRIANGULAR X-SECTION

If $D = 0.0$

$y = \frac{\eta \cdot (G_s - 1) \cdot K}{2I \cdot F \cdot S}$

$\eta = \frac{2I \cdot y \cdot S \cdot F}{(G_s - 1) \cdot K}$

$\beta = \tan^{-1} \left[\frac{\cos\lambda}{(2 \cdot \sin\theta)/(\eta \cdot \tan\phi)} + \sin\lambda \right]$ *

$F_s = \frac{\cos\theta \cdot \tan\phi}{\frac{(\sin(\lambda+\beta))}{2} \cdot \eta \cdot \tan\phi + \sin\theta \cdot \cos\beta}$

$y = y_{old}$?

No → $F_s > 1.0$?

Yes → $A = y^2 \cdot \cot\theta$

$R = \frac{A}{2 \cdot y \cdot \csc\theta}$

$N = \frac{y^{1/6}}{23.17 + 21.72 \cdot \log(1/K)}$

FOR TRAPEZOIDAL X-SECTION

Else $R = \frac{K \cdot (G_s - 1) \cdot \eta}{2I \cdot F \cdot S}$

$\eta = \frac{2I \cdot R \cdot S \cdot F}{(G_s - 1) \cdot K}$

$\beta = \tan^{-1} \frac{\cos\lambda}{(2 \cdot \sin\theta)/(\eta \cdot \tan\phi) - \sin\lambda}$

$F_s = \frac{\cos\theta \cdot \tan\phi}{\frac{(\sin(\lambda+\beta))}{2} \cdot \eta \cdot \tan\phi + \sin\theta \cdot \cos\beta}$

$R = R_{old}$?

No → $F_s > 1.0$?

Yes → $y = \frac{2 \cdot R \cdot \csc\theta - D - \sqrt{(2 \cdot R \cdot \csc\theta - D)^2 - 4 \cdot D \cdot R \cdot \csc\theta}}{2 \cdot \csc\theta}$

* modified: G.D.B. 5-19-86
FBG 5-19-86

FLOW CHART (CONTINUED)

Source: MKE Lakeview Site Calc. No. 13-727-01-02

WYL 1/28/86
FEG 2-10-86

$A = (D - Y \cdot \cot\theta) \cdot Y$

$N = \dfrac{R^{1/6}}{33.5 + 21.95 \cdot \log(R/K)}$

Endif

RUN-OFF

$QD = \dfrac{1.49}{N} \cdot A \cdot R^{2/3} \cdot S^{1/2}$

$IR = QD/B$

$V = QD/A$

THRU-FLOW

If $KI < 0.5$

$KI = 0.5$

$KI = K$

Endif

$QV = P \cdot [\cot\theta \cdot (4 \cdot Y \cdot K + 4 \cdot K^2) - 2 \cdot K \cdot D] \cdot 3.266 \cdot K^{0.5} \cdot S^{0.66}$

$IV = QV/B$

$I = IR + IV$

$TC = TE + \dfrac{L}{VR}$

If $TC < 2.5$

$T_{peak} = 2.5$

Else $T_{peak} = TC$

$IPMP = 10^{[G - H \cdot (\log T_{peak})^2]}$

$TE = TC$ *

No / Yes: $I > IPMP$

*modified: GDB. 5-19-86
FBG 5-19-86

PRINT RESULT: DITCH, SECTION, B, L, S, θ, D, K, Y, N, QV, QD, V, T, IPMP, F₂

check CASE = SECTIONS

check CASE = DITCHES

End

Determine the time of concentration, t_c, for North Ditch

Using the Upland Method; (Ref. 4)

$$t_c = l/V$$

where t_c = time of concentration (sec)
l = length of maximum watercourse (ft)
V = velocity (fps)

For this case, $l_1 = 1350'$ (sheet 10)
$S_1 = 4\%$ (conservative)
V_1 = fct. (slope, percent + physical condition)
↳ assume sheet flow (conservative)
so, $V_1 = 4.0$ fps (sheet 11)

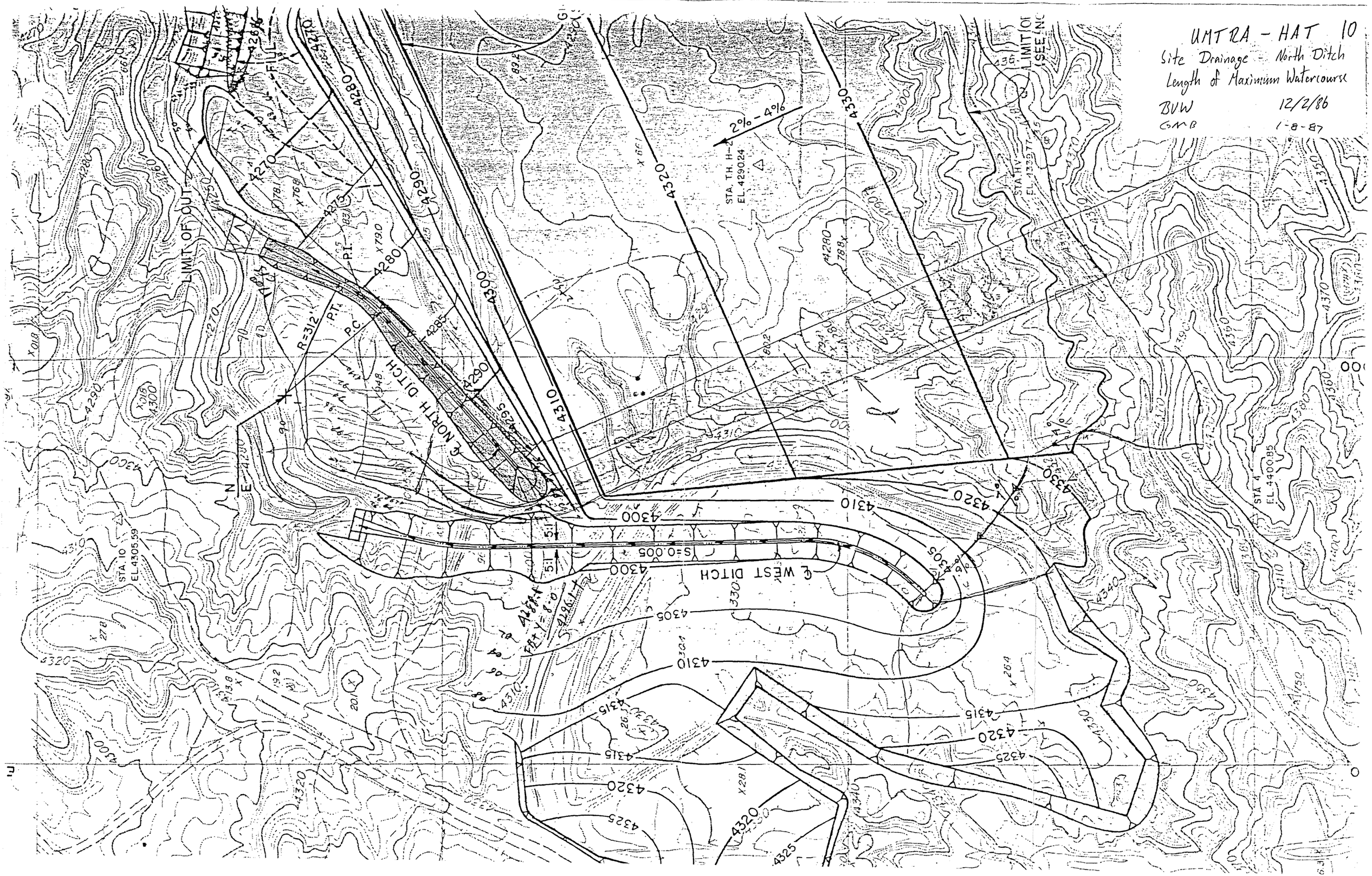
$l_2 = 150'$ (sheet 10)
$S_2 = 20\%$
$V_2 = 9.0$ fps (sheet 11)

$$\therefore \quad t_c = \Sigma\, l/V$$

$$= \left[\left(1350\,ft/4\,fps\right) + \left(150\,ft/9\,fps\right)\right]\left(1\,min/60\,sec\right)$$

$$= \underline{5.9\ min}$$

UMTRA - HAT 10
Site Drainage - North Ditch
Length of Maximum Watercourse
BVW 12/2/86
GMB 1-8-87



Site Drainage - North Ditch
BVW 12/2/86
GMB 1-8-87

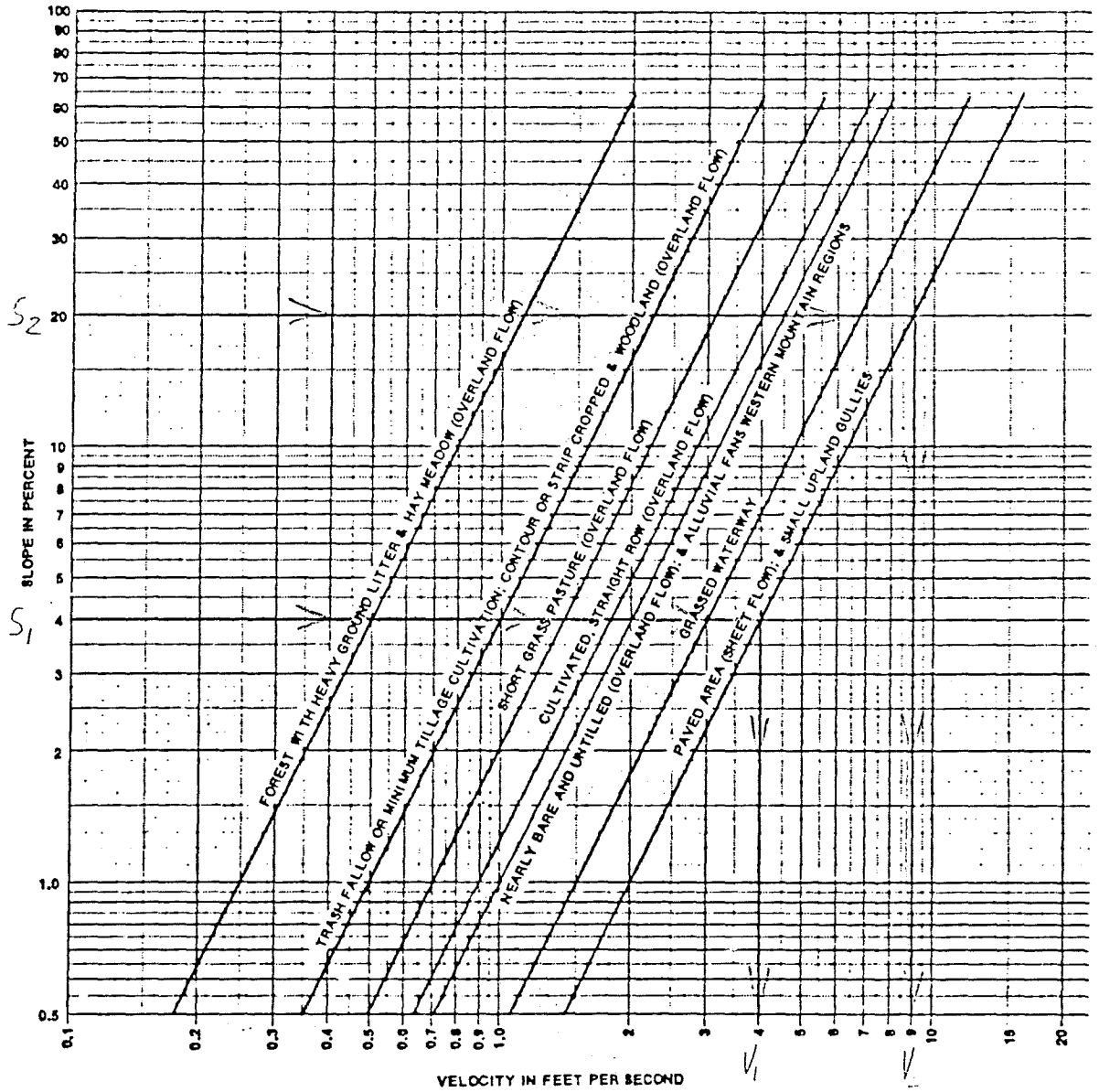


Figure 8. Velocities for upland method of estimating T_c

(Ref. 4)

The computer program RIPRAP SFDI approximates the site-specific rainfall intensity-duration curve by using the following formula:

$$I = 10^{[G - H(\log T_c)^Z]}$$

where I = rainfall intensity (in/hr)
$G = \log I_{(t=1)}$
$H = G - \log I_{(t=10)}$
T_c = time of concentration
& $Z = (1/\log 2) \log \left[\left(\frac{\log I_{(t=10)} - \log I_{(t=100)}}{H} \right) + 1 \right]$

G, H, & Z are curve-fitting parameters and have already been calculated in the Mexican Hat Site Hydrology calculations, (MKE Calc. No. 9-223-01-00). (Ref. 5).

From this calculations;

	As corrected in Rev. 01 Ref. 5
G = 2.004	G = 1.797
H = -0.499	H = -0.307
Z = 1.368	Z = 1.816

Rev 0, added

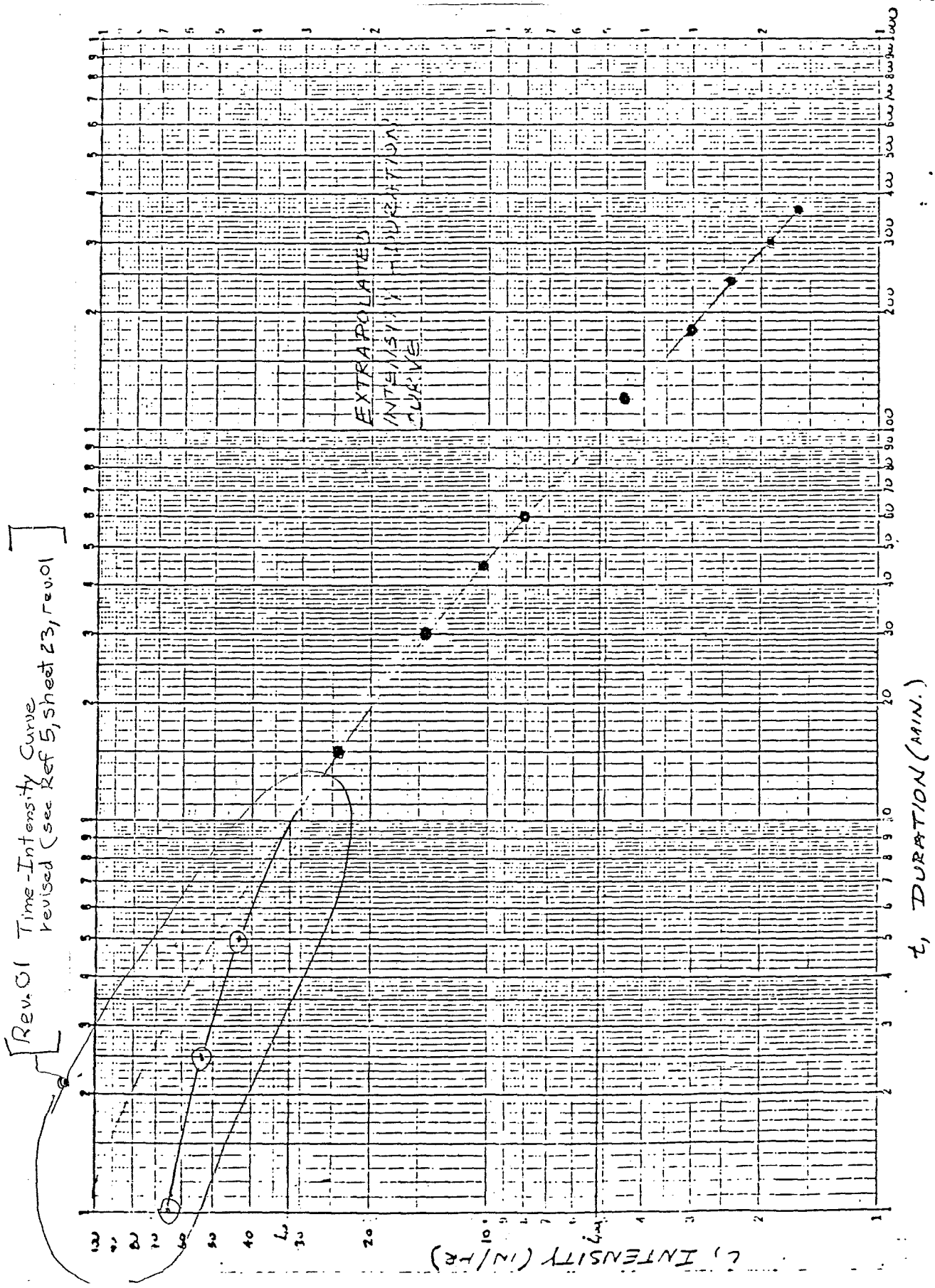
Note: The time itensity curves have been revised, after the completion of Rev. 0 of this calculation, See Sheet 13 for changes. The changes are for storms of less than 10 minutes duration, and are only significant for storms of less than 6 minutes. (See Sheet 13) Since the time of concentration is 6.5 minutes (t) and previous intensity values are conservative The values of Y, Q, tt, as calculated, are adequate.

Rev 01 added

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA - HAT	Contract No.	5025	Sheet	15
Feature	Site Drainage	Designed	BUW	File No.	
Item	North Ditch	Checked	GMB	Date	12/3/8[illegible]
				Date	1-8-8[illegible]

rev.01 OK {RFC HMT



UW-10-222-01-MD 11.4.22

In addition, physical properties of the riprap material must be determined for input into the computer model. From the RAP - Appendix D, the following properties for crushed limestone (proposed riprap material) are as follows:

Friction Angle, θ → $\theta = 42°$

Specific Gravity, G_s → $G_s = 2.64$

(Ref. 5)

It is assumed that intra-particle porosity, or void space, will be very small due to silting of the voids over time. Therefore, assume the following:

Porosity, n → $n = 0.001$

Hydraulic shear coefficients for straight channel sections with uniform flow conditions are taken from Ref. 1, fig. 5-3; as shown on sheet 16. $B = 10'$, $Y = 3.5'$ (assumed) $\Rightarrow B/Y = 2.86$

$\therefore C_{RS} \cong 1.45$ (verified on sheet 17)

Shear coefficients for bends with uniform trapezoidal section throughout are calculated using the following formula taken from Ref. 2:

$$\text{Bend Shear Coeff.} = \tau_{b\,max} / \tau_o = 3.2 \left(R/W\right)^{-0.5}$$

where R = bend radius, ft.
W = water surface width, ft.

so, $R = 312'$, $W = 14'$ (assumed)

$\therefore C = 3.2\left(312/14\right)^{-0.5} = 0.68$ ($0.68 < 1.45 \Rightarrow$ use $C = 1.45$)

For channel sections with non-uniform flow conditions, the shear coefficient is multiplied by a factor of 1.5 as suggested by Ref. 1, p. 5-14. Non-uniform flow is assumed to occur at changes in bed slope, changes in channel cross-section, and in the unstable flow range of Froude Numbers: $0.86 \leq F \leq 1.13$ (Ref. 2).

UMTRA - HAT
Site Drainage - North Dt
BVW 12/3/86
GMB 1-8-8

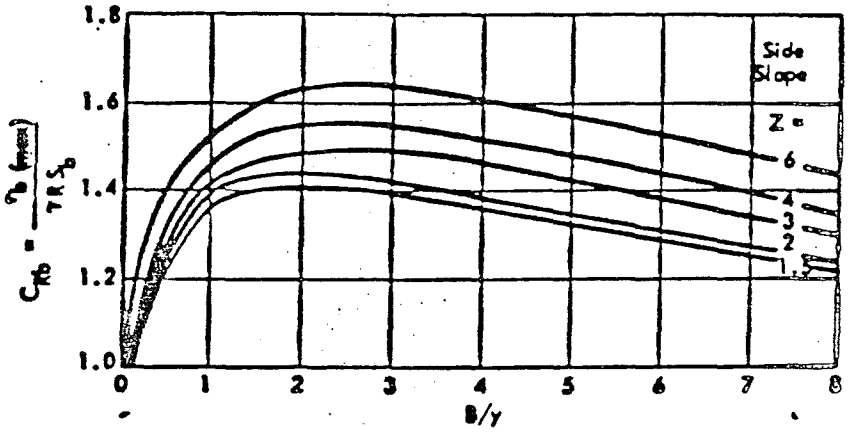


FIGURE 5-3 Maximum boundary shear stress on bottom of trapezoidal channels. (Ref. 5-2, page 13)

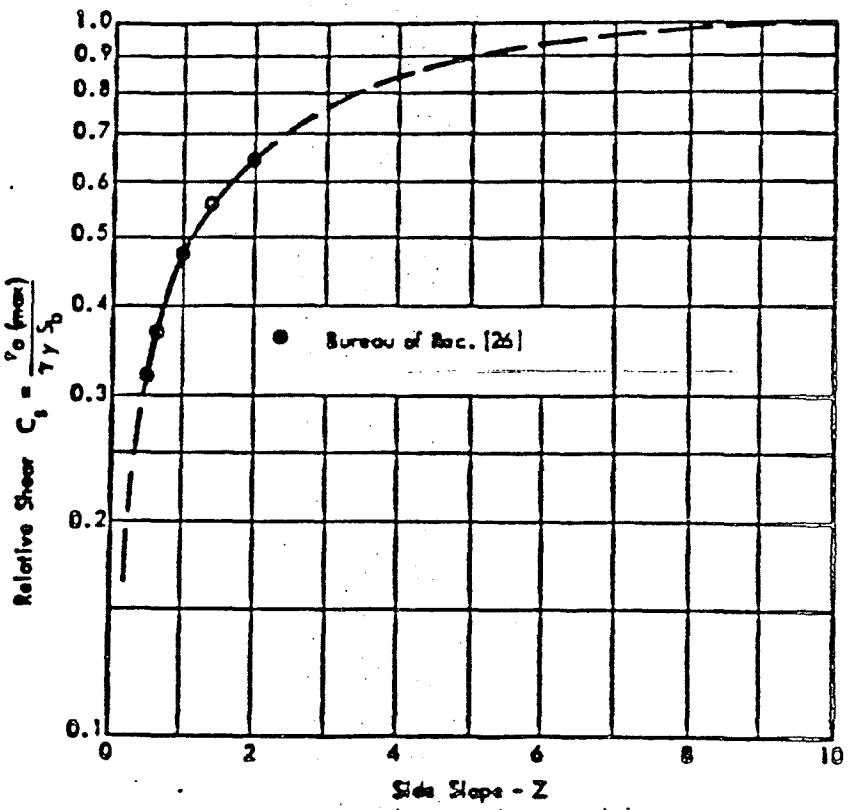


FIGURE 5-4 Maximum boundary shear stress on sides of triangular channels. (Ref. 5-2, page 12)

(Ref. 1)

To run RIPRAP SFDI, additional parameters must be specified for input into the computer.

Time of Concentration, T_c — T_c = 5.9 min (Sht 9)

Start Y = 0.10 ft (Initial water surface elevation)

Increment Y = 0.10 ft (Incremental rise in water surface elevation)

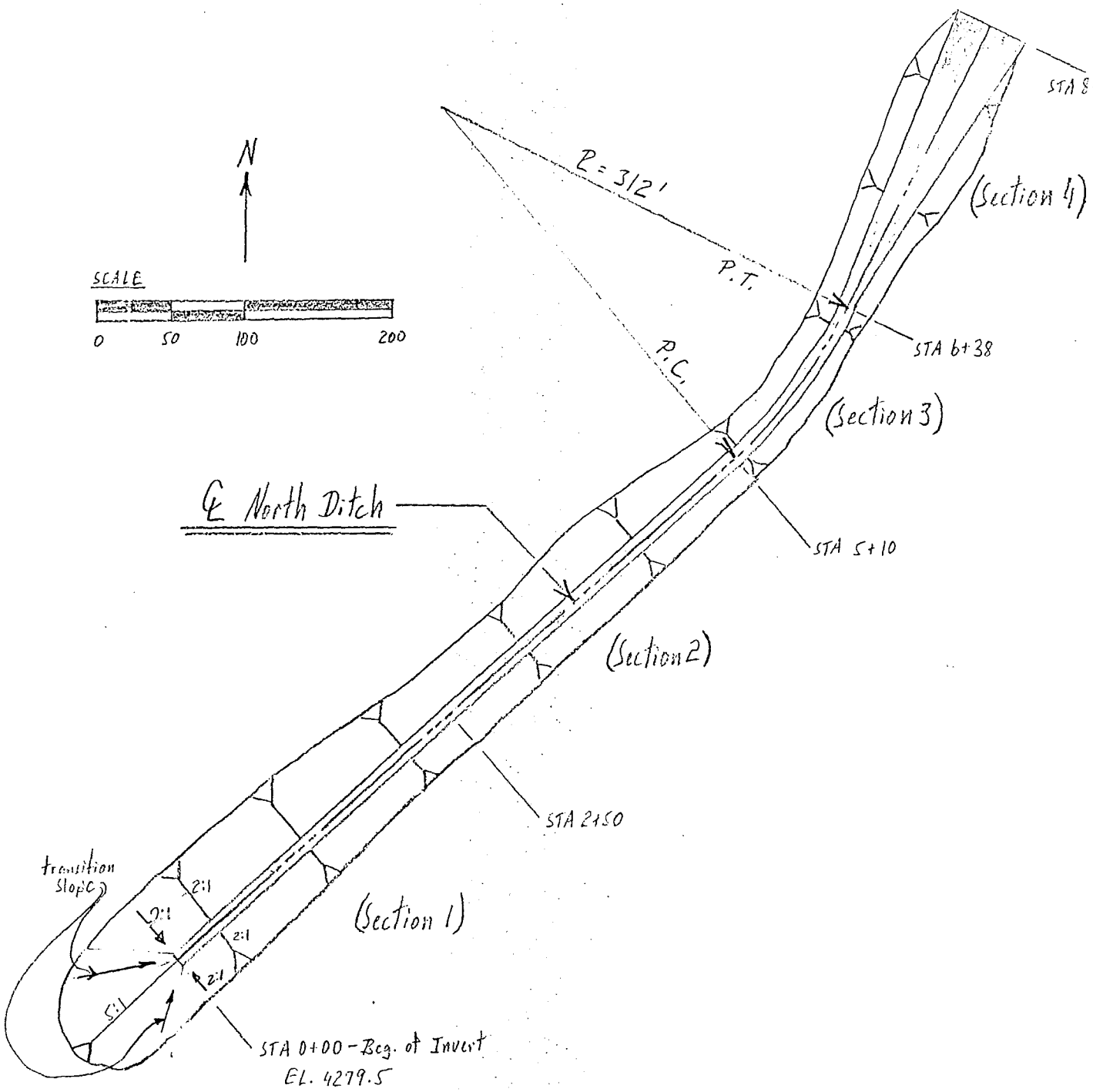
Increment K = 0.02 ft (Incremental increase in rock size)

Short Output = True (Only stores final results in the output file and will not show trial and error solution)

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 18

Project UMTRA - HAT | Contract No. 5025 | File No.
Feature Site Drainage | Designed HM / BUW | Date 10/29 & 12/
Item North Ditch | Checked GMB | Date 1-8-87

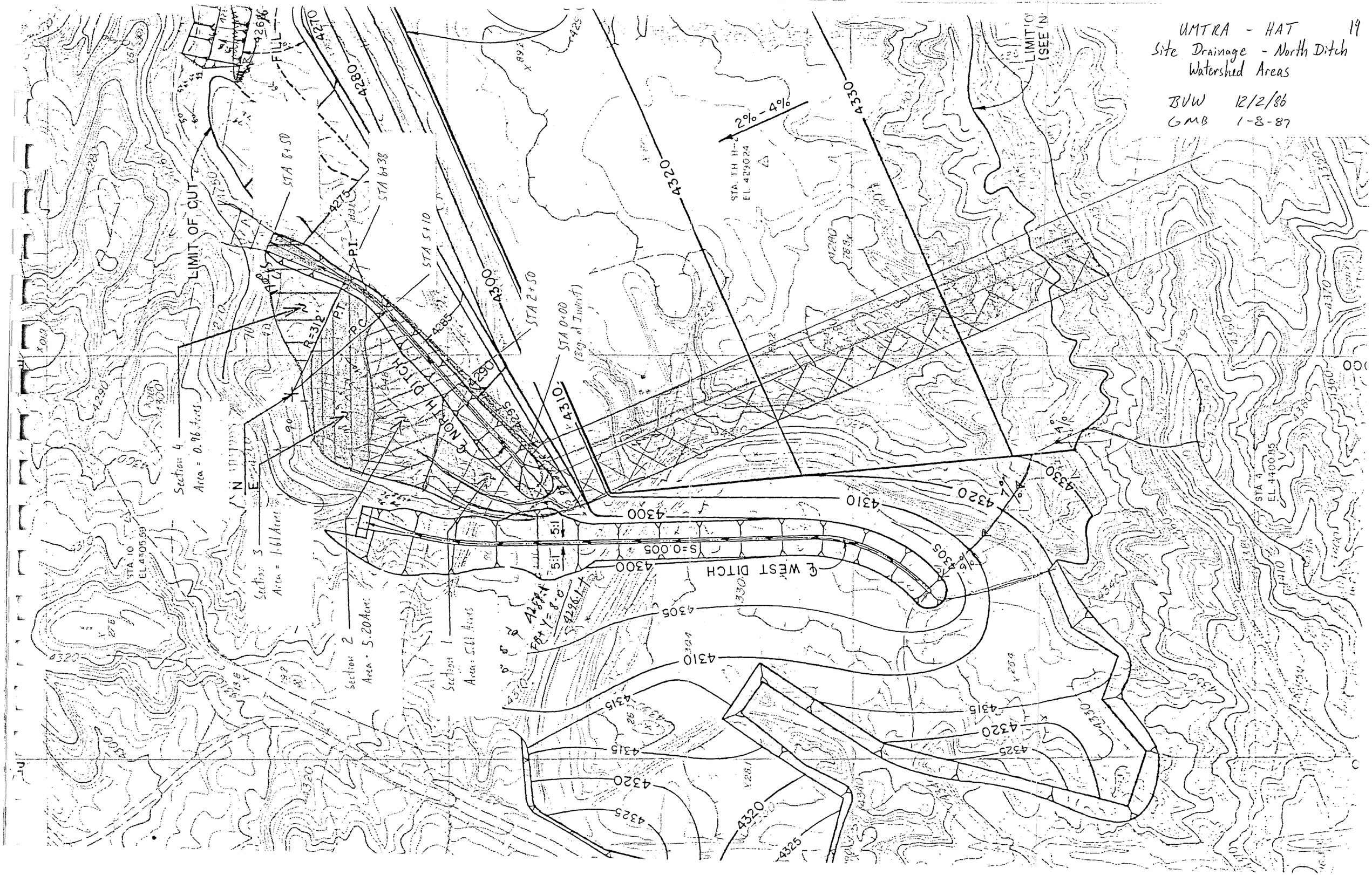


Ditch	Section	Side Slope Angle, θ (Deg.)	Bottom Width (Ft)	Ditch Length (Ft)	Watershed Area* (Acre)	Hydraulic Length (Ft)	Slope (%)	Shear Coefficient	Start Rock (F
2	1	26.6	10	250	5.61	250	1.0	1.45	0.
2	2	26.6	10	260	10.81	260	1.0	1.45	0.
2	3	26.6	10	128	12.42	128	1.0	1.45	0.
2	4	26.6	50	212	13.38	212	1.0	1.45	0.

*

UMTRA - HAT
Site Drainage - North Ditch
Watershed Areas

BVW 12/2/86
GMB 1-8-87



MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - HAT
Feature: Site Drainage
Item: North Ditch

Contract No. 5020
Designed BWW
Checked GMB

Sheet 20
File No.
Date 1/8/87
Date 1-8-87

Computer Input:

```
** MORRISON / KNUDSEN ENGINEERS, INC.     2 JAN 87 ** 15:41:25 ** DATA **
*****************************************************************************
** UMTRA MEXICAN HAT
** NORTH DITCH        GMB 1-2-87
TIME CONCENTRATION FROM EMBANKMENT :        5.900

ROCK SPECIFIC GRAVITY              :        2.640

ROCK POROSITY                      :        0.001

ROCK FRICTION ANGLE                :       42.000

WATER UNIT WEIGHT                  :       62.400

G                                  :        2.004

H                                  :        0.499

Z                                  :        1.368
```

DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF	START ROCK (FT)
2	1	26.6	10.0	250.0	5.61	250.0	1.	1.45	.25
2	2	26.6	10.0	260.0	10.81	260.0	1.	1.45	.25
2	3	26.6	10.0	128.0	12.42	128.0	1.	1.45	.25
2	4	26.6	50.0	212.0	13.38	212.0	1.	1.45	.25

1

Program: RIPRAP SFDI

Filename: DI8

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - MAT
Feature: Site Drainage
Item: North Ditch
Contract No. 5025
Designed: GMB
Checked: GMB
Sheet 21
File No.
Date 1/5/87
Date 1-8-87

Computer Output:

```
** MORRISON / KNUDSEN ENGINEERS, INC.     2 JAN 87 ** 15:41:25 ** PAGE   1
*****************************************************************************
** UMTRA MEXICAN HAT
** NORTH DITCH      GMB 1-2-87
*****************************************************************************
**                                                                          **
** DITCH NO:  2 (SECTION 1)                                                 **
** ------------                                                             **
** WATERSHED AREA       (ACRES):     5.610      b/y = 10'/2.4 = 4.2 ⟹ C_RB = 1.37 ≈ 1.4  **
** DITCH LENGTH         (FEET ):   250.000                                  **
** HYDRAULIC LENGTH     (FEET ):   250.000                                  **
** SIDE SLOPE           (DEG. ):    26.600      Froude No., F = V/√gy = 6.70 fps / √32.2(2.4) = 0.76 (Subcrit., Stable)  **
** BOTTOM WIDTH         (FEET ):    10.000                                  **
** LONGITUDINAL SLOPE   (%    ):     1.000                                  **
**                                                                          **
**  K=D50    Y       N       QV      QD        V         T       IPMP    SAFETY  **
**  (IN)    (FT)            (CFS)   (CFS)   (FT/SEC)   (MIN)   (IN/HR)  FACTOR  **
** ------ ----- ------ ------ ------- -------- ------ ------- ------  **
**   6.26   2.40  0.031   0.00  237.89     6.70   6.52   42.40    1.00  **
**                                                                          **
*****************************************************************************
*****************************************************************************
**                                                                          **
** DITCH NO:  2 (SECTION 2)                    b/y = 10'/3.4' = 2.9 ⟹ C_RB = 1.42 ≈ 1.4  **
** ------------                                                             **
** WATERSHED AREA       (ACRES):    10.810                                  **
** DITCH LENGTH         (FEET ):   260.000                                  **
** HYDRAULIC LENGTH     (FEET ):   260.000      F = 7.12 / √(32.2(3.4)) = 0.73 (Subcrit., Stable)  **
** SIDE SLOPE           (DEG. ):    26.600                                  **
** BOTTOM WIDTH         (FEET ):    10.000                                  **
** LONGITUDINAL SLOPE   (%    ):     1.000                                  **
**                                                                          **
**  K=D50    Y       N       QV      QD        V         T       IPMP    SAFETY  **
**  (IN)    (FT)            (CFS)   (CFS)   (FT/SEC)   (MIN)   (IN/HR)  FACTOR  **
** ------ ----- ------ ------ ------- -------- ------ ------- ------  **
**   8.28   3.40  0.033   0.01  435.12     7.62   7.09   40.25    1.00  **
**                                                                          **
*****************************************************************************
```

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA-NIT
Feature: Site Drainage
Item: North Ditch

Contract No. 5025
Designed: [illegible]
Checked: GMB

Sheet: 62
File No.:
Date: [illegible]
Date: 1-8-87

```
*****************************************************************************
**                                                                         *
** DITCH NO:  2 (SECTION 3)                                                *
** ------------                                                            *
** WATERSHED AREA        (ACRES):    12.420                                *
** DITCH LENGTH          (FEET ):   128.000                                *
** HYDRAULIC LENGTH      (FEET ):   128.000                                *
** SIDE SLOPE            (DEG. ):    26.600                                *
** BOTTOM WIDTH          (FEET ):    10.000                                *
** LONGITUDINAL SLOPE    (%    ):     1.000                                *
**                                                                         *
**  K=D50    Y       N       QV      QD        V        T      IPMP    SAFETY *
**  (IN)    (FT)            (CFS)   (CFS)   (FT/SEC)  (MIN)   (IN/HR)  FACTOR *
** ------ ----- ------ ------ -------- -------- ------ ------- ------       *
**   8.69   3.60  0.033   0.01  487.43     7.88   7.36   39.25    1.00      *
**                                                                         *
*****************************************************************************
```

Bad of R = 3'

$\therefore C = 5.2\left[\frac{312'}{10' + 2(3)(3.5')}\right]^{-0.5}$

$= 0.89$ ok

$F = \frac{5.89}{\sqrt{32.2(1.6)}} = 0.73$ (Subcrit, Stable)

1

```
** MORRISON / KNUDSEN ENGINEERS, INC.     2 JAN 87 ** 15:41:25 ** PAGE
*****************************************************************************
** UMTRA MEXICAN HAT
** NORTH DITCH       GMB 1-2-87
*****************************************************************************
**                                                                         *
** DITCH NO:  2 (SECTION 4)                                                *
** ------------                                                            *
** WATERSHED AREA        (ACRES):    13.380                                *
** DITCH LENGTH          (FEET ):   212.000                                *
** HYDRAULIC LENGTH      (FEET ):   212.000                                *
** SIDE SLOPE            (DEG. ):    26.600                                *
** BOTTOM WIDTH          (FEET ):    50.000                                *
** LONGITUDINAL SLOPE    (%    ):     1.000                                *
**                                                                         *
**  K=D50    Y       N       QV      QD        V        T      IPMP    SAFETY *
**  (IN)    (FT)            (CFS)   (CFS)   (FT/SEC)  (MIN)   (IN/HR)  FACTOR *
** ------ ----- ------ ------ -------- -------- ------ ------- ------       *
**   5.45   1.60  0.030   0.01  501.49     5.99   7.96   37.49    1.00      *
**                                                                         *
*****************************************************************************
```

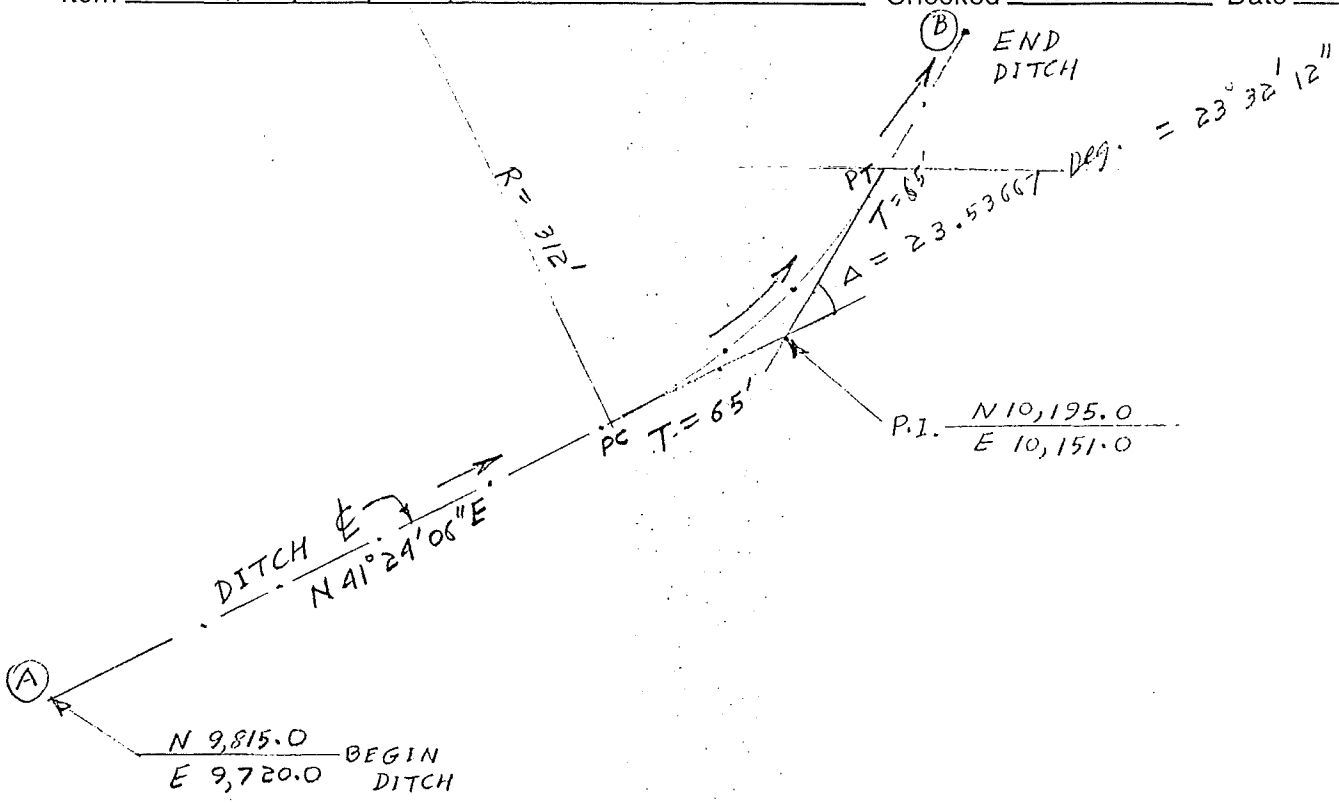
$b/y = 50'/1.6' = 31.3 \Rightarrow C_{RB} = 1.0$ ok

$F = \frac{5.99}{\sqrt{32.2(1.6)}} = 0.82$ (Subcrit, Stable)

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 23

Project UMTRA/HAT — Contract No. 502502 — File No.
Feature SITE DRAINAGE – NORTH DITCH — Designed HM — Date DEC 19/88
Item CONTROL POINT COORDS. — Checked GMB — Date 1-8-87



Bearing of ditch ℄ (A) – PC is given by

$$\tan\theta = \frac{10195. - 9815.}{10151. - 9720.} = 0.8816705$$

$$\therefore \theta = 41.401673 \text{ Degrees}$$

$$\text{or } \theta = N\ 41^\circ\ 24'\ 06''\ E$$

Bearing of P.I – PT = 41° 24' 06" + 23° 32' 12" = N 64° 56' 18" E = 64.93833

POINT	N	E	BEARING θ	LENGTH L'	LATITUDE (L SIN θ)'	DEPARTURE (L COS θ)'
P.I.	10,195.0	10,151.0	S 41° 24' 06" W	65'	−42.99	−48.76
PC	10,152.0	10,102.2				
P.I.	10,195.0	10,151.0	N 64° 56' 18" E	65'	+58.88	+27.53
PT	10,253.9	10,178.5				

EROSION PROTECTION

The north ditch is assumed to be excavated into non-ripable rock (see sheet 25) as estimated by a Seismic Refraction Survey (Ref 6.). The seismic refraction survey was performed north of the the North Ditch and is assumed to hold true in the location of the north ditch. Since the ditch is constructed in non-ripable rock no riprap will be provided except in the outlet key trench where the water level and ditch invert will rise above the estimated non-rippable rock surface.

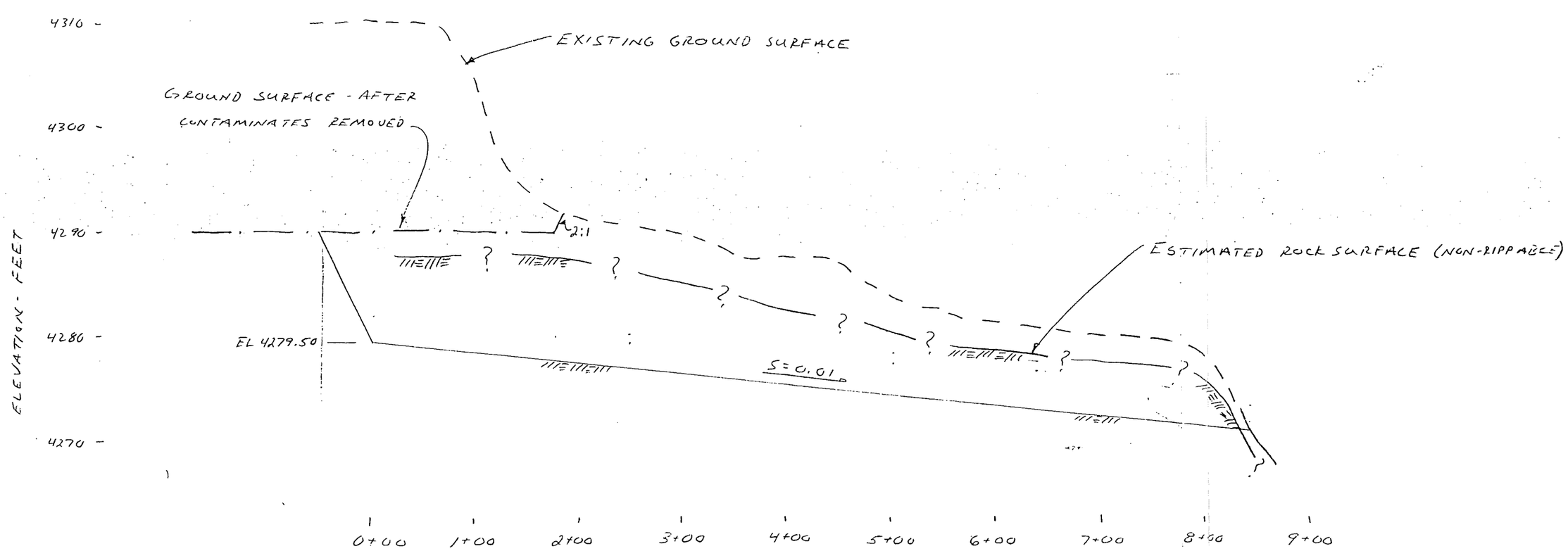
It should be noted that the non rippable rock surface is an estimate and must be verified during construction. If during construction it is found that the non rippable rock surface falls below the estimated PMP water level further evaluation will be required to determine if erosion protection is needed in the ditch.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-MAT
Feature SITE DRAINAGE
Item NORTH DITCH

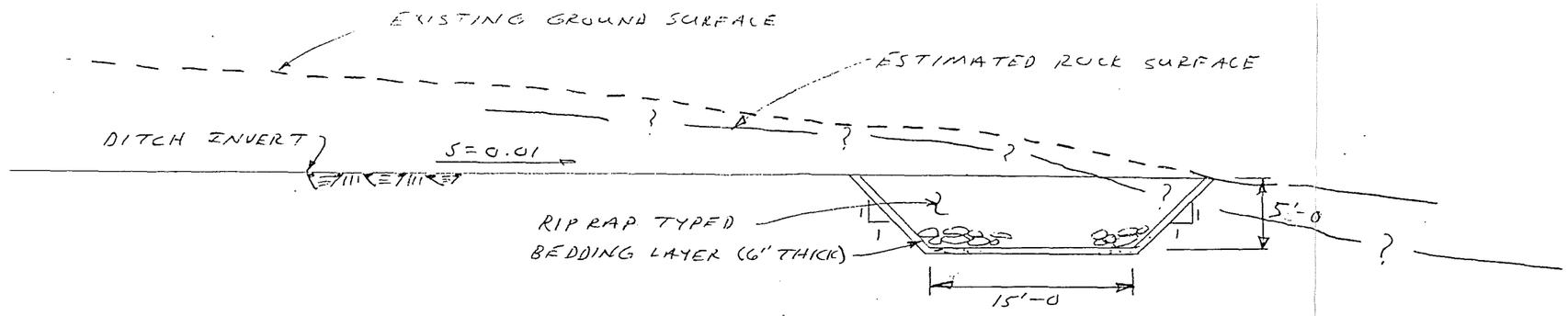
Contract No. 5025
Designed CMB
Checked HM

Sheet 25
File No.
Date 1-5-86
Date Jan 09/87



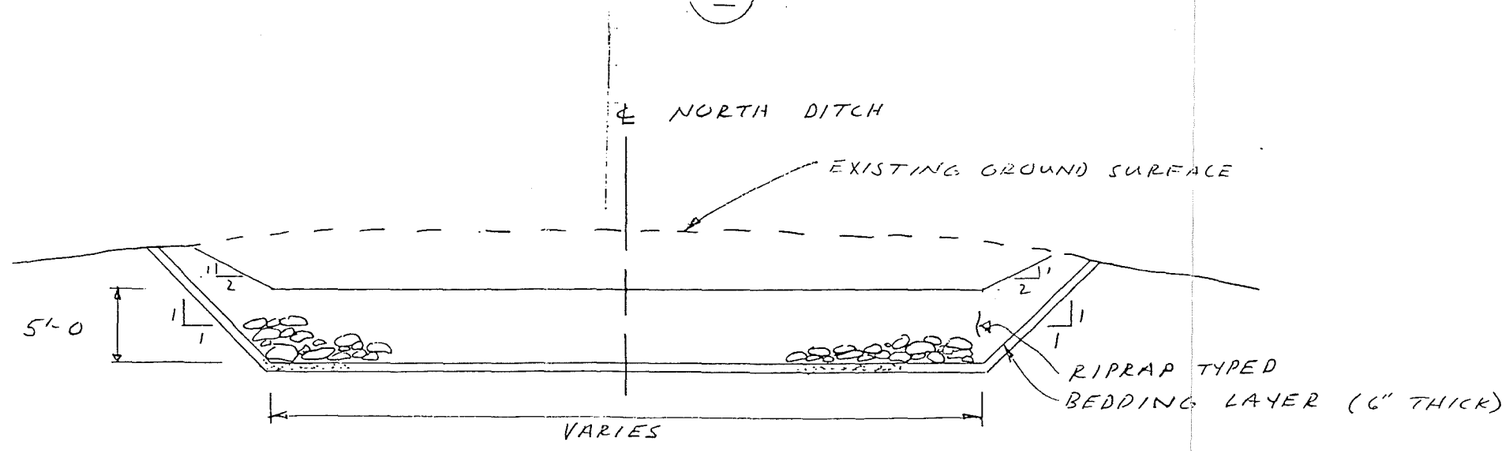
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA-HAT	Contract No.	5025	Sheet	27
Feature	SITE DRAINAGE	Designed	GMB	File No.	
Item	NORTH DITCH	Checked	HM	Date	1-6-87
				Date	JAN 08/87



NORTH DITCH END PROTECTION

SECTION B



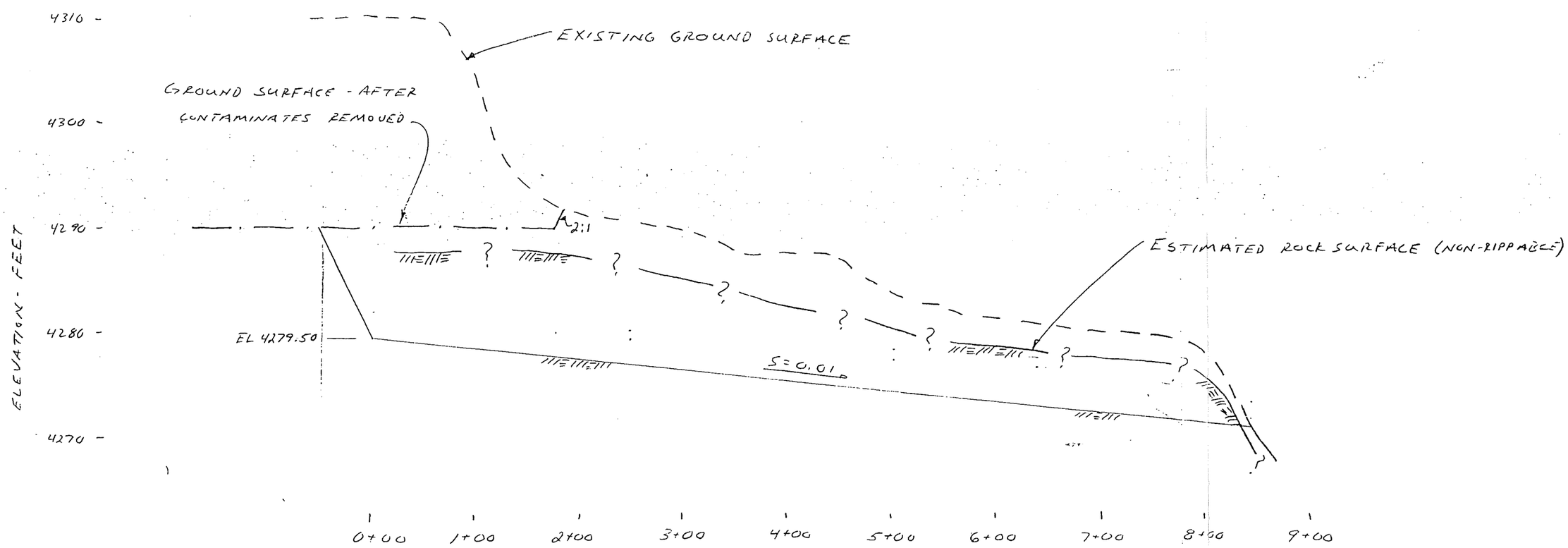
NORTH DITCH END PROTECTION

SECTION A

SCALE 1" = 10'

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-HAT	Contract No. 5-025	Sheet 25	
Feature SITE DRAINAGE	Designed CMB	File No.	
Item NORTH DITCH	Checked HM	Date 1-5-86	Date Jan 03/87

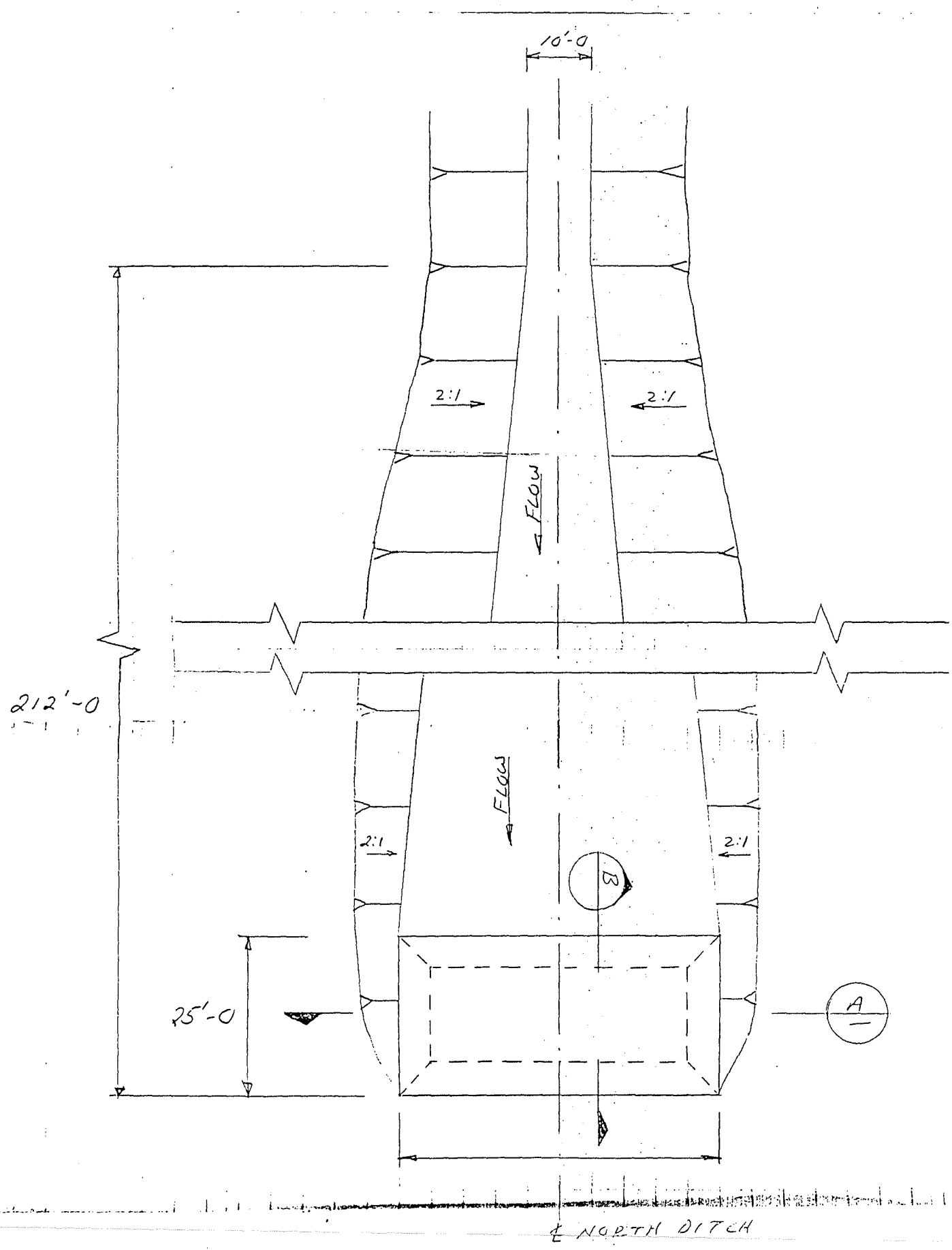


MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UPH TRA - HAT
Feature: SITE DRAINAGE
Item: NORTH DITCH

Contract No. 5G.25
Designed GMB
Checked HM

Sheet 26
File No.
Date 1-7-87
Date Jun 02/87

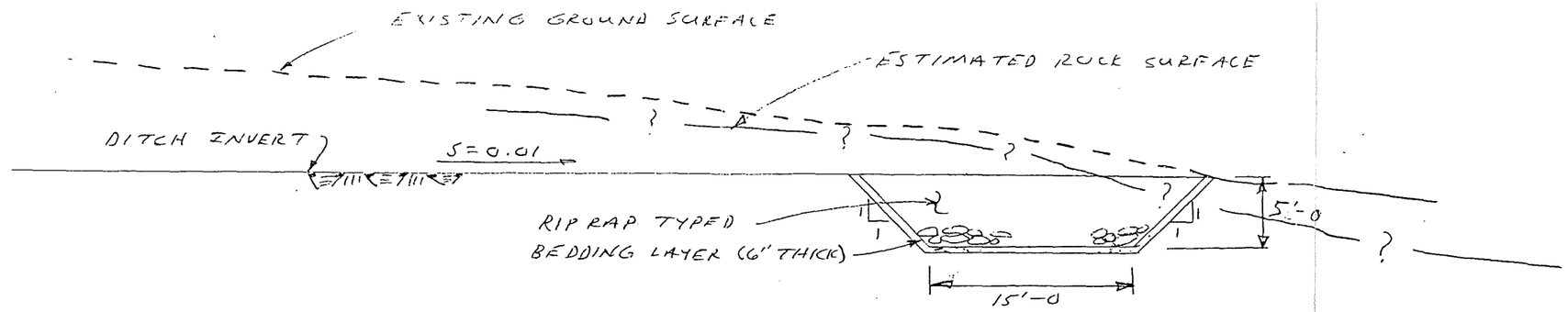


WEST DITCH TOE OUTLET DETAIL

SCALE 1" = 20'

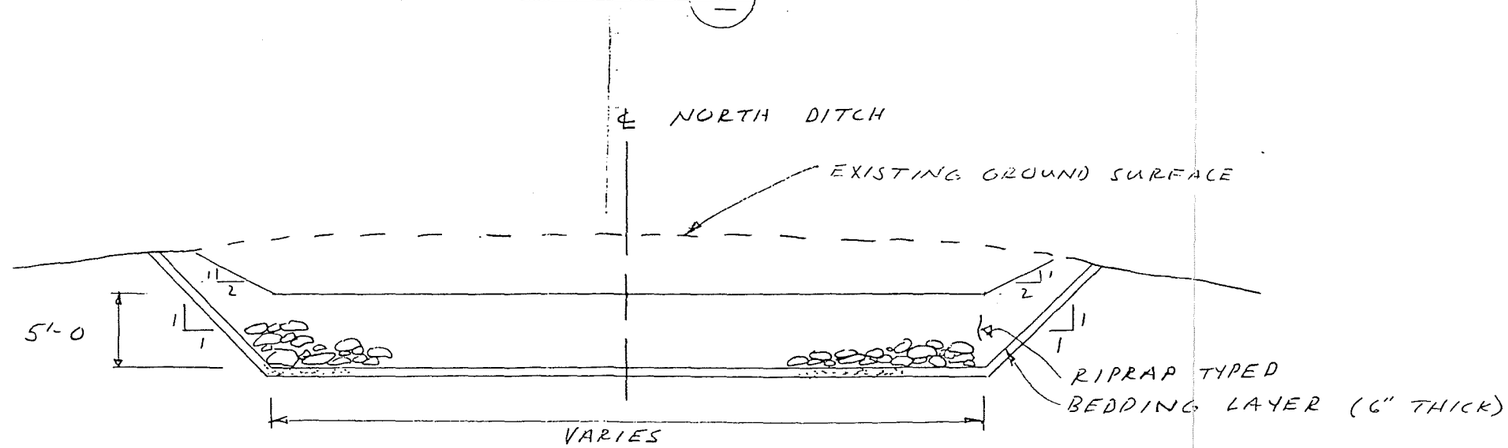
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UM TRA-HAT	Contract No.	5025	Sheet	27
Feature	SITE DRAINAGE	Designed	GMB	File No.	
Item	NORTH DITCH	Checked	HM	Date	1-6-87
				Date	Jan 08/87



NORTH DITCH END PROTECTION

SECTION B



NORTH DITCH END PROTECTION

SECTION A

SCALE 1" = 10'

References:

1. Morrison-Knudsen Engineers, UMTRA Design Procedures, MKE Document No. 4005-GEN-Q-01-00571-02, May 1986.

2. U.S. Army Corps of Engineers, Hydraulic Design of Flood Control Channels, EM 1110-2-1601, July 1970.

3. U.S. Department of Energy, Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Mexican Hat, Utah - Draft, February 1986, MKE Document No. 5025-HAT-R-03-00195-00.

4. McCuen, R.H., A Guide to Hydrologic Analysis Using SCS Methods, Prentice-Hall, Inc., 1982.

5. Morrison-Knudsen Engineers, UMTRA - Mexican Hat Calculation No. 9-223-01-00, "Site Hydrology."

6. ——, UMTRA - Mexican Hat, Seismic Refraction Survey, MKE Document No. 5025-HAT-R-01-00406-00.

Calculation Cover Sheet

Calc. No. 9-228-02-02

Contract No. ESC1 Discipline 5025-02 No. of Sheets ~~35~~ 42

Project

UMTRA-HAT

Feature

SITE DRAINAGE

Item

WEST DITCH

Sources of Data

1. MKE UMTRA Design Procedures Manual MKE Doc. No 4005-GEN-Q-01-00571-02, 1986
2. US Bureau of Reclamations. Design of Small Dams, 1977.
3. MKE UMTRA-HAT, "Site Hydrology," Calc No 9-223-01-00

~~**Sources of Formulae & References**~~

4. U.S. DOE "Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Mexican Hat, Utah" Draft, Feb 1986 MKE Doc No 5025-HAT-R-03-00198-00 (Appn A-D).
5. US Army Corp of Engineers, Hydraulic Design of Flood Control Channels. July 1970.
6. UMTRA-HAT "Erosion Protection, Concentrated Flow Areas - East Side of Tailings Pile." MKE Calc No 9-227-01.
7. MKE Calc. No. 9-259-04-00, Rock Quality Evaluation, Shadow Mountain Basalt

Preliminary Calc. ☒ Final Calc. ☒ Supersedes Calc. No. _____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
02	change in rock source see sheet A1 for summary	H. Mojumder	5/26/88	AB Hoey	6/6/88	A. [illegible]	6/6/88
01	revise Time-intensity ref. (Sheet 10)	R.F. Claire	5/8/87	H. Mojumder	7/17/87	A. [illegible]	7/17/87
0	———	G.M. Bletgen	12/9/86	BB Van Wagner	1/7/87	A. [illegible]	1/8/87

Form 42-110

I PURPOSE:

The purpose of this calculation is to design and locate the drainage ditch on the west side of the embankment. The purpose of this ditch is to direct runoff from the west and north-west of the embankment away from the embankment as well as catching runoff from the west embankment sideslope and a small portion of the top of the embankment.

II METHOD

The ditch dimensions and rock sizes are calculated using an MKE computer program entitled "RIPRAP SFD1." The program determines the depth of flow, flow velocity, flowrate, and the $D_{50(min)}$ rock size. The following parameters are required as input:

- time of concentration, T_c (min)
- rock specific gravity, porosity, and friction angle
- rainfall intensity vs duration curve fitting parameters, G, H, and e
- ditch side slope, bottom width, invert slope, shear coefficient, reach lengths, watershed area, and shear coefficient.

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - HAT	Contract No. 5025	Sheet A1	
Feature PERMANENT SITE DRAINAGE	Designed HM	File No.	
Item WEST DITCH	Checked ABH	Date May 26/88	Date 6-3-88

This entire sheet is part of REV 02

SUMMARY OF REV 02

The rock source for erosion protection of the West ditch is likely to be the Shadow Mountain quarry rather than the Alhambra rock quarry. REV 02 calculates the average D_{50}(min) rock size based on the properties of the rock found at the Shadow Mountain quarry. The parameter of significance is found to be the specific gravity, which is 2.73 for Shadow Mountain rock versus 2.60 for the Alhambra rock quarry, the other parameters basically remaining the same. As a result, D_{50}(min) using Shadow Mountain rock is 4.8 inches, versus 5.5 inches using Alhambra rock.

REV 02 includes revisions to the following sheets:

Sheets 4, 5, 12, 18 thru 21, 22, 23

Following new sheets have been added:

Sheets A1, 4A, 23A, 36 thru 40

III DITCH DESIGN

The ditch is designed with a base width of 10', 5:1 sideslopes, and a 0.5% longitudinal slope. A flare section is used (STA 13+25 to 14+25) to reduce the flow depth and velocity at the ditch outlet. A key is also designed at the ditch outlet to minimize the headcutting errosion.

The program uses the Rational Method with the runoff coefficient, c, equal to 1 for the design flow. The ditch is sized using Manning's equation. The rock is sized using the safety factor method with a minimum safety factor of 1.0. The ditch is to be designed for the PMP storm (Ref 1). $D_{100(max)}$ and $D_{100(min)}$ can be determined using the following relationships (Ref 1, ch. 5):

$$D_{100(min)} = \sqrt[3]{2}\ D_{50(min)} = 1.26\ D_{50(min)}$$

$$D_{100(max)} = \sqrt[3]{5}\ D_{50(min)} = 1.71\ D_{50(min)}$$

The thickness of the riprap can be determined using the following relationships (Ref 1, ch 5):

$$\left.\begin{array}{l} T_{min} \geq 1.9\ D_{50(min)} \\ T_{min} \geq 1.5\ D_{50(max)} \\ T_{min} \geq 12'' \end{array}\right\} \text{whichever is greater}$$

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: UMTRA - HAT
Feature: SITE DRAINAGE
Item: WEST DITCH

Contract No. 5025
Designed: GMD
Checked: BVW

Sheet 4
File No.
Date: 12-9-86
Date: 1/7/87

IV DESIGN SUMMARY

HM 5/26/88
ABH 6-3-88

REV02
Sheet 4 Superseded by Sheet 4A

STATION	BOTTOM WIDTH (ft)	FLOW DEPTH (ft)	DESIGN FLOW (cfs)	DESIGN VELOCIT (fps)	CALCULATED D_{50} (min) (in)	D_{50} (min) (in)
3+41	10.0	4.70	1214	7.7	3.70	3.36
4+91	10.0	4.90	1282	7.6	3.84	3.48
5+91	10.0	6.50	2456	8.9	4.94	4.51
8+00	10.0	6.70	2557	8.8	5.06	4.63
10+00	10.0	6.80	2706	9.0	5.14	4.68
11+18	10.0	6.90	2781	9.0	5.21	4.75
12+85	10.0	6.90	2781	9.0	5.21	4.75
13+25	10.0	6.90	2779	9.0	5.21	4.75
13+75	20.0	6.10	2784	9.0	5.11	4.73
14+25	30.0	5.5	2777	8.8	5.02	4.56
14+50	30.0	5.5	2772	8.8	5.02	4.56

See sheets 18-21
Superseded by Sheets 36-40

See Sheets 36-40

MORRISON-KNUDSEN ENGINEERS, INC.
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Project: UMTRA - HAT
Feature: Site Drainage
Item: West Ditch

Contract No. 5025-02
Designed: ABH
Checked: HM

Sheet 4A
File No.
Date 6-3-88
Date June 06/88

Revision 2 / Design Summary

(this sheet replaces sheet 4 in its entirety)

Section	Station (feet)	Bottom Width (feet)	Flow Depth (feet)	Design Flow (cfs)	Design Velocity (cfs)	Calc. D_{50} (min) (inch)
1	3+41	10.0	4.60	1176.	7.74	3.36
2	4+91	10.0	4.80	1250.	7.65	3.48
3	5+91	10.0	6.40	2398.	8.91	4.51
4	8+00	10.0	6.60	2511.	8.84	4.63
5	10+00	10.0	6.70	2666.	9.14	4.68
6	11+18	10.0	6.80	2745.	9.17	4.75
7	12+85	10.0	6.80	2752. X	9.19	4.75
8	13+25	10.0	6.80	2746. X	9.17	4.75
9	13+75	20.0	6.10	2753. X	8.93	4.73
10	14+25	20.0	5.40	2749. X	8.93	4.56
11	14+50	30.0	5.40	2744.	8.91	4.56

(see also sheets 36 to 40).

EROSION PROTECTION (see sheet 23)

$D_{50\,(min)}$ = 5.5 in

$D_{100\,(min)}$ = 6.9 in

$D_{100\,(max)}$ = 9.4 in

Layer thickness = 12 in

Bedding layer = 6 in thick

superseded by REV 02, below:

Erosion Protection (See sheet 23A)

$D_{50(min)}$ = 4.8 inches

$D_{100(min)} = (2)^{1/3} D_{50(min)}$ (see sheet 3) = 6.0 inches

$D_{100(max)} = (5)^{1/3} D_{50(min)}$ = 8.2 inches

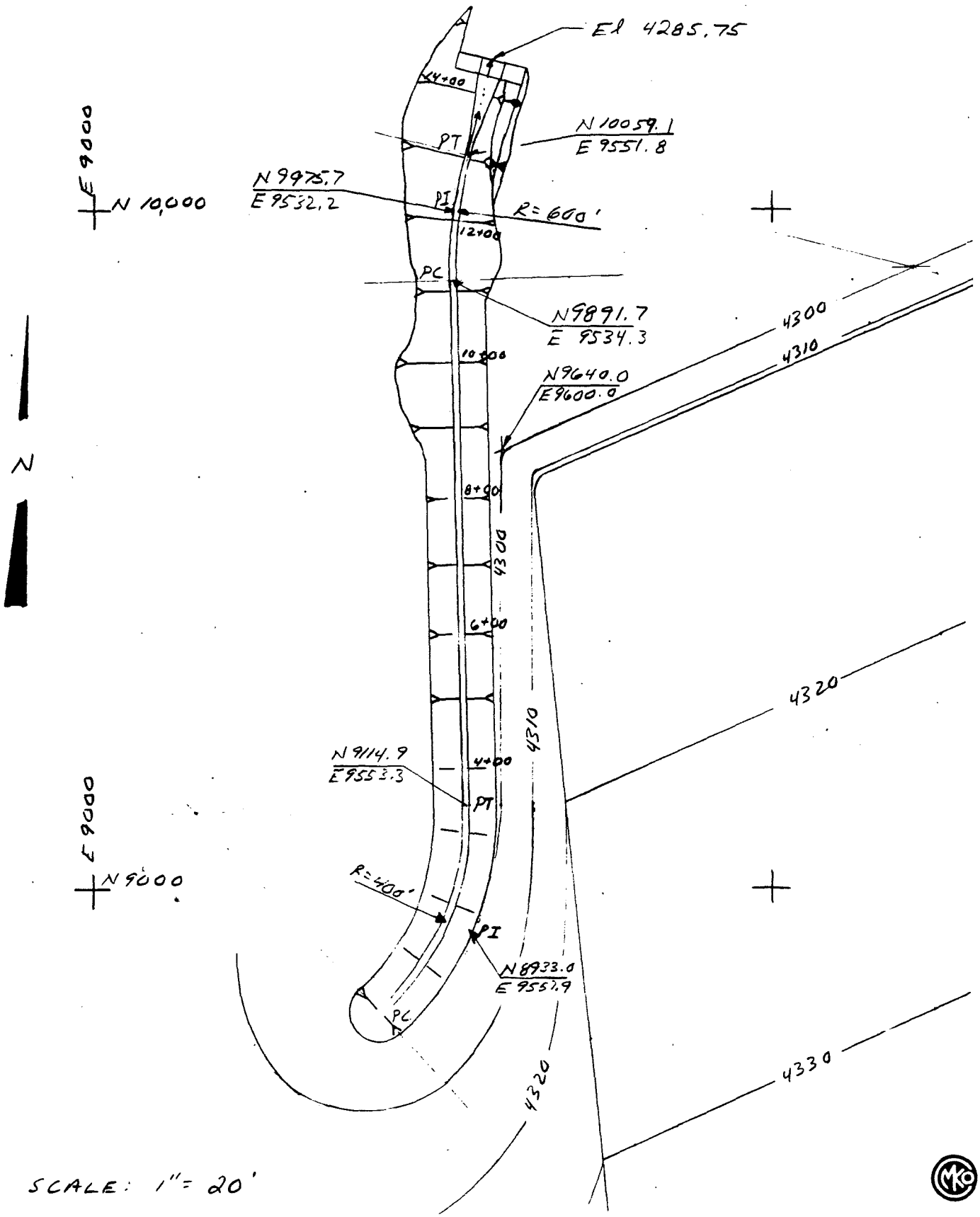
Layer thickness = 12 inches

Bedding Layer = 6 inches

Rev 02
HM May 26/88
ABH 6-3-88

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA - HAT	Contract No. 5025	Sheet 6
Feature	SITE DRAINAGE	Designed GMB	File No.
Item	WEST DITCH	Checked JVW	Date 12-5-86
			Date 1/7/87



SCALE: 1" = 20'

IV CALCULATION

(1) Drainage Area

The drainage area for the west ditch is measured from the Site Grading Plan (1" = 200' scale) using a planimeter.

The drainage area extends beyond the southern area of the available topography. The drainage area beyond the southern edge of the topography was estimated by Judson Leong, MKE, San Francisco, on a site visit 5 February, 1986.

The drainage area for the west ditch is shown on the following sheet.

REACH	accum	DRAINAGE AREA (ac)
(0)	(0)	29.4
341	341	38.6
150	491	41.6
100	591	80.7
209	800	86.1
200	1000	93.2
118	1118	97.1
167	1285	98.8
40	1325	99.1
50	1375	99.8
50	1425	100.1
25	1450	100.2

MORRISON-KNUDSEN ENGINEERS, INC.
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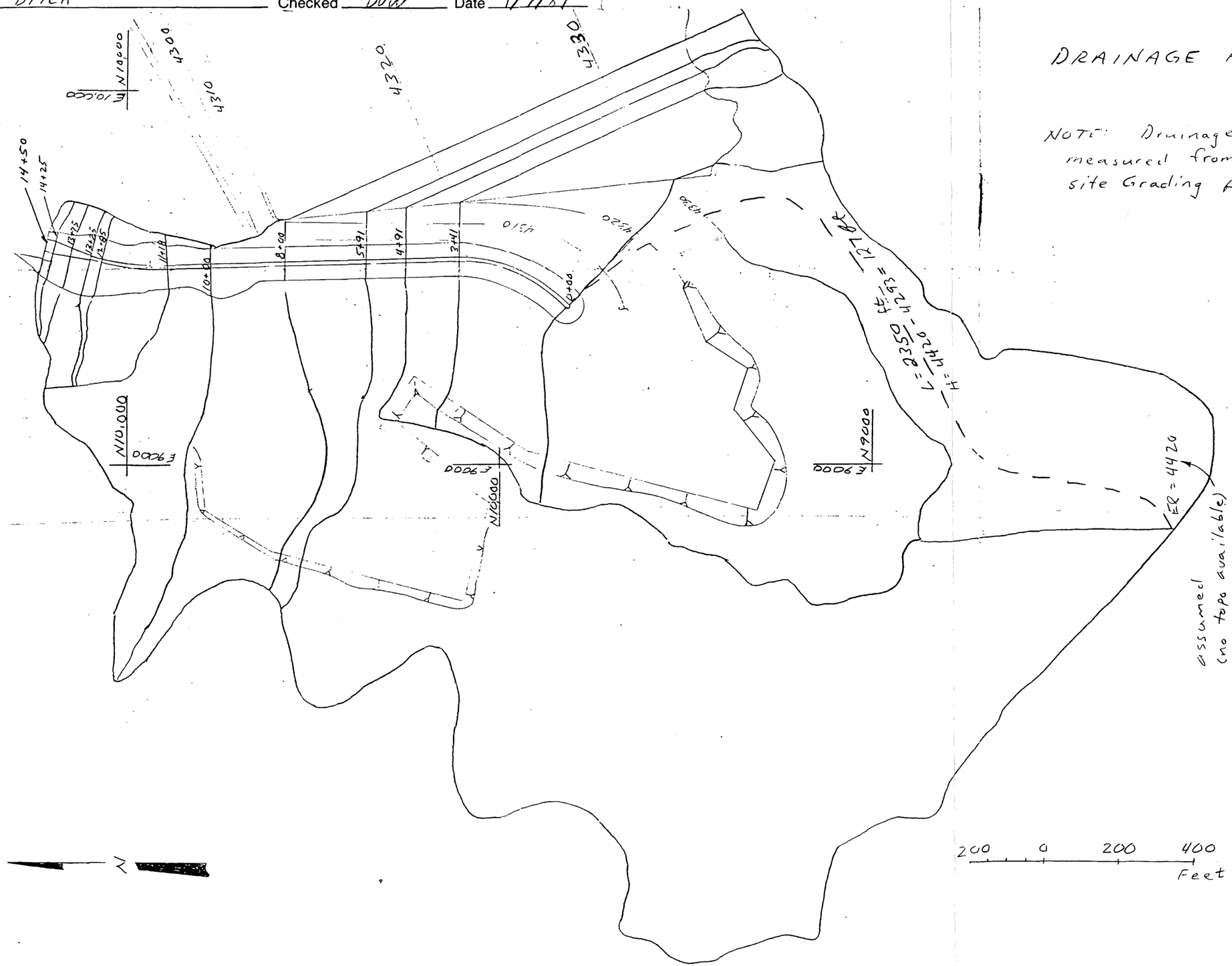
Project	UMTRA - HAT	Contract No. 5025	Sheet 8
Feature	SITE DRAINAGE	Designed GMB	File No.
Item	WEST DITCH	Checked BWW	Date 11-26-86
			Date 1/7/87

8

DRAINAGE AREA

NOTE: Drainage area measured from 1" = 200' site Grading plan.



(2) Time of Concentration

The time of concentration is estimated using the Kirpich formula (Ref. 2, pg 67)

$$T_c = \left[\frac{11.9\,(L)^3}{H}\right]^{0.385}$$

where L = length of longest watercourse, mi

H = Elevation difference, ft

T_c = Time of concentration, hr

$L = 2350$ ft $= 0.445$ mi
$H = 4420 - 4293 = 127$ ft
} see sheet 8

$$T_c = \left[\frac{11.9\,(0.445)^3}{127}\right]^{0.385} = 0.158 \text{ hr}$$

$$= \underline{\underline{9.5 \text{ min}}}$$

(3) G, H, and Z

G, H, and Z are curve fitting parameters for site specific rainfall intensity vs duration. G, H, and Z have been determined in the site Hydrology calc. (Ref 3, sheet 23).

$$G = \begin{bmatrix} \cancel{1.797} \\ \cancel{2.604} \\ -0.307 \\ -0.\cancel{499} \\ \cancel{1.768} \\ 1.816 \end{bmatrix}$$

rev.01 see note below.

$H =$ (program use $\pm$ 0.499)

$Z =$

The computer program SF01 uses G, H, and Z to develope the duration vs intensity curve which is described by the following formula:

$$I = 10^{G + H(\log t)^Z}$$

where I = rainfall intensity (in/hr)
t = storm duration (min)
(taken as the time of concentration in the Rational Method)

[In ref 3, sheet 23, the Intensity-duration curve was revised in revision 01. The change is only significant for durations of less than 6 minutes. Since the time of concentration for the west ditch is 9.5 min. + the revised curve will not impact the existing design values of a, y & D_{50}, as calculated are valid and do not require any change.] Rev.01

MORRISON-KNUDSEN ENGINEERS, INC.
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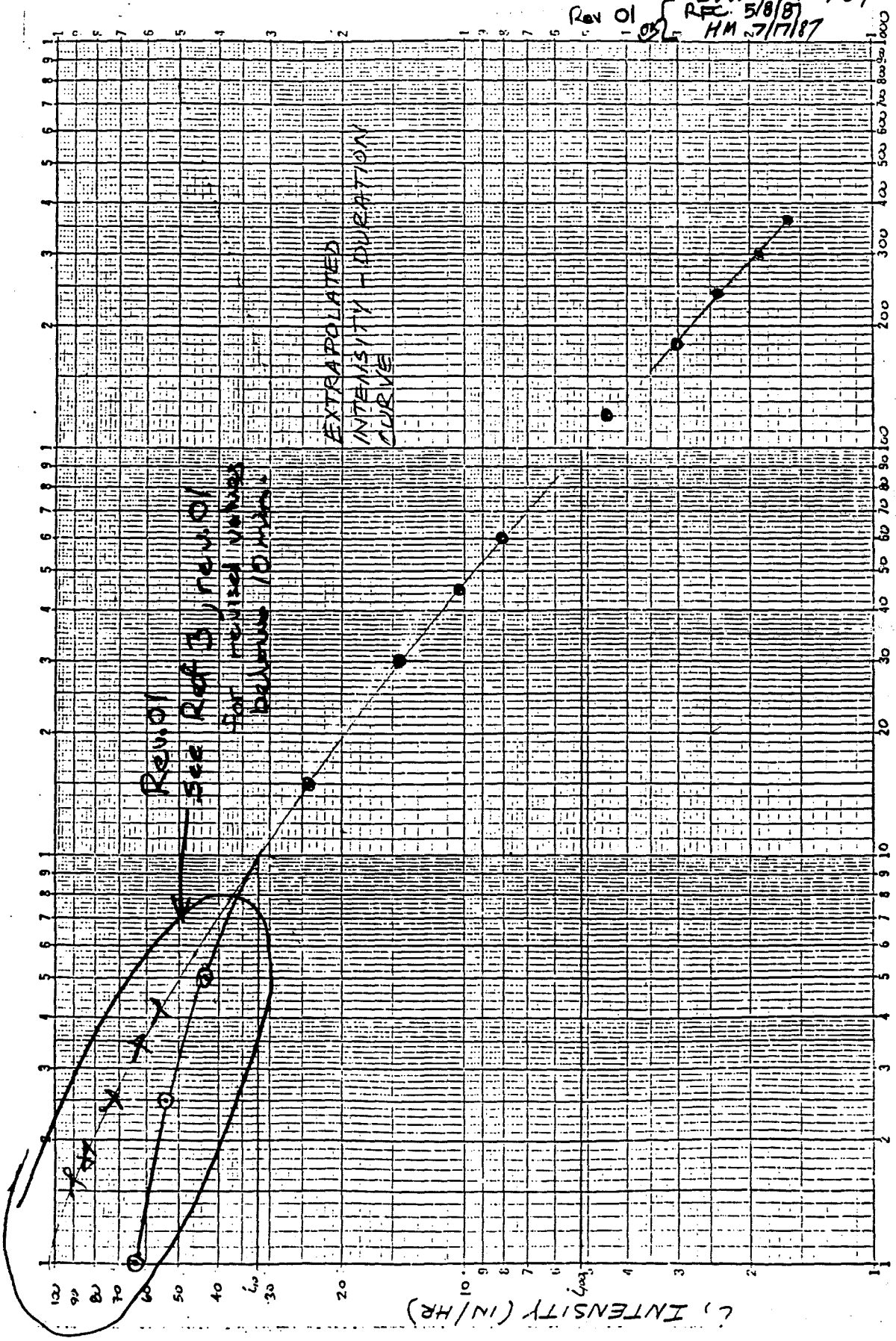
Project: UMTRA-HAT
Feature: SITE HYDROLOGY
Item:

Contract No. 5025-02
Designed: POG
Checked: HM

Sheet 11
File No.
Date: 6-5-86
Date: 8/20/85

Ref to Calc No 9-223-01-00 GMB 10-14-86
BVW 1/7/87
Rev 01 RFC 5/8/87
HM 7/17/87



Deleted see ref 3 rev. 01 for values

GMB 10-14-86

(1) $G = \log i_1 = \log 101 = 2.004$

(2) $H = \log i_{10} - H = \log 32 - 2.004$

(3) $Z = \left(\frac{1}{\log 2}\right) \log \left[\frac{(\log i_{100} - \log i_{10})}{H}\right] + 1 = \left(\frac{1}{\log 2}\right) \log \left[\frac{\log 32 - \log 32}{-0.499}\right] + 1 = 1.368$

Rev. 01

(4) Rock Friction Angle, ϕ

$\phi = 42.0°$ (Ref 4, pg D-185)

(5) Specific Gravity, G_s

~~$G_s = 2.64$~~ ~~(Ref. 4, pg D-185)~~

$G_s = 2.73$ for Shadow Mountain Quarry Rock (Ref. 7)

(6) Porosity

The porosity will be taken as 0.001 assuming that silt will fill in the riprap voids in time.

REV 02

HM MAY 26/88
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(7) SHEAR COEFFICIENT, C_{Rb}

$$C_{Rb} = \frac{\tau_{b\,max}}{\gamma_w \, R \, S}$$ Ref. 1, pg 5-9

where C_{Rb} = shear coefficient, base

$\tau_{b\,max}$ = peak local shear stress on the base

R = hydraulic radius

S = longitudinal ditch slope

γ_w = unit weight of water, 62.4 lb/ft³

Straight Reach:

use Ref. 1, fig 5-3, pg 5-25

assume $y = 6.9'$ (water depth)

$B = 10'$, $Z = 5$ (5:1 side slope)

$B/y = \frac{10}{6.9} = 1.45$

$C_{Rb} = 1.55$ use 1.6

Bend:

$r = 400$ ft

$$C_{Rb} = \frac{\tau_b}{\tau_o} = 3.1 \left(\frac{r}{w}\right)^{-0.5}$$ Ref 2, pg III-36

(assume rough channel)

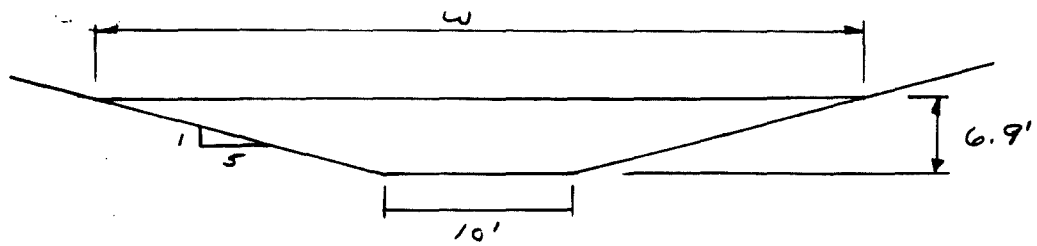
where τ_o = average boundry shear, psf

τ_b = max. boundry shear affected by bend

r = radius of bend

w = water surface width at upstream end of bend.

Shear coef. (bend) continued



$w = 10 + 2[5(6.9)] = 79$ ft

Bend 1

$r = 400'$

$C_{RB} = \frac{\tau_b}{\tau_o} = 3.1\left(\frac{400}{79}\right)^{-0.5} = 1.4 < 1.6$

Bend 2.

$r = 600$

$C_{RB} = \frac{\tau_b}{\tau_o} = 3.1\left(\frac{600}{79}\right)^{-0.5} = 1.1 < 1.6$

$\therefore$ use $\underline{\underline{C_{RB} = 1.6}}$

UMTRA-HAT
GMB 10-14-86
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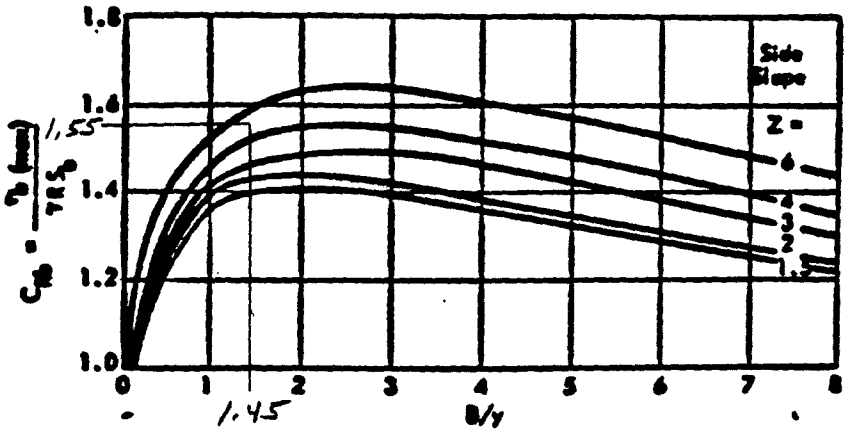

FIGURE 5-3 Maximum boundary shear stress on bottom of trapezoidal channels. (Ref. 5-2, page 13)

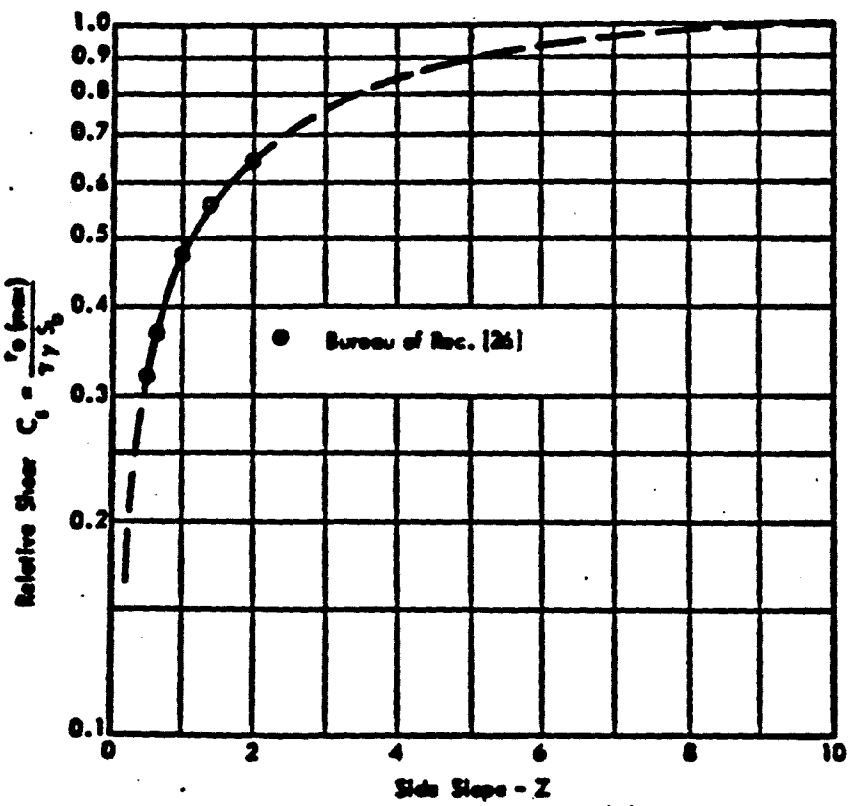

FIGURE 5-4 Maximum boundary shear stress on sides of triangular channels. (Ref. 5-2, page 12)

Additional Input Parameters

(8) Increment K = 0.02

(Incremental increase in rock size for trial solution)

(9) Initial T Prime = 9.6 min

(Initial time of concentration)

(10) Increment y = 0.1

(Incremental rise in water surface elevation for trial solution)

(11) Start y = 0.10

(Initial water surface elevation for trial solution)

(12) Short Output = true

(will only store final results in the output file and will not show trial and error solution)

MORRISON-KNUDSEN ENGINEERS, INC.
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Project UMTRA - HAT
Feature PERMANENT SITE DRAINAGE
Item DRAINAGE DITCH

Contract No. 5025
Designed GMB
Checked BVW

Sheet 17
File No.
Date 11-26-86
Date 1/7/87

INPUT PARAMETERS SUMMARY

SECTION	ϕ SIDE SLOPE ANGLE (Deg)	BOTTOM WIDTH (ft)	DITCH LENGTH (ft)	WATER-SHED AREA (ac)	HYDRAULIC LENGTH (ft)	SLOPE (%)	SHEAR COEF.	STARTING ROCK SIZE, d_{50} (ft)
1	11.3	10	341	38.6	341	0.5	1.6	0.10
2	11.3	10	150	41.6	150	0.5	1.6	0.10
3	11.3	10	100	80.7	100	0.5	1.6	0.10
4	11.3	10	209	86.1	209	0.5	1.6	0.10
5	11.3	10	200	93.2	200	0.5	1.6	0.10
6	11.3	10	118	97.1	118	0.5	1.6	0.10
7	11.3	10	167	98.8	167	0.5	1.6	0.10
8	11.3	10	40	99.1	40	0.5	1.6	0.10
9	11.3	20	50	99.8	50	0.5	1.6	0.10
10	11.3	30	50	100.1	50	0.5	1.6	0.10
11	11.3	30	25	100.2	25	0.5	1.6	0.10

GMB 11-26-86
BVW 1/7/87

** MORRISON / KNUDSEN ENGINEERS, INC. 26 NOV 86 ** 8:01:12 ** DATA **

** UPTPA MEXICAN HAT G. M. BLEEGEN 26 NOVEMBER, 86'

** WEST DITCH - EROSION PROTECTION

TIME CONCENTRATION FROM EMBANKMENT : 9.500

ROCK SPECIFIC GRAVITY : 2.600

REV. 02

ROCK POROSITY : 0.001

ROCK FRICTION ANGLE : 42.000

Sheets 18 thru 21 superseded by Sheets 36 thru 40

WATER UNIT WEIGHT : 62.400

G : 2.004

H : 0.499

HM May 26/88
ABA 6-3-88

Z : 1.368

	DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF	START ROCK (FT)
BC	1	1	11.3	10.0	341.0	38.6	341.0	0.5	1.6	0.10
EC	1	2	11.3	10.0	150.0	41.6	150.0	0.5	1.6	0.10
	1	3	11.3	10.0	100.0	60.7	100.0	0.5	1.6	0.10
	1	4	11.3	10.0	209.0	86.1	209.0	0.5	1.6	0.10
	1	5	11.3	10.0	200.0	93.2	200.0	0.5	1.6	0.10
BC	1	6	11.3	10.0	118.0	97.1	118.0	0.5	1.6	0.10
EC	1	7	11.3	10.0	167.0	98.8	167.0	0.5	1.6	0.10
	1	8	11.3	10.0	40.0	99.1	28.0	0.5	1.6	0.10
	1	9	11.3	20.0	50.0	99.8	50.0	0.5	1.6	0.10
	1	10	11.3	30.0	50.0	100.1	50.0	0.5	1.6	0.10
	1	11	11.3	30.0	25.0	100.2	25.0	0.5	1.6	0.10

END DATA

** MORRISON / KNUDSEN ENGINEERS, INC. 26 NOV 86 ** 8:01:12 ** PAGE 1

** UPTPA MEXICAN HAT G. M. BLEEGEN 26 NOVEMBER, 86'

** WEST DITCH

** DITCH NO: 1 (SECTION 1)

** WATERSHED AREA (ACRES): 38.600

** DITCH LENGTH (FEET): 341.000

** HYDRAULIC LENGTH (FEET): 341.000

** SIDE SLOPE (DEG.): 11.300

** BOTTOM WIDTH (FEET): 10.000

** LONGITUDINAL SLOPE (%): 0.500

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPHP (IN/HR)	SAFETY FACTOR
3.70	4.70	0.026	0.01	1213.93	7.70	10.24	31.45	1.00

** DITCH NO: 1 (SECTION 2)

GMB 11-26-86
BVW 1/7/87

```
** HYDRAULIC LENGTH     (FEET ):  150.000                                  **
** SIDE SLOPE            (DEG. ):   11.300                                  **
** BOTTOM WIDTH          (FEET ):   10.000                                  **
** LONGITUDINAL SLOPE (%       ):    0.500                                  **
**                                                                          **
**  K=050   Y      N      QV      QD       V       T      IPMP   SAFETY     **
**  (IN)   (FT)           (CFS)   (CFS)  (FT/SEC) (MIN)  (IN/HR) FACTOR     **
** ------ ----- ------ ------ ------- -------- ------ ------- ------      **
**   3.84  4.90  0.027   0.01 1282.33     7.58  10.57   30.63   1.00       **
**                                                                          **
****************************************************************************
****************************************************************************
**                                                                          **
** DITCH NO:  1 (SECTION 3)                                                 **
** ------------                                                             **
** WATERSHED AREA        (ACRES):   80.700                                  **
** DITCH LENGTH          (FEET ):  100.000                                  **
** HYDRAULIC LENGTH      (FEET ):  100.000                                  **
** SIDE SLOPE            (DEG. ):   11.300                                  **
** BOTTOM WIDTH          (FEET ):   10.000                                  **
** LONGITUDINAL SLOPE (%       ):    0.500                                  **
**                                                                          **
**  K=050   Y      N      QV      QD       V       T      IPMP   SAFETY     **
**  (IN)   (FT)           (CFS)   (CFS)  (FT/SEC) (MIN)  (IN/HR) FACTOR     **
** ------ ----- ------ ------ ------- -------- ------ ------- ------      **
**   4.94  6.50  0.028   0.01 2455.81     8.38  10.76   30.43   1.00       **
**                                                                          **
****************************************************************************
1
** MORRISON / KNUDSEN ENGINEERS, INC.   26 NOV 86 **  8:01:12 ** PAGE  2
****************************************************************************
** UNTEA MEXICAN HAT          G. M. BLEEGEN     26 NOVEMBER, 86'
** WEST DITCH
****************************************************************************
**                                                                          **
** DITCH NO:  1 (SECTION 4)                                                 **
** ------------                                                             **
** WATERSHED AREA        (ACRES):   86.100                                  **
** DITCH LENGTH          (FEET ):  209.000                                  **
** HYDRAULIC LENGTH      (FEET ):  209.000                                  **
** SIDE SLOPE            (DEG. ):   11.300                                  **
** BOTTOM WIDTH          (FEET ):   10.000                                  **
** LONGITUDINAL SLOPE (%       ):    0.500                                  **
**                                                                          **
**  K=050   Y      N      QV      QD       V       T      IPMP   SAFETY     **
**  (IN)   (FT)           (CFS)   (CFS)  (FT/SEC) (MIN)  (IN/HR) FACTOR     **
** ------ ----- ------ ------ ------- -------- ------ ------- ------      **
**   5.06  6.70  0.028   0.01 2556.95     8.77  11.15   29.70   1.00       **
**                                                                          **
****************************************************************************
****************************************************************************
**                                                                          **
** DITCH NO:  1 (SECTION 5)                                                 **
** ------------                                                             **
** WATERSHED AREA        (ACRES):   93.200                                  **
** DITCH LENGTH          (FEET ):  200.000                                  **
** HYDRAULIC LENGTH      (FEET ):  200.000                                  **
** SIDE SLOPE            (DEG. ):   11.300                                  **
** BOTTOM WIDTH          (FEET ):   10.000                                  **
** LONGITUDINAL SLOPE (%       ):    0.500                                  **
**                                                                          **
**  K=050   Y      N      QV      QD       V       T      IPMP   SAFETY     **
**  (IN)   (FT)           (CFS)   (CFS)  (FT/SEC) (MIN)  (IN/HR) FACTOR     **
```

REV. 02

Sheets 18 thru 21 superseded by Sheets 36 thru 40

HM May 26/88
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BUW 1/7/87

REV.02

Sheets 18 thru 21 Superseded by Sheets 36 thru 40

HM May 26/88
ABH 6-3-88

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**********************************************************************
**                                                                  **
** DITCH NO:  1 (SECTION 6)                                         **
** ------------                                                     **
** WATERSHED AREA        (ACRES):   97.100                          **
** DITCH LENGTH          (FEET ):  118.000                          **
** HYDRAULIC LENGTH      (FEET ):  118.000                          **
** SIDE SLOPE            (DEG. ):   11.300                          **
** BOTTOM WIDTH          (FEET ):   10.000                          **
** LONGITUDINAL SLOPE (%       ):    0.500                          **
**                                                                  **
**  K=D50    Y       N      QV      QD        V        T     IPHP   SAFETY  **
**  (IN)    (FT)            (CFS)   (CFS)  (FT/SEC)  (MIN)  (IN/HR) FACTOR  **
** ------ ----- ------ ------ -------- -------- ------ ------ ------  **
**   5.21   6.90  0.028   0.01 2781.92     9.05  11.74   28.65   1.00  **
**                                                                  **
**********************************************************************
1
** MORRISON / KNUDSEN ENGINEERS, INC.   26 NOV 86 **  9:01:12 ** PAGE  3
**********************************************************************
** ULTRA MEXICAN HAT          G. M. BLEEGEN     26 NOVEMBER, 86'
** WEST DITCH
**********************************************************************
**                                                                  **
** DITCH NO:  1 (SECTION 7)                                         **
** ------------                                                     **
** WATERSHED AREA        (ACRES):   98.800                          **
** DITCH LENGTH          (FEET ):  167.000                          **
** HYDRAULIC LENGTH      (FEET ):  167.000                          **
** SIDE SLOPE            (DEG. ):   11.300                          **
** BOTTOM WIDTH          (FEET ):   10.000                          **
** LONGITUDINAL SLOPE (%       ):    0.500                          **
**                                                                  **
**  K=D50    Y       N      QV      QD        V        T     IPHP   SAFETY  **
**  (IN)    (FT)            (CFS)   (CFS)  (FT/SEC)  (MIN)  (IN/HR) FACTOR  **
** ------ ----- ------ ------ -------- -------- ------ ------ ------  **
**   5.21   6.90  0.028   0.01 2780.06     9.05  12.05   28.14   1.00  **
**                                                                  **
**********************************************************************
**********************************************************************
**                                                                  **
** DITCH NO:  1 (SECTION 8)                                         **
** ------------                                                     **
** WATERSHED AREA        (ACRES):   99.100                          **
** DITCH LENGTH          (FEET ):   40.000                          **
** HYDRAULIC LENGTH      (FEET ):   28.000                          **
** SIDE SLOPE            (DEG. ):   11.300                          **
** BOTTOM WIDTH          (FEET ):   10.000                          **
** LONGITUDINAL SLOPE (%       ):    0.500                          **
**                                                                  **
**  K=D50    Y       N      QV      QD        V        T     IPHP   SAFETY  **
**  (IN)    (FT)            (CFS)   (CFS)  (FT/SEC)  (MIN)  (IN/HR) FACTOR  **
** ------ ----- ------ ------ -------- -------- ------ ------ ------  **
**   5.21   6.90  0.028   0.01 2778.60     9.04  12.10   28.04   1.00  **
**                                                                  **
**********************************************************************
**********************************************************************
**                                                                  **
** DITCH NO:  1 (SECTION 9)                                         **
** ------------                                                     **
** WATERSHED AREA        (ACRES):   99.860                          **
** DITCH LENGTH          (FEET ):   50.000                          **
** HYDRAULIC LENGTH      (FEET ):
```

```
** LONGITUDINAL SLOPE (%     ):     0.500                                  **
**                                                                          **
**  X=D50    Y        N       QV       QD        V        T      IPMP   SAFETY  **
**  (IN)    (FT)             (CFS)    (CFS)   (FT/SEC)  (MIN)   (IN/HR) FACTOR  **
** ------ ----- ------ ------ ------- -------- ------ ------- ------  **
**   5.11   6.10  0.028   0.01 2783.62     9.03  12.19   27.89   1.00  **
**                                                                          **
****************************************************************************
```

GMB 11-26-86
BWW 1/7/87

```
1
** MORRISON / KNUDSEN ENGINEERS, INC.    26 NOV 86 **  8:01:12 ** PAGE  4
****************************************************************************
** UNTRA MEXICAN HAT          G. M. BLEEGEN     26 NOVEMBER, 86'
** WEST DITCH
****************************************************************************
**                                                                          **
** DITCH NO:  1 (SECTION 10)                                                **
** ------------                                                             **
** WATERSHED AREA       (ACRES):  100.100                                   **
** DITCH LENGTH         (FEET ):   50.000                                   **
** HYDRAULIC LENGTH     (FEET ):   50.000                                   **
** SIDE SLOPE           (DEG. ):   11.300                                   **
** BOTTOM WIDTH         (FEET ):   30.000                                   **
** LONGITUDINAL SLOPE (%     ):    0.500                                   **
**                                                                          **
**  X=D50    Y        N       QV       QD        V        T      IPMP   SAFETY  **
**  (IN)    (FT)             (CFS)    (CFS)   (FT/SEC)  (MIN)   (IN/HR) FACTOR  **
** ------ ----- ------ ------ ------- -------- ------ ------- ------  **
**   5.02   5.50  0.028   0.01 2776.63     8.78  12.28   27.74   1.00  **
**                                                                          **
****************************************************************************
****************************************************************************
**                                                                          **
** DITCH NO:  1 (SECTION 11)                                                **
** ------------                                                             **
** WATERSHED AREA       (ACRES):  100.200                                   **
** DITCH LENGTH         (FEET ):   25.000                                   **
** HYDRAULIC LENGTH     (FEET ):   25.000                                   **
** SIDE SLOPE           (DEG. ):   11.300                                   **
** BOTTOM WIDTH         (FEET ):   30.000                                   **
** LONGITUDINAL SLOPE (%     ):    0.500                                   **
**                                                                          **
**  X=D50    Y        N       QV       QD        V        T      IPMP   SAFETY  **
**  (IN)    (FT)             (CFS)    (CFS)   (FT/SEC)  (MIN)   (IN/HR) FACTOR  **
** ------ ----- ------ ------ ------- -------- ------ ------- ------  **
**   5.02   5.50  0.028   0.01 2771.71     8.76  12.33   27.66   1.00  **
**                                                                          **
****************************************************************************
1
COST OF RUN:     $       5.44 =       34.26 CPU SECONDS  *  $.15 / CPU SECON
```

REV02

Sheets 18 thru 21 Superseded by Sheets 36 thru 40

HM May 26/88
ABH 6-3-88

FLOW DEPTH

~~Maximum flow depth = 6.9 ft~~
~~see sheets 18-21 for reaches 6, 7, and 8~~

Superseded by REV 02

Maximum flow depth = 6.8 ft
see sheets 38-39 for reaches 6, 7 and 8

REV 02
HM May 26/88
ABH 6-3-88

Use minimum ditch depth of 8.0' to include ~~1.1'~~ 1.2' of freeboard ✓

Erosion protection for the ditch will be placed up to 8' above the ditch invert. Where the ditch side slope coincides with the embankment side slope the ditch riprap will terminate 8' above the ditch invert at which point the smaller embankment side slope erosion protection will be carried on. ✓

This entire sheet superseded by REV02 on Sheet 23A. HM May 26/88 ABH 6-3-88

RIPRAP DESIGN

D_{50} rock size:

REACH 1	D_{50} = 3.70"		REACH 7	D_{50} = 5.21"
2.	D_{50} = 3.84"		8	D_{50} = 5.21"
3	D_{50} = 4.94"		9	D_{50} = 5.11"
4	D_{50} = 5.06"		10	D_{50} = 5.02"
5.	D_{50} = 5.14"		11	D_{50} = 5.02"
6.	D_{50} = 5.21"			

use D_{50} = 5.50 in

D_{100} rock size:

$D_{100(min)} = \sqrt[3]{2}\ D_{50\,(min)} = 1.26\ (5.5) = 6.9"$ (Ref 1 ch 5)

$D_{100\,(max)} = \sqrt[3]{5}\ D_{50\,(min)} = 1.71\ (5.5) = 9.4"$

Riprap layer thickness:

$T_{min} = 1.9\ D_{50} = 1.9\ (5.5) = 10.5"$ (Ref 1 ch 5)

or T_{min} = 12" (which ever greater)

use T_{min} = 12"

Bedding layer thickness:

use 6" layer thickness

This entire sheet is part of REV02.

D_{50} (min) rock size: (see sheets 36-40)

REACH	D_{50} (min) - Inches
1	3.36
2	3.48
3	4.51
4	4.63
5	4.68
6	4.75 ←
7	4.75 ←
8	4.75 ←
9	4.73
10	4.56
11	4.56

Use D_{50} (min) = 4.8 inches

D_{100} rock sizes: (see sheet 3)

$$D_{100}(min) = (2)^{1/3} D_{50}(min) = 1.26(4.8) = 6.0 \text{ inches}$$

$$D_{100}(max) = (5)^{1/3} D_{50}(min) = 1.71(4.8) = 8.2 \text{ inches}$$

Riprap Layer Thickness:

$$T_{min} = 1.9\, D_{50}(min) = 1.9(4.8) = 9.1 \text{ inches}$$

Or T_{min} = 12 inches, whichever is greater.

$$T_{min} = 1.5\,(D_{50})_{max}$$

Use T_{min} = 12 inches

$$D_{50}(max) = \frac{12}{1.5} = 8.0 \text{ inches}$$

Bedding Layer Thickness:

Use 6 inches bedding layer thickness.

CHECK SUPER ELEVATION ON BENDS

The water surface will rise on the outside wall of the bends due to the centrifugal force caused by the flow. The radius of the curves are large so the rise will be small and can be calculated by the following equation (Ref 5, pg 27+28)

$$\Delta y = C \frac{v^2 w}{g r}$$

where Δy = rise in water surface on outside wall
v = channel velocity (mean)
C = coefficient based on flow type and channel cross section
w = channel width at water surface elevation
g = accel. of gravity, 32.2 ft/s²
r = radius

$C = 0.5$ for tranquil flow and trapezoid x-sect. (Ref. 5, pg 28)

$w = [(6.9)5]2 + 10 = 79$ ft

First Curve

$r = 400'$

$v = 7.70$ ft/s (sheet 18)

$$\Delta y = 0.5 \frac{(7.70)^2 (79)}{32.2 (400)}$$

$= \underline{0.18 \text{ ft}}$ ←

Second Curve

$r = 600'$

$v = 9.05$ ft/s (sheet 20)

$$\Delta y = 0.5 \frac{(9.05)^2 (79)}{32.2 (600)}$$

$= \underline{0.17 \text{ ft}}$

∴ Freeboard is adequate to prevent overtopping at either of the curves.

CHECK RATE OF DIVERGENCE AT FLARE SECTION

The flared section (STA 13+25 to STA 14+25, from a bottom width of 10' to 30') must be checked to determine if a smooth transition is provided for the expanding section. The allowable angle of divergence is defined as (Ref 2, pg 393):

$$\alpha = \tan^{-1} \frac{1}{3\mathbb{F}}$$

where α = angle of divergence
$\mathbb{F}$ = Froude no.

$$\mathbb{F} = \frac{V}{\sqrt{gy}}$$

where V = velocity in flared section
y = flow depth in flared section

average for flared sections:

$$V = \frac{9.03 + 8.78}{2} = 8.91 \text{ fps}$$

$$y_{av} = \frac{6.10 + 5.50}{2} = 5.80 \text{ ft}$$

$$\mathbb{F} = \frac{8.91}{\sqrt{32.2(5.8)}} = 0.65$$

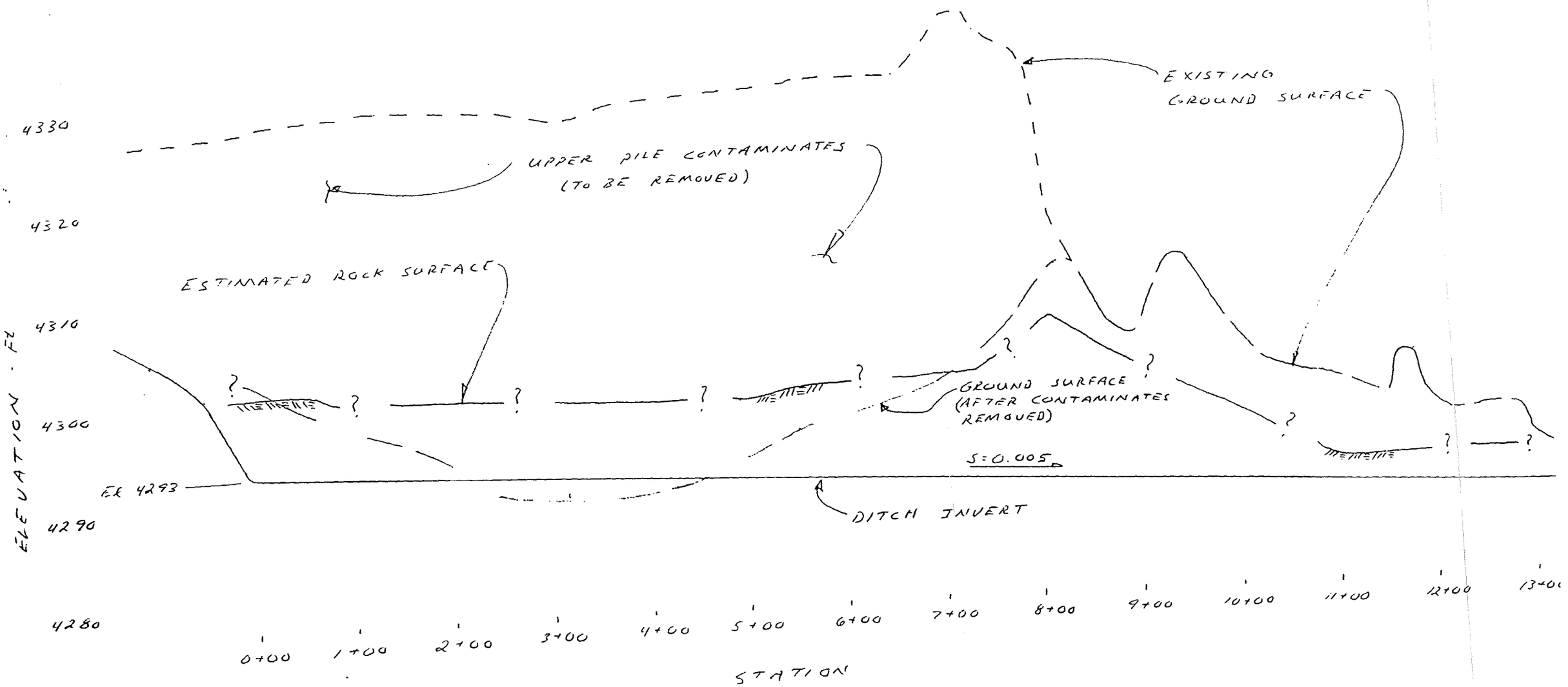
$$\alpha = \tan^{-1} \frac{1}{3(0.65)} = 27.07°$$ (max. allowable angle of divergence)

actual divergence: 100 longitudinal : 10 lateral

$$\alpha = \tan^{-1} \frac{10}{100} = 5.71° < 27.07° \therefore \underline{\underline{ok}}$$

KEY DESIGN

A key trench will be constructed at the ditch outlet to reduce errosion due to head cutting. The outlet velocity is estimated as 8.76 fps (sheet 21). The Corp of Engineers (Ref 5, plate 38) suggest a key trench be designed with a depth of twice the riprap thickness and a length of three times the riprap thickness. A larger key trench is used for this ditch outlet due to the relatively high exit velocity. A depth of 5'-0 and a length of 15'-0 with 1:1 side slopes will be used for the key trench. A design methodology for estimating a suitable rock size is unknown therefore a $D_{50(min)}$ rock size of 8" is choosen for the key trench. (See sheets 33-35 for key trench detail).

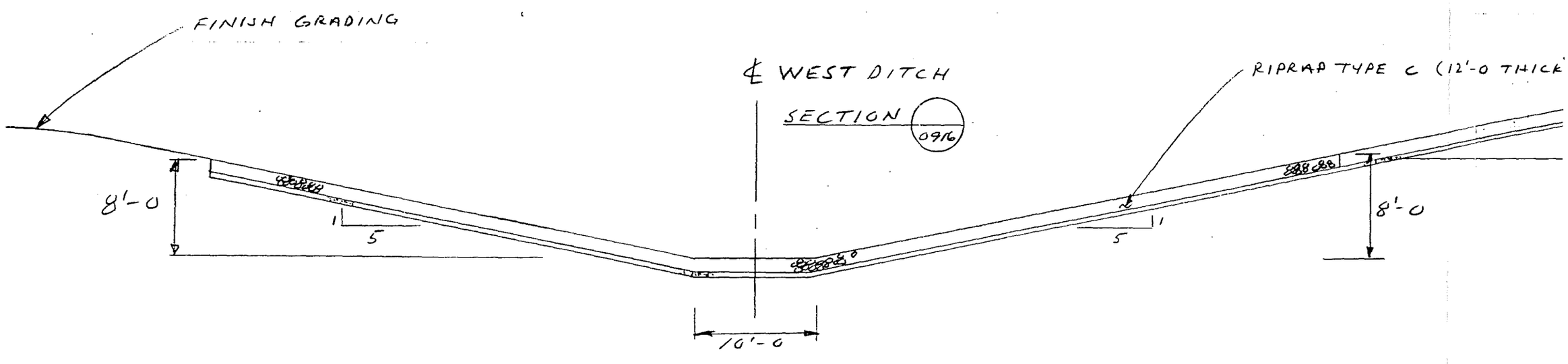


WEST DITCH PROFILE

SCALE: VERTICAL 1" = 10'
HORIZONTAL 1" = 100'

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

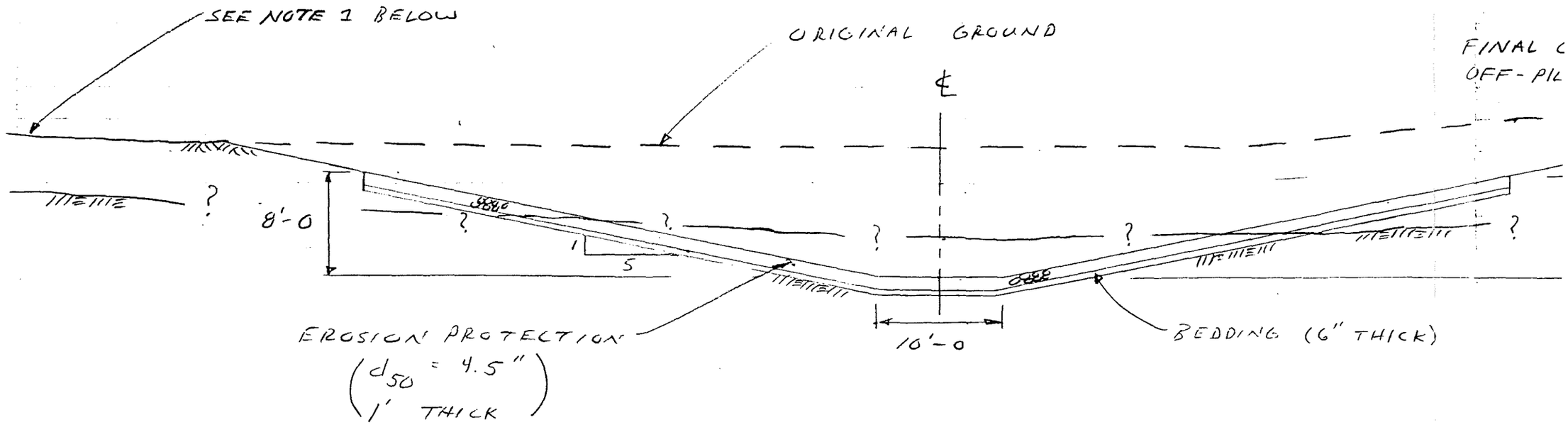
Project		Contract No.	Sheet 28
Feature		Designed GMB	File No.
Item		Checked BVW	Date 11-25-86
			Date 1/7/87



TYPICAL SECTION ADJACENT TO EMBANKMENT

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project	UMTRA-HAT	Contract No. 5025	Sheet 29
Feature	PERMANENT SITE DRAINAGE	Designed GMB	File No.
Item	DRAINAGE DITCH	Checked BVW	Date 12-8-86
			Date 1/7/87



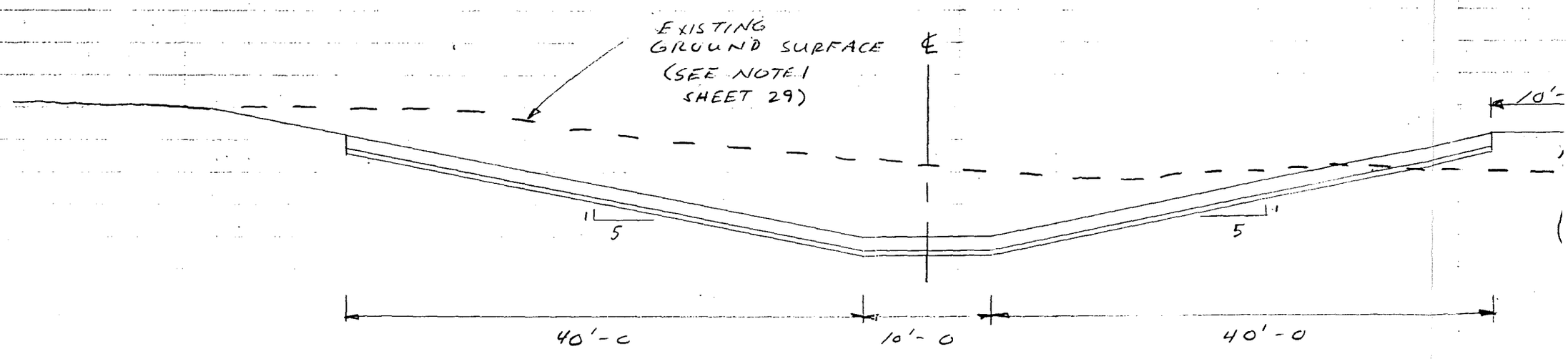
NOTE: 1. GROUND SURFACE WILL BE APPROXIMATELY 0.5" LOWER

TYPICAL SECTION

1" = 10'

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA - HAT	Contract No. 5025	Sheet 30	
Feature SITE DRAINAGE	Designed GMB	File No.	
Item WEST DITCH	Checked BUW	Date 12-9-86	Date 1/7/87

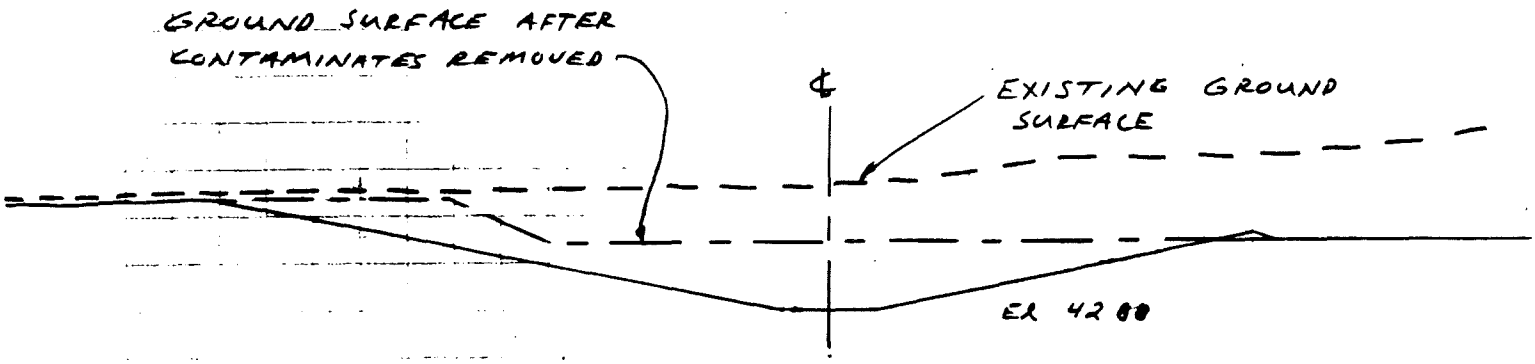


TYPICAL SECTION WHERE FILL IS REQUIRED

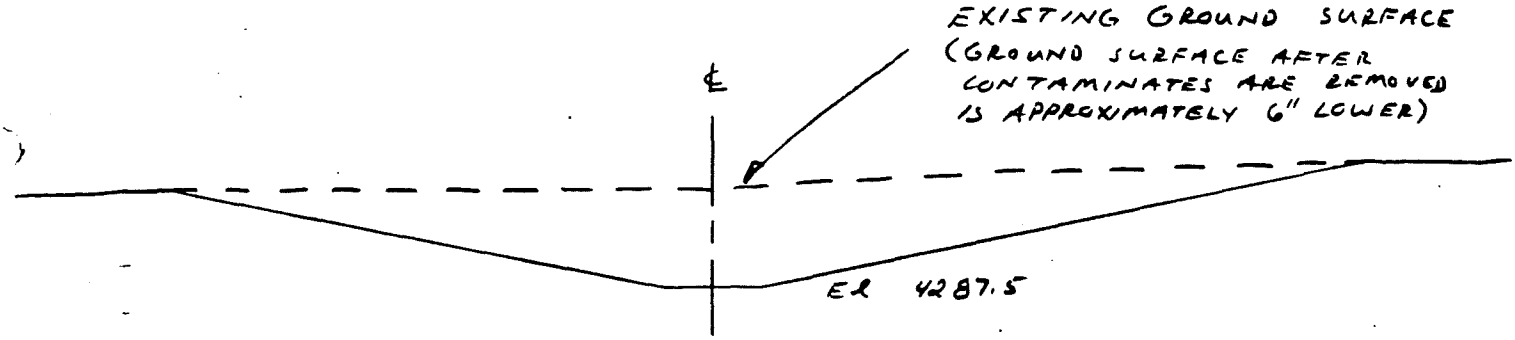
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 31

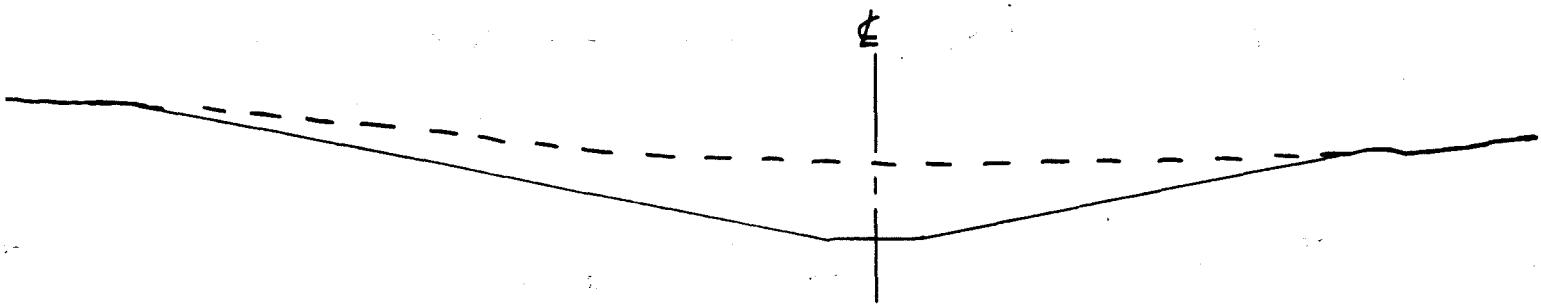
Project UMTRA - HAT | Contract No. 5025 | File No.
Feature SITE DRAINAGE | Designed GMB | Date 12-2-86
Item WEST DITCH | Checked DUW | Date 1/7/87



STA 10+00
1" = 20'



STA 11+00
1" = 20'

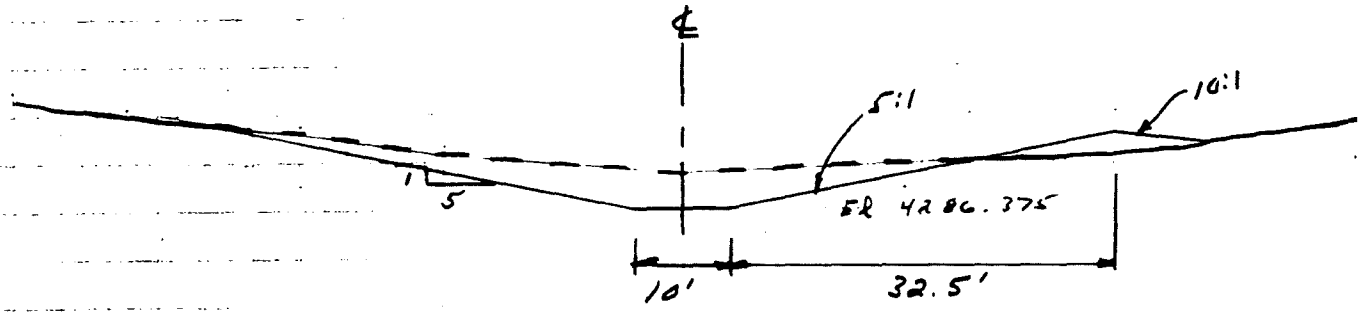


STA 12+00
1" = 20'

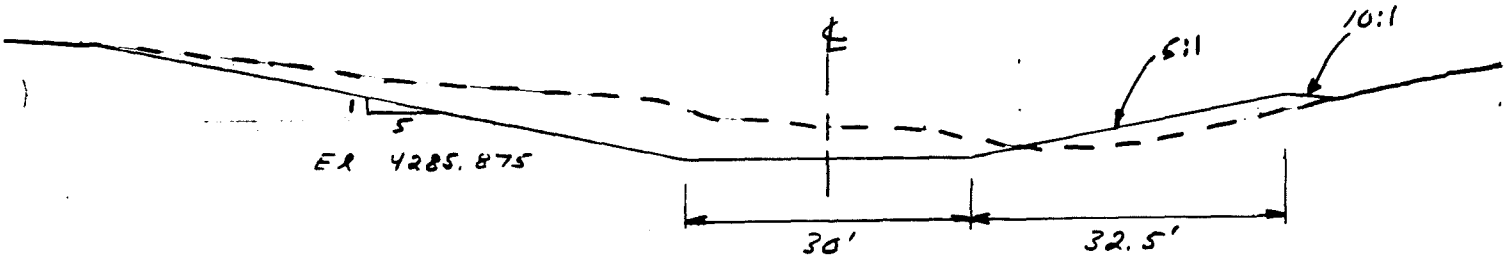
MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 32

Project UMTRA-HAT | Contract No. 5025 | File No.
Feature SITE DRAINAGE | Designed GMB | Date 11-21-8
Item WEST DITCH | Checked BUW | Date 1/7/87



STA 13+25
1" = 10'

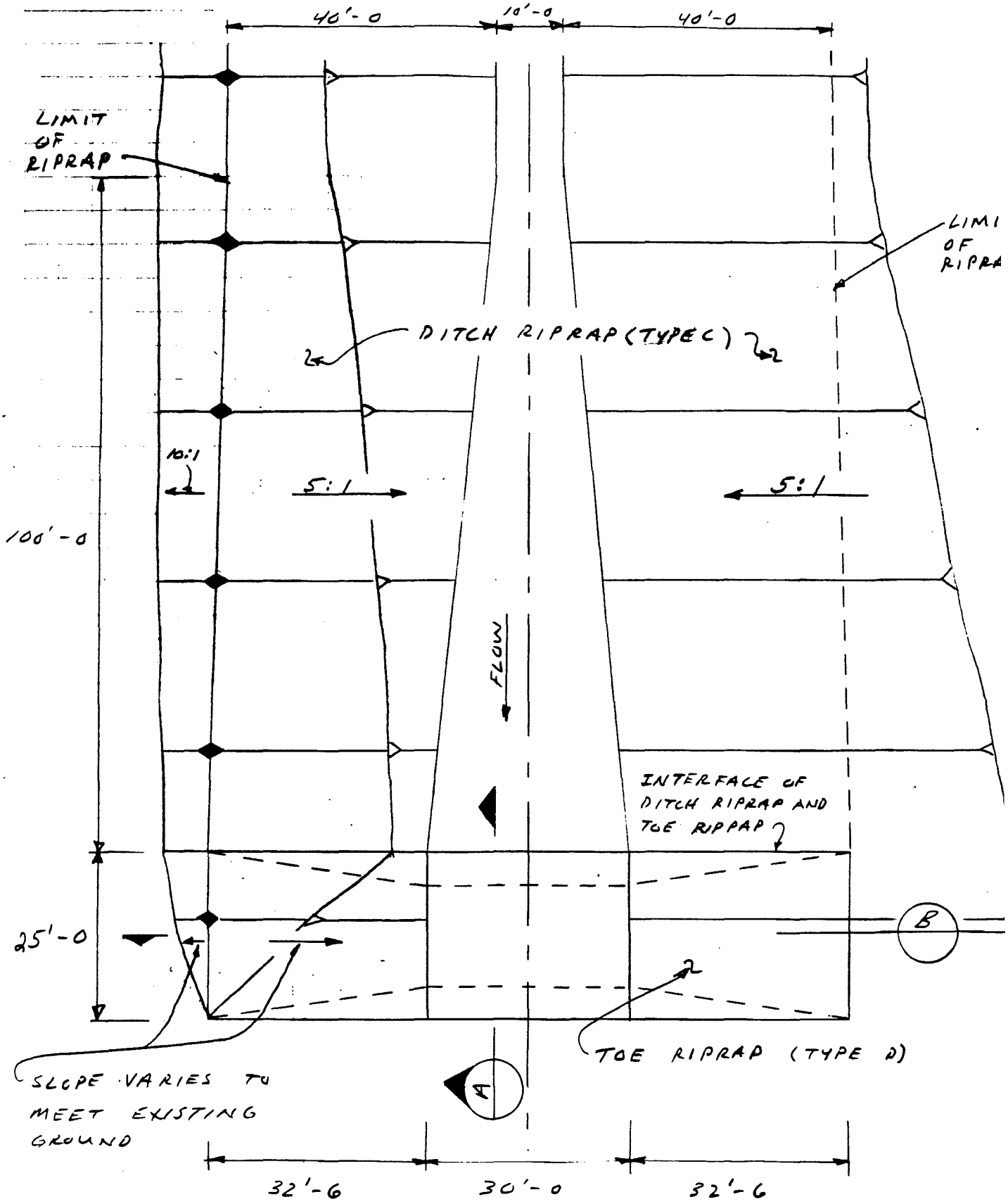


STA 14+25
1" = 10'

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Sheet 33

Project UMTRA - HAT | Contract No. 5025 | File No.
Feature PERMANENT SITE DRAINAGE | Designed GMB | Date 11-21-8
Item WEST DITCH | Checked BUW | Date 1/7/8



WEST DITCH OUTLET
1"= 20'

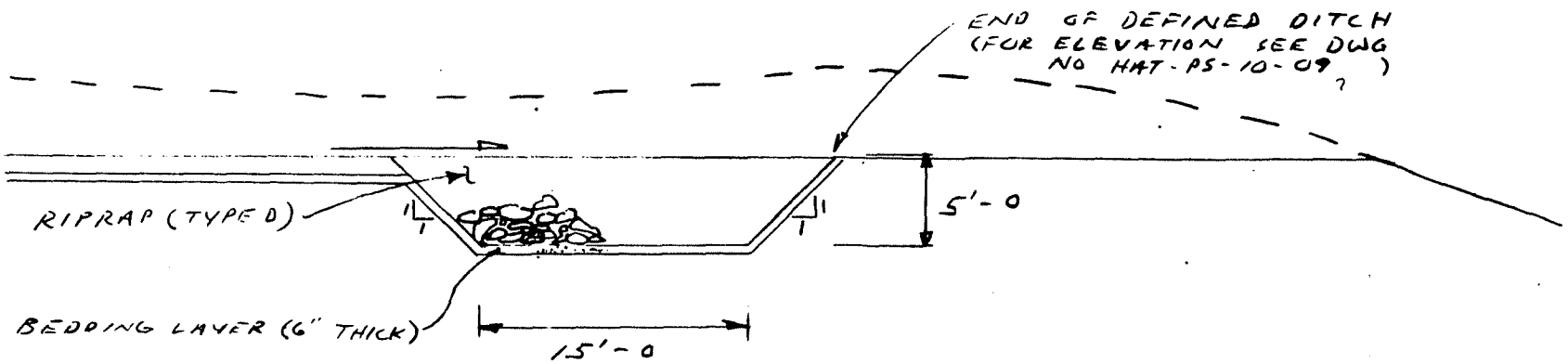
WEST ℄ DITCH

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project: LAMTRA - HAT
Feature: PERMANENT SITE REMINAGE
Item: WEST DITCH

Contract No. 5625
Designed: GMB
Checked: JSW

Sheet 34
File No.
Date 11-24-8
Date 1/12/8



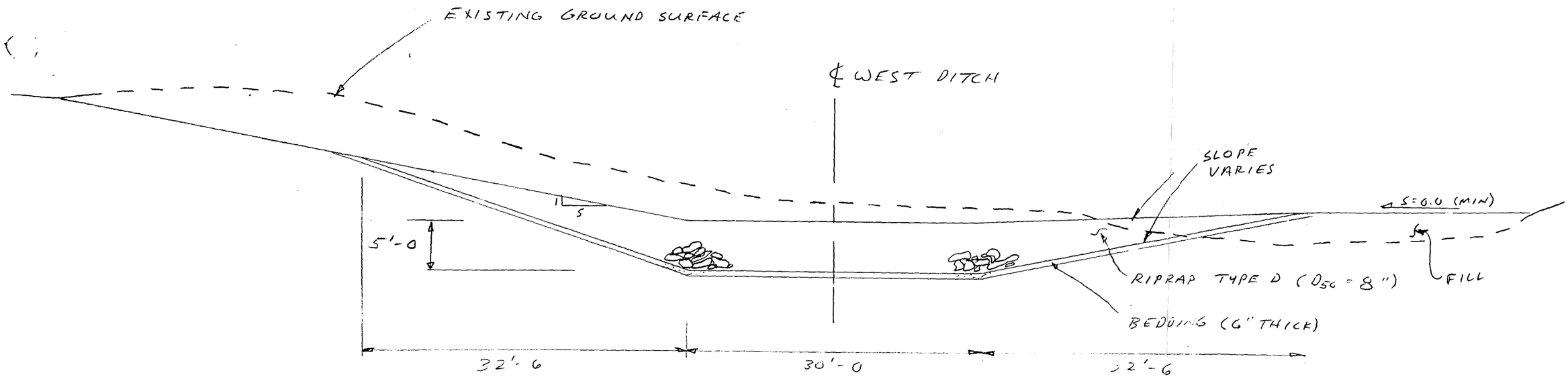
WEST DITCH OUTFALL END PROTECTION

SECTION A

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

Project UMTRA-HAT	Contract No. 5025	Sheet 35	
Feature SITE DRAINAGE	Designed GMB	File No.	
Item WEST DITCH	Checked BVW	Date 12-9-86	Date 1/7/87

35



WEST DITCH OUTFALL END PROTECTION

SECTION B

1" = 10'

** MORRISON / KNUDSEN ENGINEERS, INC. 26-MAY-88 **11:14:51 ** DATA **
****
** UMTRA MEXICAN HAT **
** WEST DITCH WITH SHADOW MOUNTAIN ROCK **

HM May 26/88
ABH 6-3-88

TIME CONCENTRATION FROM EMBANKMENT : 9.500

ROCK SPECIFIC GRAVITY : 2.730 REV02

ROCK POROSITY : 0.001

ROCK FRICTION ANGLE : 42.000

WATER UNIT WEIGHT : 62.400

G : 1.797

H : 0.307

Z : 1.816

Discussed in REV01 – see Sheet 10 & 11.

DITCH	SEC	THETA (DEG)	BOTTOM WIDTH (FT)	DITCH LENGTH (FT)	SHED AREA (ACRES)	HYDR LENGTH (FT)	SLOPE (%)	SHEAR COEFF	START ROCK (FT)
1	1	11.3	10.0	341.0	38.6	341.0	0.5	1.6	0.10
1	2	11.3	10.0	150.0	41.6	150.0	0.5	1.6	0.10
1	3	11.3	10.0	100.0	80.7	100.0	0.5	1.6	0.10
1	4	11.3	10.0	209.0	86.1	209.0	0.5	1.6	0.10
1	5	11.3	10.0	200.0	93.2	200.0	0.5	1.6	0.10
1	6	11.3	10.0	118.0	97.1	118.0	0.5	1.6	0.10
1	7	11.3	10.0	167.0	98.8	167.0	0.5	1.6	0.10
1	8	11.3	10.0	40.0	99.1	40.0	0.5	1.6	0.10
1	9	11.3	20.0	50.0	99.8	50.0	0.5	1.6	0.10
1	10	11.3	30.0	50.0	100.1	50.0	0.5	1.6	0.10
1	11	11.3	30.0	25.0	100.2	25.0	0.5	1.6	0.10

```
** MORRISON / KNUDSEN ENGINEERS, INC.    26-MAY-88 **11:14:51   ** PAGE  1
*****************************************************************************
** UMTRA MEXICAN HAT                                   HM May 26/88          **
** WEST DITCH WITH SHADOW MOUNTAIN ROCK                ADH 6-3-88            **
*****************************************************************************
**                                                                           **
** DITCH NO:   1 (SECTION 1)                                                 **
** ------------                                                              **
** WATERSHED AREA      (ACRES):    38.600                                    **
** DITCH LENGTH        (FEET ):   341.000                                    **
** HYDRAULIC LENGTH    (FEET ):   341.000                                    **
** SIDE SLOPE          (DEG. ):    11.300                                    **
** BOTTOM WIDTH        (FEET ):    10.000                                    **
** LONGITUDINAL SLOPE  (%    ):     0.500                                    **
**                                                                           **
**  K=D50   Y      N      QV      QD        V        T      IPMP    SAFETY   **
**  (IN)   (FT)          (CFS)   (CFS)   (FT/SEC)  (MIN)   (IN/HR)  FACTOR   **
** ------ ----- ------ ------ ------- -------- ------ ------- ------         **
**   3.36  4.60  0.026   0.01 1176.04     7.74  10.23   30.47    1.00        **
**                                                                           **
*****************************************************************************
*****************************************************************************
**                                                                           **
** DITCH NO:   1 (SECTION 2)                                                 **
** ------------                                                              **
** WATERSHED AREA      (ACRES):    41.600                                    **
** DITCH LENGTH        (FEET ):   150.000                                    **
** HYDRAULIC LENGTH    (FEET ):   150.000                                    **
** SIDE SLOPE          (DEG. ):    11.300                                    **
** BOTTOM WIDTH        (FEET ):    10.000                                    **
** LONGITUDINAL SLOPE  (%    ):     0.500                                    **
**                                                                           **
**  K=D50   Y      N      QV      QD        V        T      IPMP    SAFETY   **
**  (IN)   (FT)          (CFS)   (CFS)   (FT/SEC)  (MIN)   (IN/HR)  FACTOR   **
** ------ ----- ------ ------ ------- -------- ------ ------- ------         **
**   3.48  4.80  0.026   0.01 1249.91     7.65  10.56   30.05    1.00        **
**                                                                           **
*****************************************************************************
*****************************************************************************
**                                                                           **
** DITCH NO:   1 (SECTION 3)                                                 **
** ------------                                                              **
** WATERSHED AREA      (ACRES):    80.700                                    **
** DITCH LENGTH        (FEET ):   100.000                                    **
** HYDRAULIC LENGTH    (FEET ):   100.000                                    **
** SIDE SLOPE          (DEG. ):    11.300                                    **
** BOTTOM WIDTH        (FEET ):    10.000                                    **
** LONGITUDINAL SLOPE  (%    ):     0.500                                    **
**                                                                           **
**  K=D50   Y      N      QV      QD        V        T      IPMP    SAFETY   **
**  (IN)   (FT)          (CFS)   (CFS)   (FT/SEC)  (MIN)   (IN/HR)  FACTOR   **
** ------ ----- ------ ------ ------- -------- ------ ------- ------         **
**   4.51  6.40  0.027   0.01 2397.68     8.91  10.75   29.71    1.00        **
**                                                                           **
*****************************************************************************
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** MORRISON / KNUDSEN ENGINEERS, INC.    26-MAY-88 **11:14:51   ** PAGE  2
*************************************************************************
** UMTRA MEXICAN HAT                                    HM May 26/88     **
** WEST DITCH WITH SHADOW MOUNTAIN ROCK                 ABH 6-3-88.      **
*************************************************************************
**                                                                       **
** DITCH NO:   1 (SECTION 4)                                            **
** ------------                                                         **
** WATERSHED AREA      (ACRES):    86.100                               **
** DITCH LENGTH        (FEET ):   209.000                               **
** HYDRAULIC LENGTH    (FEET ):   209.000                               **
** SIDE SLOPE          (DEG. ):    11.300                               **
** BOTTOM WIDTH        (FEET ):    10.000                               **
** LONGITUDINAL SLOPE  (%    ):     0.500                               **
**                                                                       **
**  K=D50   Y      N     QV     QD       V        T     IPMP   SAFETY   **
**  (IN)   (FT)         (CFS)  (CFS)  (FT/SEC)  (MIN)  (IN/HR) FACTOR   **
** ------ ----- ------ ------ ------- -------- ------ ------- ------   **
**   4.63  6.60  0.027   0.01 2510.67     8.84  11.14   29.16   1.00   **
**                                                                       **
*************************************************************************
*************************************************************************
**                                                                       **
** DITCH NO:   1 (SECTION 5)                                            **
** ------------                                                         **
** WATERSHED AREA      (ACRES):    93.200                               **
** DITCH LENGTH        (FEET ):   200.000                               **
** HYDRAULIC LENGTH    (FEET ):   200.000                               **
** SIDE SLOPE          (DEG. ):    11.300                               **
** BOTTOM WIDTH        (FEET ):    10.000                               **
** LONGITUDINAL SLOPE  (%    ):     0.500                               **
**                                                                       **
**  K=D50   Y      N     QV     QD       V        T     IPMP   SAFETY   **
**  (IN)   (FT)         (CFS)  (CFS)  (FT/SEC)  (MIN)  (IN/HR) FACTOR   **
** ------ ----- ------ ------ ------- -------- ------ ------- ------   **
**   4.68  6.70  0.027   0.01 2665.69     9.14  11.51   28.60   1.00   **
**                                                                       **
*************************************************************************
*************************************************************************
**                                                                       **
** DITCH NO:   1 (SECTION 6)                                            **
** ------------                                                         **
** WATERSHED AREA      (ACRES):    97.100                               **
** DITCH LENGTH        (FEET ):   118.000                               **
** HYDRAULIC LENGTH    (FEET ):   118.000                               **
** SIDE SLOPE          (DEG. ):    11.300                               **
** BOTTOM WIDTH        (FEET ):    10.000                               **
** LONGITUDINAL SLOPE  (%    ):     0.500                               **
**                                                                       **
**  K=D50   Y      N     QV     QD       V        T     IPMP   SAFETY   **
**  (IN)   (FT)         (CFS)  (CFS)  (FT/SEC)  (MIN)  (IN/HR) FACTOR   **
** ------ ----- ------ ------ ------- -------- ------ ------- ------   **
**   4.75  6.80  0.028   0.01 2744.52     9.17  11.72   28.26   1.00   **
**                                                                       **
*************************************************************************
```

** UMTRA MEXICAN HAT HM May 26/88 **
** WEST DITCH WITH SHADOW MOUNTAIN ROCK ABH 6-3-88 **

** DITCH NO: 1 (SECTION 7)

WATERSHED AREA	(ACRES):	98.800
DITCH LENGTH	(FEET):	167.000
HYDRAULIC LENGTH	(FEET):	167.000
SIDE SLOPE	(DEG.):	11.300
BOTTOM WIDTH	(FEET):	10.000
LONGITUDINAL SLOPE	(%):	0.500

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
4.75	6.80	0.028	0.01	2752.48	9.19	12.02	27.86	1.00

** DITCH NO: 1 (SECTION 8)

WATERSHED AREA	(ACRES):	99.100
DITCH LENGTH	(FEET):	40.000
HYDRAULIC LENGTH	(FEET):	40.000
SIDE SLOPE	(DEG.):	11.300
BOTTOM WIDTH	(FEET):	10.000
LONGITUDINAL SLOPE	(%):	0.500

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
4.75	6.80	0.028	0.01	2745.99	9.17	12.10	27.71	1.00

** DITCH NO: 1 (SECTION 9)

WATERSHED AREA	(ACRES):	99.800
DITCH LENGTH	(FEET):	50.000
HYDRAULIC LENGTH	(FEET):	50.000
SIDE SLOPE	(DEG.):	11.300
BOTTOM WIDTH	(FEET):	20.000
LONGITUDINAL SLOPE	(%):	0.500

K=D50 (IN)	Y (FT)	N	QV (CFS)	QD (CFS)	V (FT/SEC)	T (MIN)	IPMP (IN/HR)	SAFETY FACTOR
4.73	6.10	0.027	0.01	2753.45	8.93	12.19	27.59	1.00

```
** MORRISON / KNUDSEN ENGINEERS, INC.    26-MAY-88 **11:14:51  ** PAGE  4
*************************************************************************
** UMTRA MEXICAN HAT                                          HM May 26/88 **
** WEST DITCH WITH SHADOW MOUNTAIN ROCK                       ABH 6-3-88   **
*************************************************************************
**                                                                       **
** DITCH NO:   1 (SECTION10)                                            **
** ------------                                                         **
** WATERSHED AREA      (ACRES):   100.100                               **
** DITCH LENGTH        (FEET ):    50.000                               **
** HYDRAULIC LENGTH    (FEET ):    50.000                               **
** SIDE SLOPE          (DEG. ):    11.300                               **
** BOTTOM WIDTH        (FEET ):    30.000                               **
** LONGITUDINAL SLOPE  (%    ):     0.500                               **
**                                                                       **
**  K=D50    Y       N      QV      QD        V         T      IPMP    SAFETY  **
**  (IN)    (FT)           (CFS)   (CFS)   (FT/SEC)  (MIN)   (IN/HR)  FACTOR  **
** ------ ----- ------ ------ -------- --------- ------ -------- ------  **
**   4.56   5.40  0.027   0.01 2749.08      8.93  12.28    27.46    1.00  **
**                                                                       **
*************************************************************************
*************************************************************************
**                                                                       **
** DITCH NO:   1 (SECTION11)                                            **
** ------------                                                         **
** WATERSHED AREA      (ACRES):   100.200                               **
** DITCH LENGTH        (FEET ):    25.000                               **
** HYDRAULIC LENGTH    (FEET ):    25.000                               **
** SIDE SLOPE          (DEG. ):    11.300                               **
** BOTTOM WIDTH        (FEET ):    30.000                               **
** LONGITUDINAL SLOPE  (%    ):     0.500                               **
**                                                                       **
**  K=D50    Y       N      QV      QD        V         T      IPMP    SAFETY  **
**  (IN)    (FT)           (CFS)   (CFS)   (FT/SEC)  (MIN)   (IN/HR)  FACTOR  **
** ------ ----- ------ ------ -------- --------- ------ -------- ------  **
**   4.56   5.40  0.027   0.01 2744.49      8.91  12.33    27.39    1.00  **
**                                                                       **
*************************************************************************
```

UMT 10719

9.13.1.1

UMTRA - DOE/AL -050509 .0000

United States Department of Energy

SURF008886

Remedial Action Plan for the Codisposal and Stabilization of the Monument Valley and Mexican Hat Uranium Mill Tailings at Mexican Hat, Utah

Appendix F

Final

February 1993

Appendix B of the
Cooperative Agreement
No. DE-FC04-83AL16258

Uranium Mill Tailings Remedial Action Project

MON605.02.02 Box 2
SMON13.1.1

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APPENDIX F

GROUNDWATER HYDROLOGY CALCULATIONS

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TABLE OF CONTENTS

Calculation No.	Title
HAT-07-91-14-02-00	Slug Test Analyses for Monitor Wells: Mexican Hat Processing/Disposal Site
HAT-07-91-14-03-00	Analyses of Packer Tests at Mexican Hat UMTRA Site
HAT-09-91-14-06-00	Hydraulic Gradients and Groundwater Velocities for the Halgaito Shale Formation and the Honaker Trail Formation, Mexican Hat Site, Utah
HAT-11-91-12-02	Volume of Released Water
MON-08-92-14-03-00	Aquifer Pumping Test Analysis of Monitor Well 651
MON-08-92-14-02-00	Slug Test Analysis to Determine Hydraulic Conductivity
MON-01-11-92-14-06/07-00	Gradient Calculations at Monument Valley UMTRA Site

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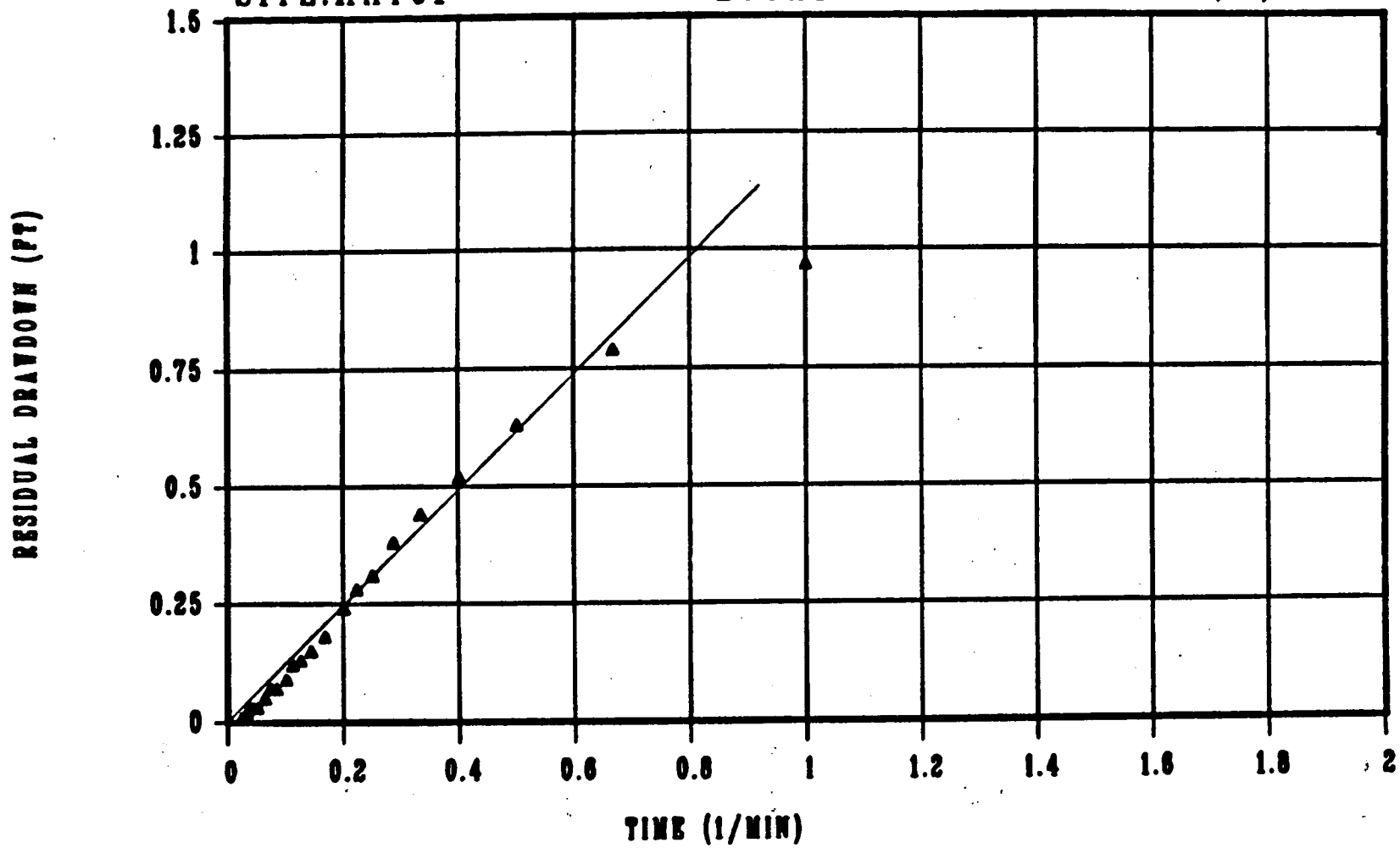
FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:909 DATE:08/14/85



NTC
7/30
7/31/91

JACOBS ENGINEERING

DATE 7/30/91

BY Cap CHKD. SUBJECT

SHEET NO. JOB NO. 7/31/91

Slug Test Summary - AAT01

Hydraulic Conductivity (ft/day)

Well ID	Skibitzke	Ferris-Knowles	Cooper-Bredehoeft-Papadopolous	Average	Standard Deviation
908	0.955	0.102	0.397	0.485	0.433
909	0.002	0.095	0.119	0.072	0.062

FORM 91-005-1 (4/81)

7/30/91
Caf
7/31/91

SLUG TEST SOLUTIONS

```
*****************************************************************
WELL IDENTIFICATION- HAT01-909
DATE OF FIELD TEST- 08/14/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     20
SKIBITSKE METHOD
FOR DISCHARGE(Q)=   .05
RESIDUAL DRAWDOWN(s')=   .01 FT
TIME TO RESIDUAL DRAWDOWN(t)=   36 MIN
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  5.52621E-04 FT/MIN = 0.80 FT/DAY
*****************************************************************
```

$K = \frac{q}{4\pi s L t}$

✓ Caf KL 7/30/91

7/30
Cap
7/31/91

SLUG TEST SOLUTIONS

****
WELL IDENTIFICATION- HAT01-909
DATE OF FIELD TEST- 08/14/85
LENGTH OF CONTRIBUTING INTERVAL,(L)= 20
SKIBITSKE METHOD
FOR DISCHARGE(Q)= .05
RESIDUAL DRAWDOWN(s')= .01 FT
TIME TO RESIDUAL DRAWDOWN(t)= 20 min INVALID
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 9.94719E-04 FT/min = 1.4 FT/DAY
****

****
WELL IDENTIFICATION- HAT01-909
DATE OF FIELD TEST- 08/14/85
LENGTH OF CONTRIBUTING INTERVAL,(L)= 20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)= .05
RECIPROCAL TIME(1/t)= .4 1/min
DRAWDOWN (s)= .5 FT
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 1.59155E-04 FT/min = 0.23 FT/DAY
****

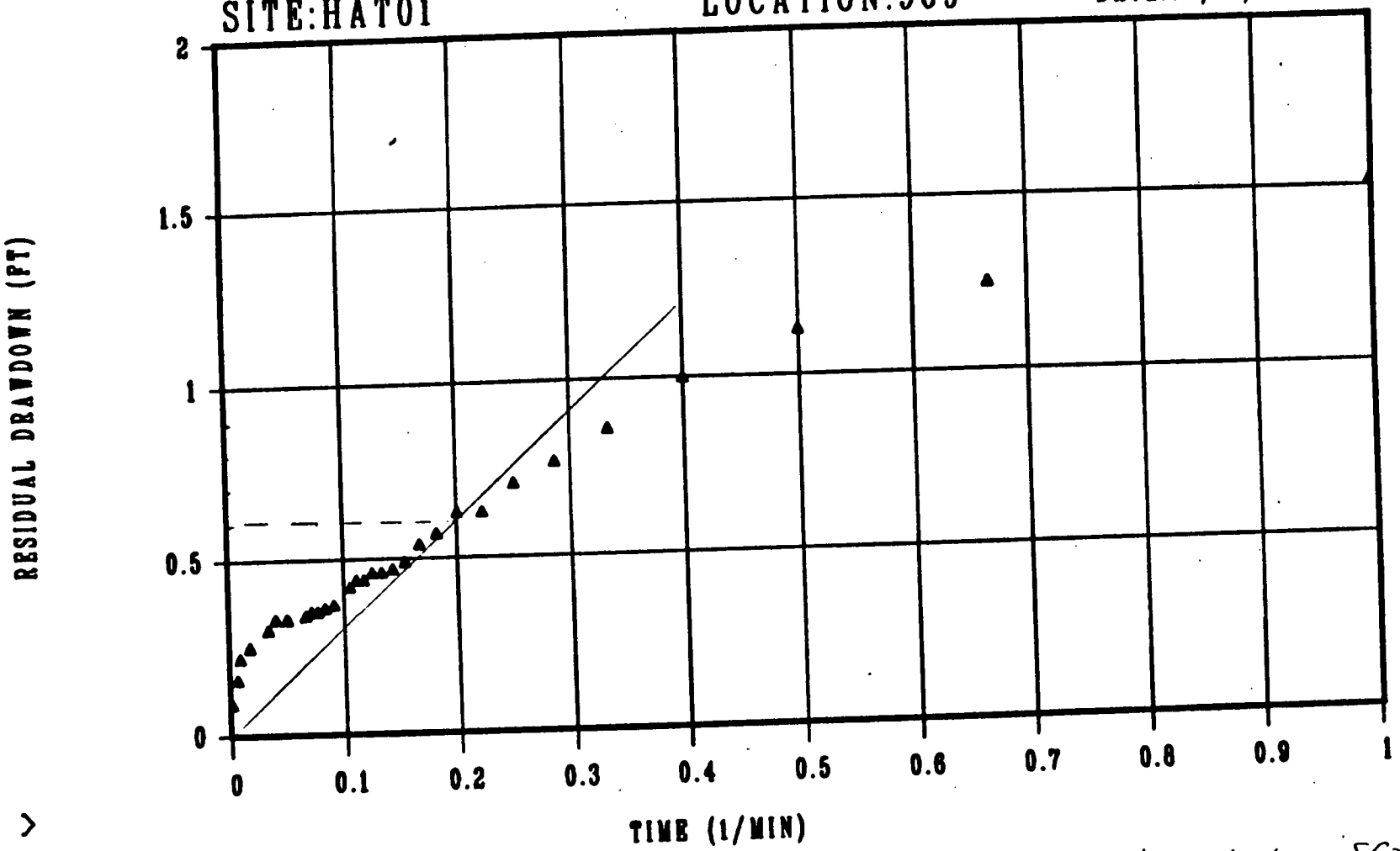
✓ KAL
✓ Cap: 7/10/91

****
WELL IDENTIFICATION- HAT01-909
DATE OF FIELD TEST- 08/14/85
LENGTH OF CONTRIBUTING INTERVAL,(L)= 20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)= .083
TIME(t)= 95 sec
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 3.62579E-06 FT/sec = 0.31 FT/DAY

✓ Cap ✓ KAL
7/10/91

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:909 DATE:04/11/85

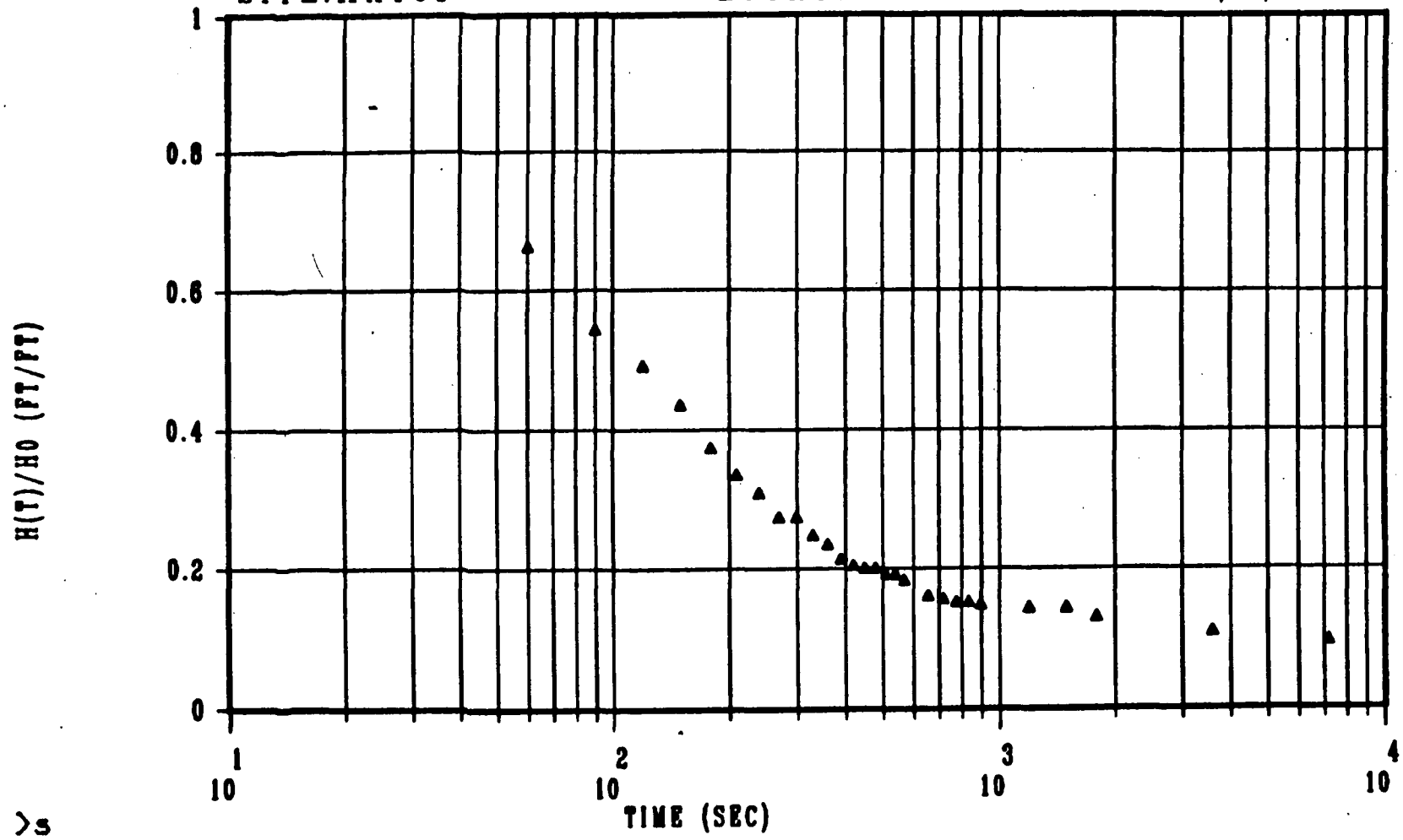


checked by SColarullo
8/6/85

7/30
4/31/91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:909 DATE:04/10/85



>s

checked by J Colarullo
8/6/85

KAL 7/30/91
7/31/91

$K = \frac{q}{4\pi s L t}$ 7/31 Cap

WELL IDENTIFICATION- HAT01-909
DATE OF FIELD TEST- 04/10/85
LENGTH OF CONTRIBUTING INTERVAL, (L)= 20
SKIBITSKE METHOD
FOR DISCHARGE(Q)= .05
RESIDUAL DRAWDOWN(s')= .09 FT
TIME TO RESIDUAL DRAWDOWN(t)= 1860 min
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 1.18843E-06 FT/min = 0.002 FT
****

KAL 7/10/91
Cap

****
WELL IDENTIFICATION- HAT01-909
DATE OF FIELD TEST- 04/10/85
LENGTH OF CONTRIBUTING INTERVAL, (L)= 20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)= .05
RECIPROCAL TIME(1/t)= .2 min
DRAWDOWN (s)= .6 FT
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 6.63146E-05 FT/min = 0.10 FT/D
****

KAL 7/10/
Cap

****
WELL IDENTIFICATION- HAT01-909
DATE OF FIELD TEST- 04/10/85
LENGTH OF CONTRIBUTING INTERVAL, (L)= 20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR: WELL RADIUS (Rc)= .084 FT.
TIME(t)= 250 sec.
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 1.4112E-06 FT/sec = 0.12 FT/DA
****

Cap KAL 7/10/9

KAR 7/30
CEP 7/31/9
checked by Scola 8/6/85

SLUG TEST DATA

SITE: HAT04 MEXICAN HAT
LOCATION: 909
DATE: 04/10/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/HO [FT./FT.]
.00	.00000	0	36.94	.00	.0000
1.00	1.00000	60	38.46	-1.52	-.6632
1.50	.66667	90	38.19	-1.25	-.5454
2.00	.50000	120	38.07	-1.13	-.4931
2.50	.40000	150	37.94	-1.00	-.4363
3.00	.33333	180	37.80	-.86	-.3752
3.50	.28571	210	37.71	-.77	-.3360
4.00	.25000	240	37.65	-.71	-.3098
4.50	.22222	270	37.57	-.63	-.2749
5.00	.20000	300	37.57	-.63	-.2749
5.50	.18182	330	37.51	-.57	-.2487
6.00	.16667	360	37.48	-.54	-.2356
6.50	.15385	390	37.43	-.49	-.2138
7.00	.14286	420	37.41	-.47	-.2051
7.50	.13333	450	37.40	-.46	-.2007
8.00	.12500	480	37.40	-.46	-.2007
8.50	.11765	510	37.38	-.44	-.1920
9.00	.11111	540	37.38	-.44	-.1920
9.50	.10526	570	37.36	-.42	-.1833
11.00	.09091	660	37.31	-.37	-.1614
12.00	.08333	720	37.30	-.36	-.1571
13.00	.07692	780	37.29	-.35	-.1527
14.00	.07143	840	37.29	-.35	-.1527
15.00	.06667	900	37.28	-.34	-.1484
20.00	.05000	1200	37.27	-.33	-.1440
25.00	.04000	1500	37.27	-.33	-.1440
30.00	.03333	1800	37.24	-.30	-.1309
60.00	.01667	3600	37.19	-.25	-.1091
120.00	.00833	7200	37.16	-.22	-.0960
180.00	.00556	10800	37.10	-.16	-.0698
1860.00	.00054	111600	37.03	-.09	-.0393

DATA FILE NAME

UMTRA*EZPLOTH004 - CFJOHN
UMTRA*EZPLOTH005
UMTRA*EZPLOTH006
UMTRA*EZPLOTH007-CFJON1

FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

KAL
7/30/9
CAP
7/31/91

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Ha101 LOCATION ID: 909

SLUG VOLUME (ft.³): 0.05 FT³

INITIAL WATER LEVEL:

DATE: 85/7/27

TIME: 6:15P

DEPTH (ft FROM TOC): 36.37

STATIC WATER LEVEL:

DATE: 85/8/14 TIME: 2:30p

DEPTH (ft): 35.96

OPEN INTERVAL 132.0 FT to 152.0 FT

TOTAL DEPTH OF WELL (ft): 142.35

WELL DIAM. (ft): .167

OBSERVERS: Frits

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
:00	35.96			
.5	37.21			
1:00	36.93			
.5	36.75			
2.00	36.59			
.5	36.48			
3.00	36.40			
.5	36.34			
4.00	36.27			
.5	36.24			
5.00	36.20			
6.00	36.14			
7.00	36.11			
8.00	36.09			
9.00	36.08			
10.00	36.05			
12.00	36.03			
14.00	36.03			
16.00	36.01			
20.00	35.99			

COMMENTS: dropped slug 85/7/27 6:00 P
pulled slug 85/8/14 2:30p.
note: Water samplers not in Field 85/8/2 - 5/15.
page 1 of 2

7/30/4
7/31

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Hat01 LOCATION ID: 909

SLUG VOLUME (ft.^{3}): _____

INITIAL WATER LEVEL (AT t_0):

DATE: _____

TIME: _____

DEPTH (ft FROM TOC): _____

STATIC WATER LEVEL:
DATE: 85/8/14 TIME: _____

DEPTH (ft): _____

OPEN INTERVAL (ft.) _____ to _____

TOTAL DEPTH OF WELL (ft): _____

WELL DIAM. (ft): _____

FIELD REP: _____

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
24.00	35.99			
28.00	35.99			
32.00	35.98			
36.00	35.97			
40.00	35.97			
44.00	35.97			

COMMENTS: page 2 of 2

JEG-AL-ENG-8 (3/84)

KAL 7/30/91
CAP 7/31/91

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: HAT-01 LOCATION ID: 909

SLUG VOLUME (ft.^{3}): .05

INITIAL WATER LEVEL:

DATE: 85/4/10

TIME: 3:22 PM

DEPTH (ft FROM TOC): 39.58

STATIC WATER LEVEL:

DATE: 85/4/12 TIME: 10:50 AM

DEPTH (ft): 37.94

OPEN INTERVAL NOT KNOWN to NOT KNOWN

TOTAL DEPTH OF WELL (ft): 142.35

WELL DIAM. (ft): .167

OBSERVERS: R. BANSBERG

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
0.00	37.94 36.94			
:30	—			
1:00	38.46			
:30	38.19			
2:00	38.07			
:30	37.94			
3:00	37.80			
:30	37.71			
4:00	37.65			
:30	37.57			
5:00	37.57			
:30	37.51			
6:00	37.48			
:30	37.43			
7:00	37.41			
:30	37.40			
8:00	37.40			
:30	37.38			
9:00	37.38			
:30	37.36			

COMMENTS: DROPPED SLUG 85/4/11 ≈ 9:00 A.M

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

7/30/91
Cap
7/31/91

SLUG TEST DATA

ID: HAT-01 LOCATION ID: 909

UG VOLUME (ft.^{3}): CONTINUED

NITIAL WATER LEVEL:

DATE:

TIME:

DEPTH (ft FROM TOC):

STATIC WATER LEVEL:

DATE: TIME:

DEPTH (ft):

OPEN INTERVAL to

TOTAL DEPTH OF WELL (ft):

WELL DIAM. (ft):

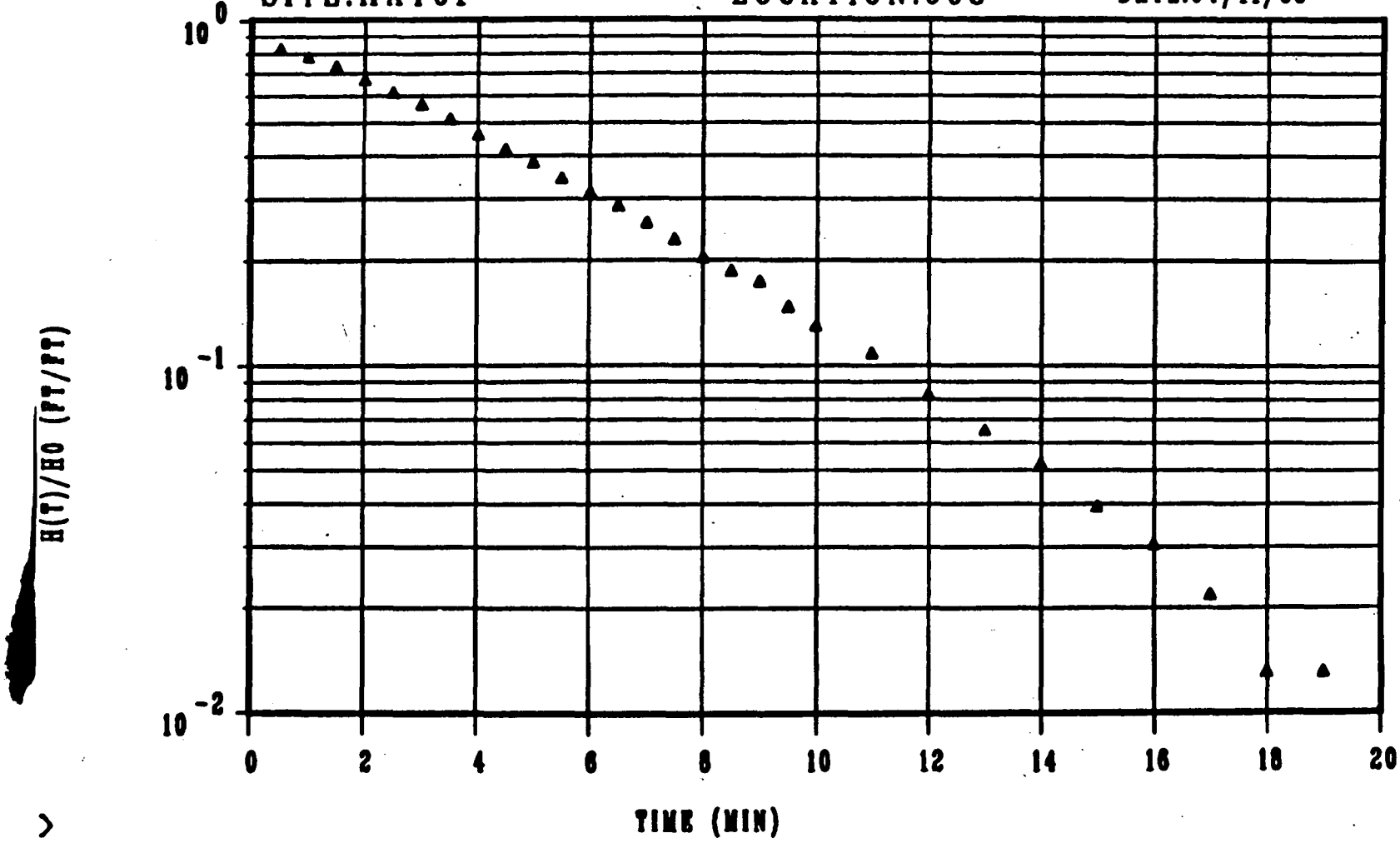
OBSERVERS:

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
11:00	37.31			
12:00	37.30			
13:00	37.29			
14:00	37.29			
15:00	37.28			
20:00	37.27			
25:00	37.27			
30:00	37.24			
35:00	—			
40:00	—			
45:00	—			
50:00	—			
55:00	—			
~~1 HOUR~~ 60	37.19			
~~2 HOUR~~ 120	37.16			
~~3 HOUR~~ 180	37.10			
~~31 HOUR~~ 1860	37.03			

COMMENTS:

HVORSLEV SLUG TEST ANALYSIS

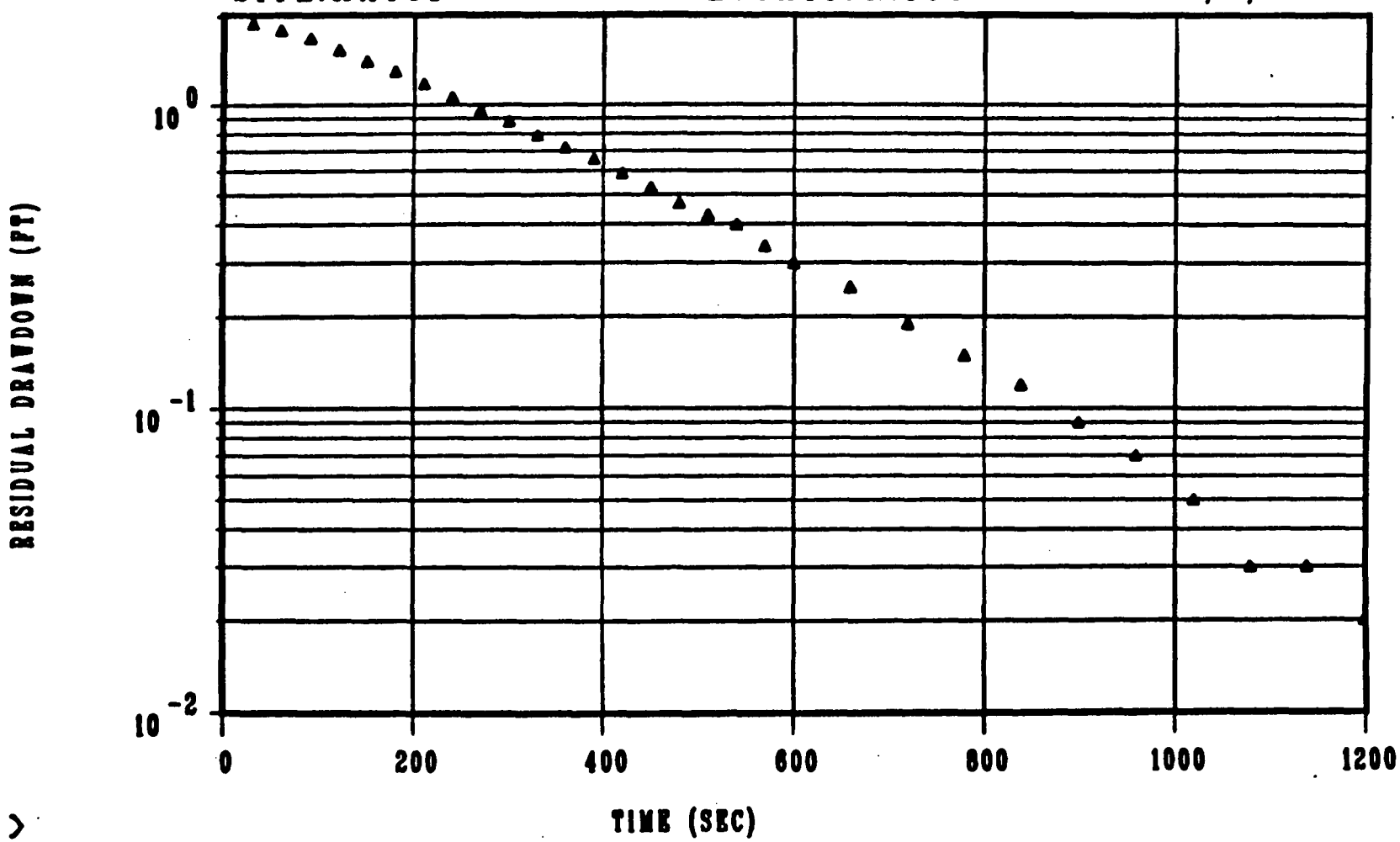
SITE:HAT01 LOCATION:908 DATE:04/11/85



KAL 7/30/91
7/31/91

BOUWER-RICE SLUG TEST ANALYSIS

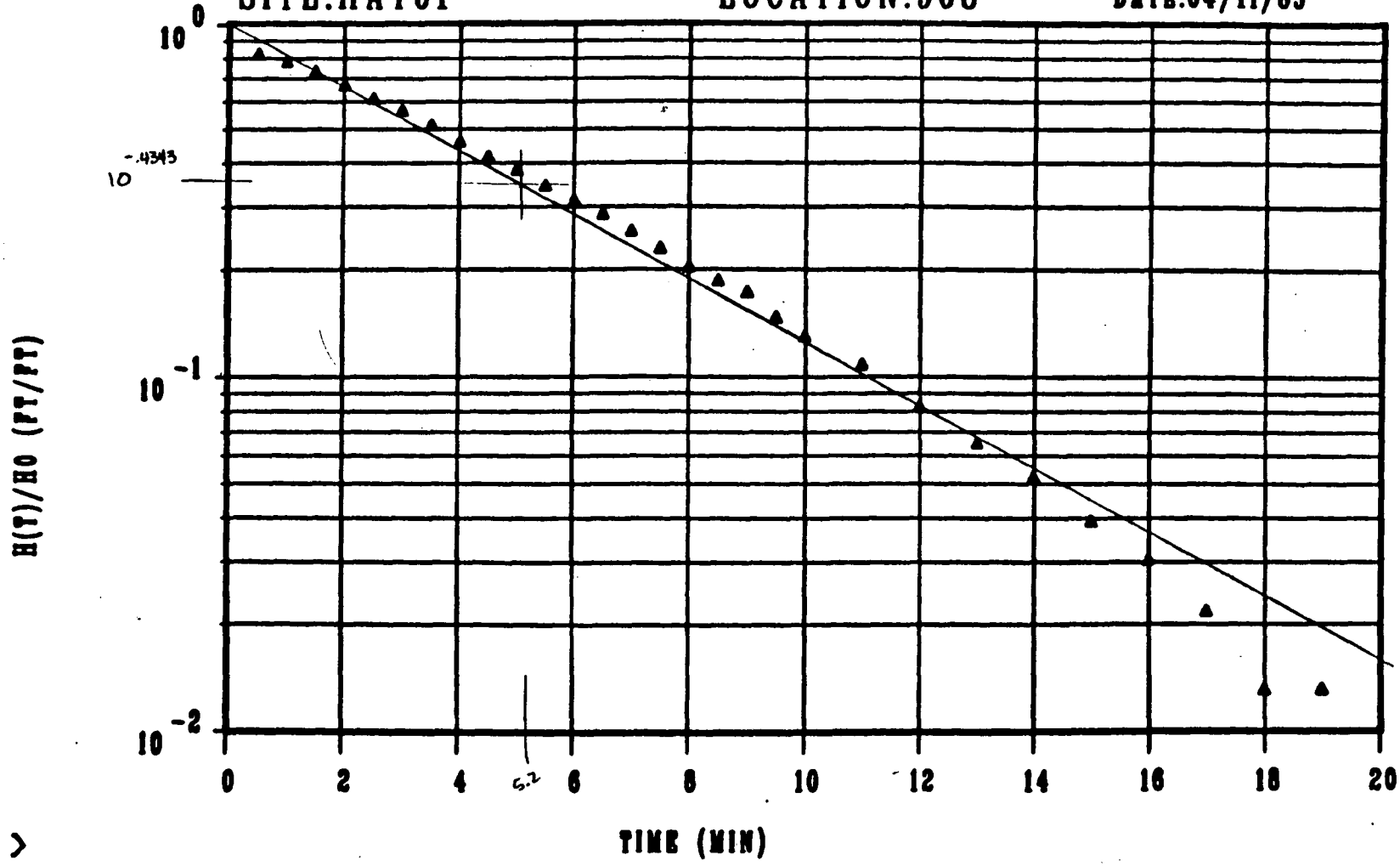
SITE:HAT01 LOCATION:908 DATE:04/11/85



7/30/9
7/31/91

HVORSLEV SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:908 DATE:04/11/85

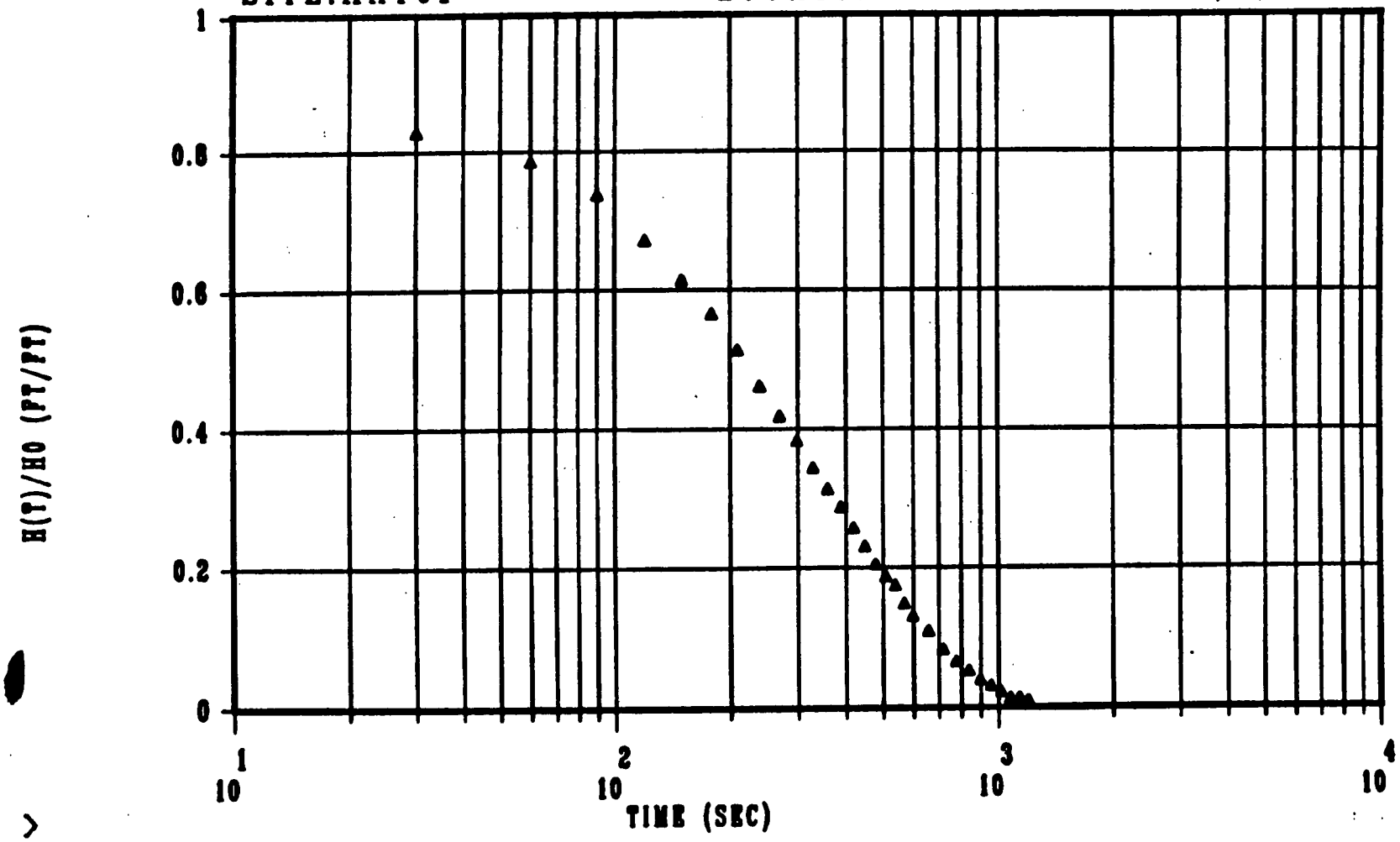


UNCONFINED

KHL 7/30/91
CGP 7/31/91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

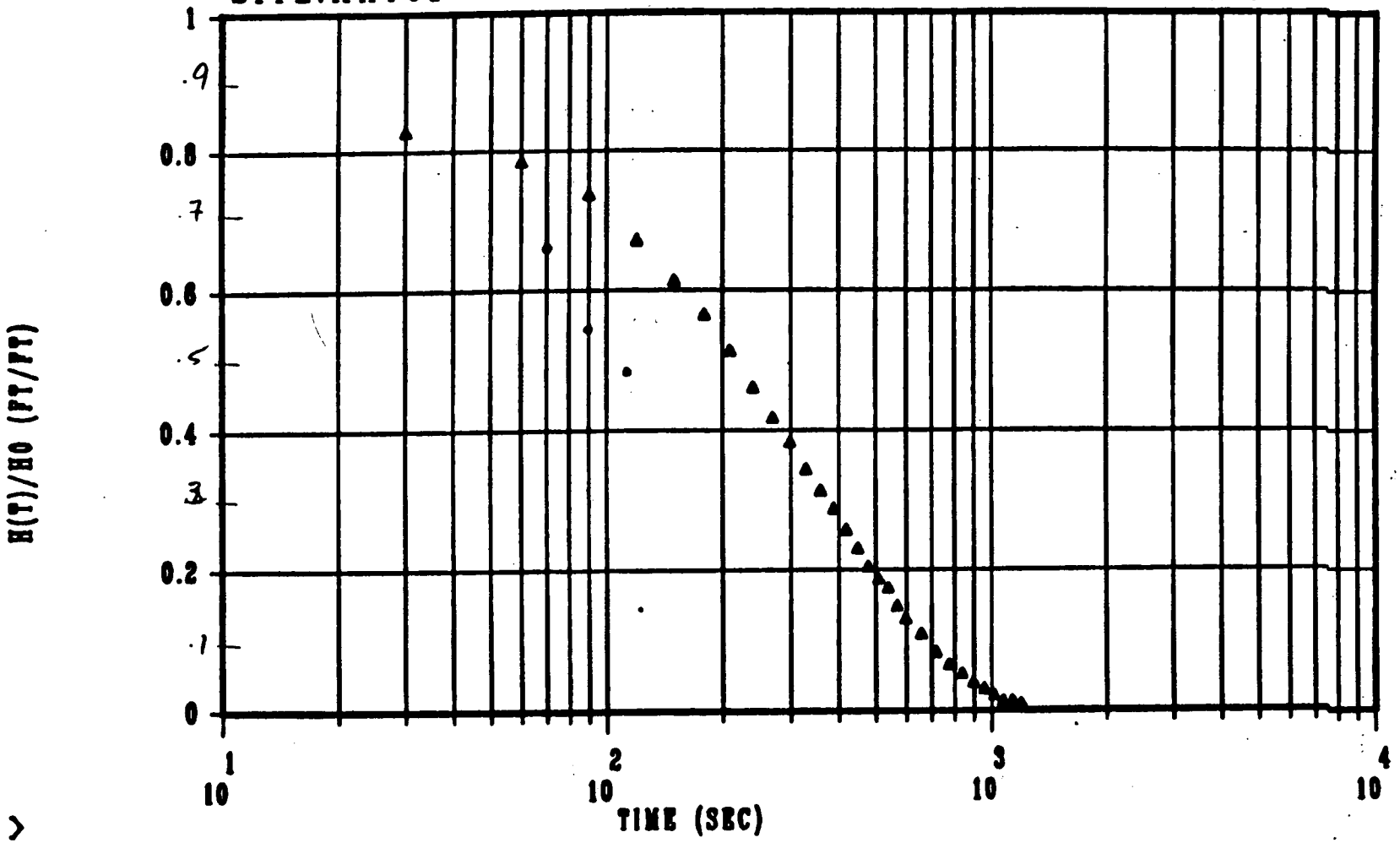
SITE:HAT01 LOCATION:908 DATE:04/11/85



7/30/91
7/31/91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:908 DATE:04/11/85

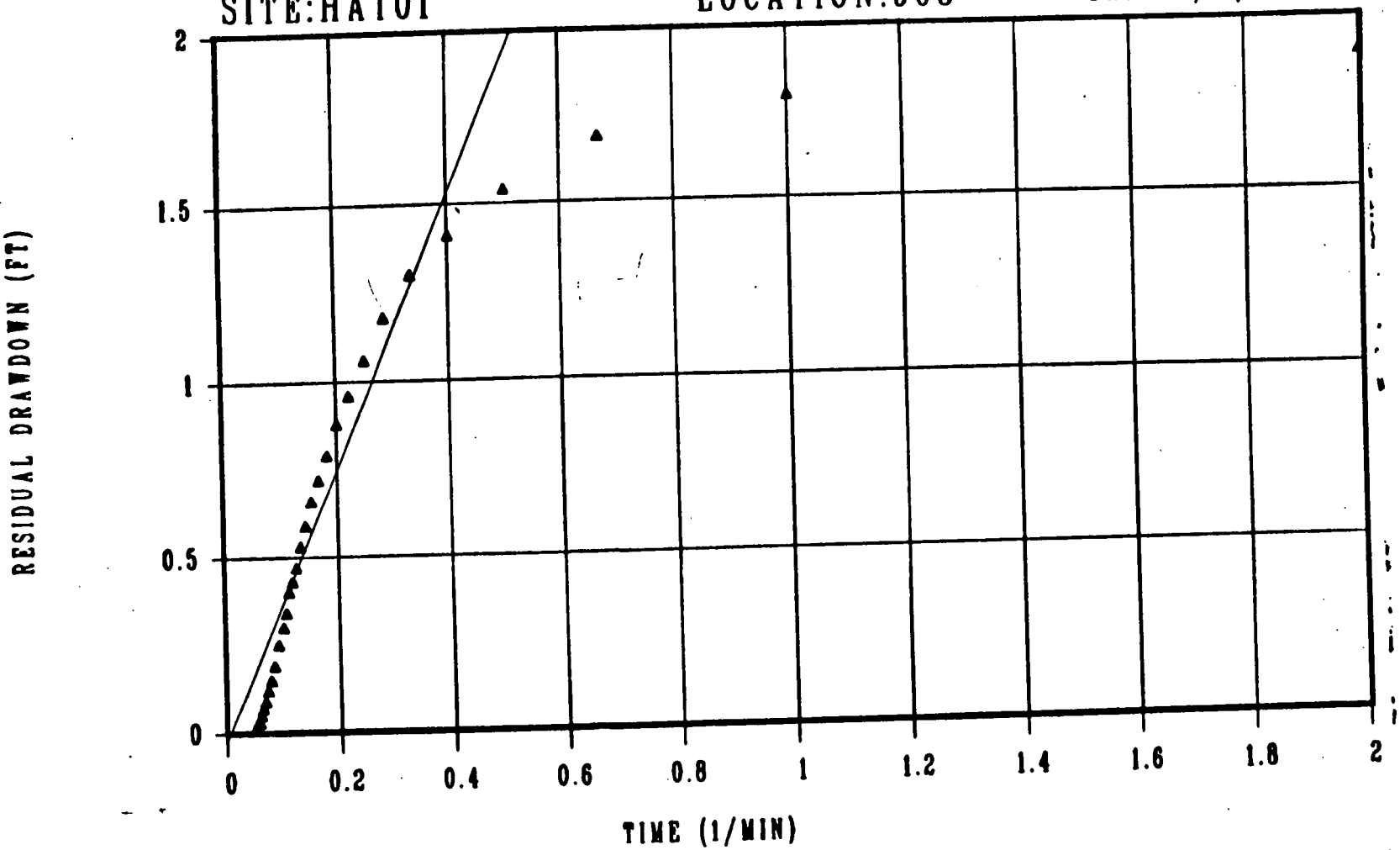


Checked by SColarullo
8/6/85

RAL 7/30/91
CAP 4/31/91

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:908 DATE:04/11/85



checked by SColarullo
8/6/85

CONFINED

7/30/91
CGO
7/31/91

KAL
7/30/91
Cap
7/31/91

SLUG TEST SOLUTIONS

$K = \frac{Q}{4\pi s L t}$

****
WELL IDENTIFICATION- HAT01-908
DATE OF FIELD TEST- 04/11/85
LENGTH OF CONTRIBUTING INTERVAL, (L)= 15 FT.
SKIBITSKE METHOD
FOR DISCHARGE(G)= .05
RESIDUAL DRAWDOWN(s')= .02 FT.
TIME TO RESIDUAL DRAWDOWN(t)= 20 min
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 6.63146E-04 FT/min = 0.96 FT/
****

✓ KAL
7/10/
✓ Cap

****
WELL IDENTIFICATION- HAT01-908
DATE OF FIELD TEST- 04/11/85
LENGTH OF CONTRIBUTING INTERVAL, (L)= 15
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(G)= .05
RECIPROCAL TIME(1/t)= .4 FT. 1/min
DRAWDOWN (s)= 1.5 FT.
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 7.07355E-05 FT/min = 0.1 FT/D
****

✓ KAL
7/10/
✓ Cap

****
WELL IDENTIFICATION- HAT01-908
DATE OF FIELD TEST- 04/11/85
LENGTH OF CONTRIBUTING INTERVAL, (L)= 15
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR: WELL RADIUS (Rc)= .084 FT.
TIME(t)= 100 sec
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 4.704E-06 FT/sec = 0.41 FT/D
****

✓ Cap
✓ KAL
7/10/9

****

7/30/91
CAP 7/31/9

SLUG TEST DATA

checked by SColarulli
8/6/85

SITE: HAT01 MEXICAN HAT
LOCATION: 908
DATE: 04/11/85

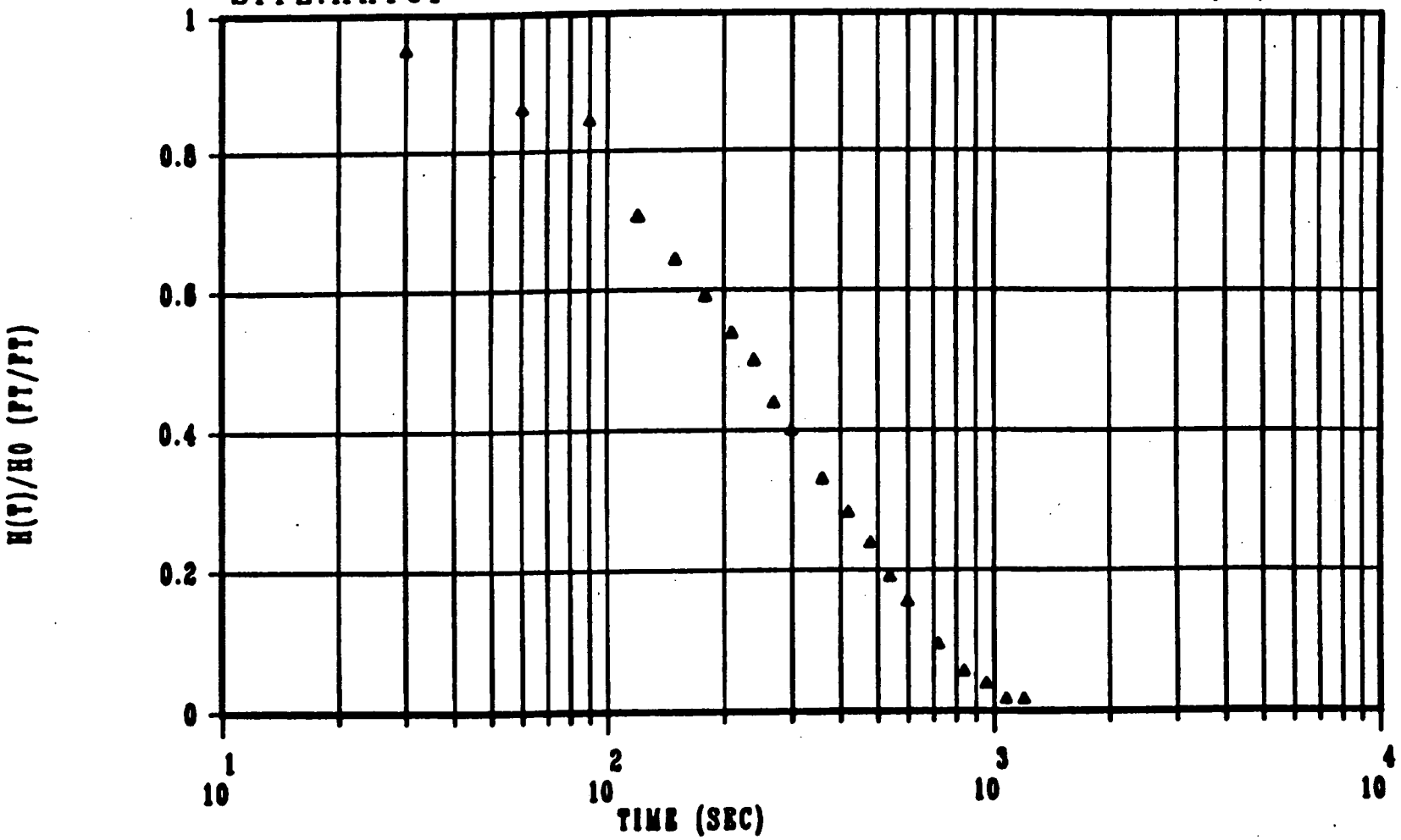
---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	50.80	.00	.0000
.50	2.00000	30	52.70	-1.90	-.8290
1.00	1.00000	60	52.60	-1.80	-.7854
1.50	.66667	90	52.49	-1.69	-.7374
2.00	.50000	120	52.34	-1.54	-.6720
2.50	.40000	150	52.21	-1.41	-.6152
3.00	.33333	180	52.10	-1.30	-.5672
3.50	.28571	210	51.98	-1.18	-.5149
4.00	.25000	240	51.86	-1.06	-.4625
4.50	.22222	270	51.76	-.96	-.4189
5.00	.20000	300	51.68	-.88	-.3840
5.50	.18182	330	51.59	-.79	-.3447
6.00	.16667	360	51.52	-.72	-.3142
6.50	.15385	390	51.46	-.66	-.2880
7.00	.14286	420	51.39	-.59	-.2574
7.50	.13333	450	51.33	-.53	-.2313
8.00	.12500	480	51.27	-.47	-.2051
8.50	.11765	510	51.23	-.43	-.1876
9.00	.11111	540	51.20	-.40	-.1745
9.50	.10526	570	51.14	-.34	-.1484
10.00	.10000	600	51.10	-.30	-.1309
11.00	.09091	660	51.05	-.25	-.1091
12.00	.08333	720	50.99	-.19	-.0829
13.00	.07692	780	50.95	-.15	-.0654
14.00	.07143	840	50.92	-.12	-.0524
15.00	.06667	900	50.89	-.09	-.0393
16.00	.06250	960	50.87	-.07	-.0305
17.00	.05882	1020	50.85	-.05	-.0218
18.00	.05556	1080	50.83	-.03	-.0131
19.00	.05263	1140	50.83	-.03	-.0131
20.00	.05000	1200	50.82	-.02	-.0087
25.00	.04000	1500	50.80	.00	.0000
30.00	.03333	1800	50.80	.00	.0000
60.00	.01667	3600	50.76	.04	.0175
120.00	.00833	7200	50.72	.08	.0349
1860.00	.00054	111600	50.73	.07	.0305

FERRIS-KNOWLES	PLOT FILE=	UMTRA*EZPLOTH100 .
HVORSLEV	PLOT FILE=	UMTRA*EZPLOTH101 .
BOWLER-RICE	PLOT FILE=	UMTRA*EZPLOTH102 .
COOPER, BREDHOEFT, PAPADOPULOS	PLOT FILE=	UMTRA*EZPLOTH103 .
@@PRNT		

KH 7/30/91
CAP 7/31/91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

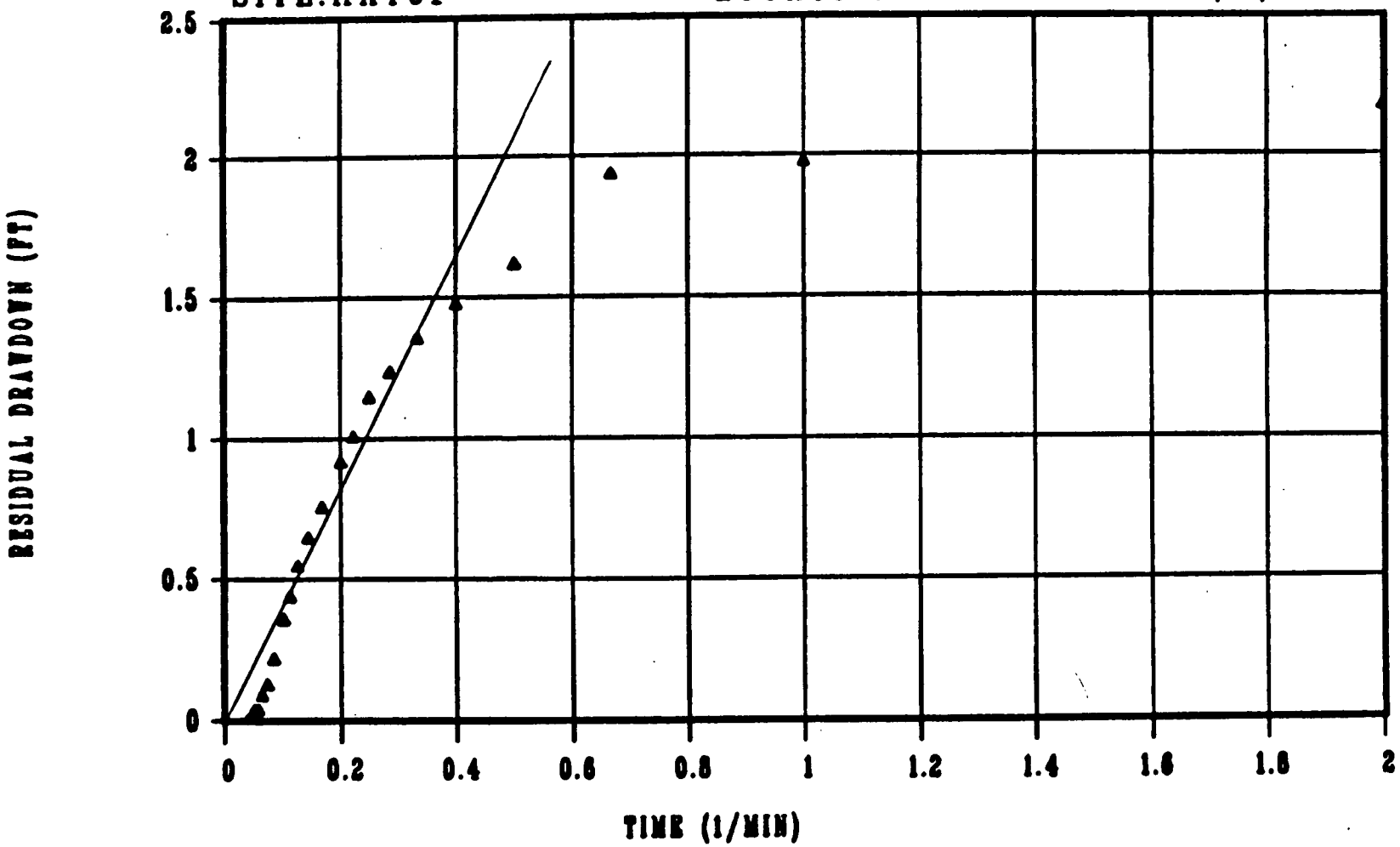
SITE:HAT01 LOCATION:908 DATE:07/31/85



KAC 7/30/91
7/31/91

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:908 DATE:07/31/85



I/SLUG TEST SOLUTIONS

7/30/91
Cap
7/31/91

$K = \frac{q}{4\pi s L t}$

```
*****************************************************************
WELL IDENTIFICATION- HAT01-908
DATE OF FIELD TEST- 07/31/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     15
SKIBITSKE METHOD
FOR DISCHARGE(Q)=   .05
RESIDUAL DRAWDOWN(s')=   .04 FT.
TIME TO RESIDUAL DRAWDOWN(t)=  20 MIN.
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.31573E-04 FT/MIN = 0.48 FT/DAY
*****************************************************************
```

✓ KAL 7/10/91
✓ Cap

```
*****************************************************************
WELL IDENTIFICATION- HAT01-908
DATE OF FIELD TEST- 07/31/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     15
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=   .05
RECIPROCAL TIME(1/t)=   .4 1/MIN
DRAWDOWN (s)=  1.6 FT
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  6.63146E-05 FT/MIN = 0.10 FT/DAY
*****************************************************************
```

✓ KAL 7/10/91
✓ Cap

```
*****************************************************************
WELL IDENTIFICATION- HAT01-908
DATE OF FIELD TEST- 07/31/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     15
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR: WELL RADIUS (Rc)=   .083 FT
TIME(t)=  100 SEC
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  4.59267E-06 FT/SEC = 0.40 FT/DAY
*****************************************************************
```

✓ KAL 7/10/91
✓ Cap

RAL
7/30/91
caf
7/31/91

SLUG TEST DATA

SITE: HAT01 MEXICAN HAT
LOCATION: 908
DATE: 07/31/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	50.94	.00	.0000
.50	2.00000	30	53.12	-2.18	-.9512
1.00	1.00000	60	52.92	-1.98	-.8639
1.50	.66667	90	52.88	-1.94	-.8465
2.00	.50000	120	52.56	-1.62	-.7069
2.50	.40000	150	52.42	-1.48	-.6458
3.00	.33333	180	52.30	-1.36	-.5934
3.50	.28571	210	52.18	-1.24	-.5411
4.00	.25000	240	52.09	-1.15	-.5018
4.50	.22222	270	51.95	-1.01	-.4407
5.00	.20000	300	51.86	-.92	-.4014
6.00	.16667	360	51.70	-.76	-.3316
7.00	.14286	420	51.59	-.65	-.2836
8.00	.12500	480	51.49	-.55	-.2400
9.00	.11111	540	51.38	-.44	-.1920
10.00	.10000	600	51.30	-.36	-.1571
12.00	.08333	720	51.16	-.22	-.0960
14.00	.07143	840	51.07	-.13	-.0567
16.00	.06250	960	51.03	-.09	-.0393
18.00	.05556	1080	50.98	-.04	-.0175
20.00	.05000	1200	50.98	-.04	-.0175
22.00	.04545	1320	50.94	.00	.0000
24.00	.04167	1440	50.94	.00	.0000
26.00	.03846	1560	50.94	.00	.0000

FERRIS-KNOWLES UMTRA*EZPLOTJD01
HVORSLEV UMTRA*EZPLOTJD02
BOWLER-RICE UMTRA*EZPLOTJD03
COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOTJD04
@@NOPR

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

7/30/9
CAP
7/31/91

SLUG TEST DATA

SITE ID: Hatal LOCATION ID: 908

SLUG VOLUME (ft.^{3}): .05 FT^3

INITIAL WATER LEVEL:

DATE: 85/7/28

TIME: 11:30 A

DEPTH (ft FROM TOC): 50.95

STATIC WATER LEVEL:

DATE: 85/7/31 TIME: 9:07 A.M.

DEPTH (ft): 50.94

OPEN INTERVAL 146 FT to 161 FT

TOTAL DEPTH OF WELL (ft): 164.20

WELL DIAM. (ft): .167

OBSERVERS: Fritts / Scarafiotti

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
Initial 0	50.94			
.5	53.12			
1:00	52.92			
.5	52.88			
2:00	52.56			
.5	52.42			
3:00	52.30			
.5	52.18			
4:00	52.09			
.5	51.95			
5:00	51.86			
6:00	51.70			
7:00	51.59			
8:00	51.49			
9:00	51.38			
10:00	51.30			
12:00	51.16			
14:00	51.07			
16:00	51.03			
18:00	50.98			

COMMENTS: dropped slug ~~[illegible]~~ 85/7/29
pulled slug 85/7/30, 9:07 A.M.

KAL 7/30/91
CEP 7/31/91

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Hat 01 LOCATION ID: 908

STATIC WATER LEVEL:
DATE: 85/7/31 TIME:

SLUG VOLUME (ft.^{3}):

DEPTH (ft):

INITIAL WATER LEVEL:

OPEN INTERVAL _____ to _____

DATE:

TOTAL DEPTH OF WELL (ft):

TIME:

WELL DIAM. (ft):

DEPTH (ft FROM TOC):

OBSERVERS:

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
20:00	50.98			
22:00	50.94			
24:00	50.94			
26:00	50.94			

COMMENTS:

page 2 of 2

MAY 30 1985
MAY 29 1985

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

KAL 7/30/91
CAP 7/31/91

SLUG TEST DATA

SITE ID: HAT-01 LOCATION ID: 908

SLUG VOLUME (ft.^{3}): 0.05 ft^3

INITIAL WATER LEVEL:

DATE: 85/4/11

TIME: 11:00 A.M

DEPTH (ft FROM TOC): 51.15

STATIC WATER LEVEL:

DATE: 85/4/17 TIME: 12:07 PM

DEPTH (ft): 50.80

OPEN INTERVAL NOT KNOWN to NOT KNOWN

TOTAL DEPTH OF WELL (ft): 164.20

WELL DIAM. (ft): .167

OBSERVERS: R. RANSBERG

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
0:00	50.80	0		
:30	52.70	1.90		
1:00	52.60	1.80		
:30	52.49	1.69		
2:00	52.34	1.54		
:30	52.21	1.41		
3:00	52.10	1.30		
:30	51.98	1.18		
4:00	51.86	1.06		
:30	51.76	0.96		
5:00	51.68	0.88		
:30	51.59	0.79		
6:00	51.52	0.72		
:30	51.46	0.66		
7:00	51.39	0.59		
:30	51.33	0.53		
8:00	51:27	0.47		
:30	51.23	0.43		
9:00	51.20	0.40		
:30	51.14	0.34		

COMMENTS: DROPPED SLUG 85/4/12 ≈ 9:00 A.M

RAC 7/30/91. Cef 7/31/91.

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: HA7-01 LOCATION ID: 908

SLUG VOLUME (ft.^{3}): CONTINUED

INITIAL WATER LEVEL:

DATE:

TIME:

DEPTH (ft FROM TOC):

STATIC WATER LEVEL:

DATE: TIME:

DEPTH (ft):

OPEN INTERVAL to

TOTAL DEPTH OF WELL (ft):

WELL DIAM. (ft):

OBSERVERS:

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
10:00	51.10	0.30		
11:00	51.05	0.25		
12:00	50.99	0.19		
13:00	50.95	0.15		
14:00	50.92	0.12		
15:00	50.89	0.09		
16:00	50.87	0.07		
17:00	50.85	0.05		
18:00	50.83	0.03		
19:00	50.83	0.03		
20:00	50.82	0.02		
25:00	50.80	0.00		
50:00	50.80	0.00		
~~1 HOUR~~ 60	50.76	+0.04		
~~2 HOUR~~ 120	50.72	+0.08		
~~31 HOURS~~ 1860	50.73	+0.07		

COMMENTS:

KHL 52
7/30/91
CAP
7/31/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-934
DATE OF FIELD TEST- 11/01/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
SKIBITSKE METHOD
FOR DISCHARGE(Q)=  .217
RESIDUAL DRAWDOWN(s')=  2.11
TIME TO RESIDUAL DRAWDOWN(t)=  2
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  8.09202E-04 FT/MIN = 5.9×10^-1 FT/DAY
*****************************************************************
```

early-time data

✓ CAP 6/24/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-934
DATE OF FIELD TEST- 11/01/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
FERRIS-KNOWLES METHOD
FOR DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .01
DRAWDOWN (s)=  1.5
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.15122E-05 FT/MIN = 1.7×10^-2 FT/DAY
*****************************************************************
```

✓ CAP 6/24/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-934
DATE OF FIELD TEST- 11/01/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR WELL RADIUS (Rc)=  .167
TIME(t)=  30
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  9.29633E-05 FT/SEC = 8.0 FT/DAY
*****************************************************************
```

probably invalid

```
*****************************************************************
WELL IDENTIFICATION- HAT01-935
DATE OF FIELD TEST- 11/01/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
SKIBITSKE METHOD
FOR DISCHARGE(Q)=  .217
RESIDUAL DRAWDOWN(s')=  1.04
TIME TO RESIDUAL DRAWDOWN(t)=  240
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 16.9184E-06 FT/MIN  1.0×10^-2 FT/DAY
*****************************************************************
```

late-time data

✓ CAP 6/24/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-935
DATE OF FIELD TEST- 11/01/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
SKIBITSKE METHOD
FOR DISCHARGE(Q)=  .217
RESIDUAL DRAWDOWN(s')=  1.2
TIME TO RESIDUAL DRAWDOWN(t)=  3.5
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 4.1115E-04 FT/MIN = 5.9x10^-1 FT/DAY
*****************************************************************
```

early-time data

KAC 7/30/91

CAP 7/31/91

✓

CAP 6/24/91

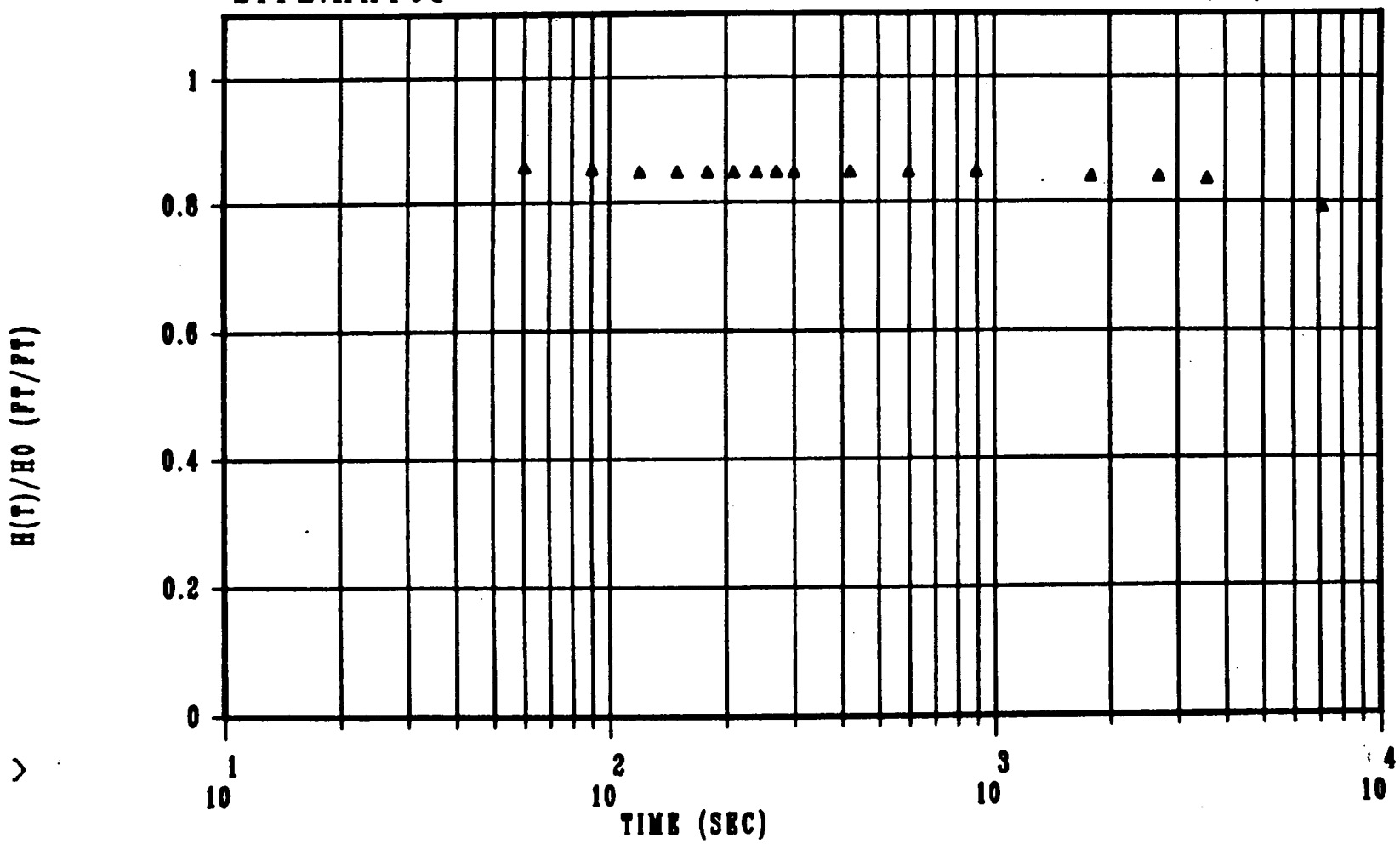
```
*****************************************************************
WELL IDENTIFICATION- HAT01-935
DATE OF FIELD TEST- 11/01/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .01
DRAWDOWN (s)=  2
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  8.63416E-06 FT/MIN= 1.2x10^-2 FT/DAY
*****************************************************************
```

✓

CAP 6/24/91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:935 DATE:11/02/85



KAL 7/30/91

9/31/91

SLUG TEST SOLUTIONS

KAL 7/30/91
CAP 7/31/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-930
DATE OF FIELD TEST- 10/30/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
SKIBITSKE METHOD
FOR DISCHARGE(Q)=  .217
RESIDUAL DRAWDOWN(s')=  .41
TIME TO RESIDUAL DRAWDOWN(t)=  90
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  4.67976E-05 FT/MIN = 6.7x10^-2 FT/DAY
*****************************************************************
```

CAP 6/24/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-930
DATE OF FIELD TEST- 10/30/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
FERRIS-KNOWLES METHOD
FOR DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .1
DRAWDOWN (s)=  1.3
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.32833E-04 FT/MIN = 1.9x10^-1 FT/DAY
*****************************************************************
```

CAP 6/24/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-930
DATE OF FIELD TEST- 10/30/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR WELL RADIUS (Rc)=  .167
TIME(t)=  20
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.39445E-04 FT/SEC = 12.5 FT/DAY
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- HAT01-934
DATE OF FIELD TEST- 11/01/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     10
SKIBITSKE METHOD
FOR DISCHARGE(Q)=  .217
RESIDUAL DRAWDOWN(s')=  1.83
TIME TO RESIDUAL DRAWDOWN(t)=  180
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  5.24235E-06 FT/MIN = 7.6x10^-3 FT/DAY
*****************************************************************
```

late-time data

CAP 6/24/91

RAC
7/30/91
CAP 7/31/91

SLUG TEST DATA

SITE: HAT04 MEXICAN HAT
LOCATION: 935
DATE: 11/02/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HET]/H0 [FT./FT.]
.00	.00000	0	173.35	.00	.0000
1.00	1.00000	60	175.48	-2.13	-.8566
1.50	.66667	90	175.47	-2.12	-.8526
2.00	.50000	120	175.46	-2.11	-.8485
2.50	.40000	150	175.46	-2.11	-.8485
3.00	.33333	180	175.46	-2.11	-.8485
3.50	.28571	210	175.46	-2.11	-.8485
4.00	.25000	240	175.46	-2.11	-.8485
4.50	.22222	270	175.46	-2.11	-.8485
5.00	.20000	300	175.46	-2.11	-.8485
7.00	.14286	420	175.46	-2.11	-.8485
10.00	.10000	600	175.46	-2.11	-.8485
15.00	.06667	900	175.46	-2.11	-.8485
30.00	.03333	1800	175.44	-2.09	-.8405
45.00	.02222	2700	175.44	-2.09	-.8405
60.00	.01667	3600	175.43	-2.08	-.8365
120.00	.00833	7200	175.32	-1.97	-.7922
180.00	.00556	10800	175.18	-1.83	-.7359

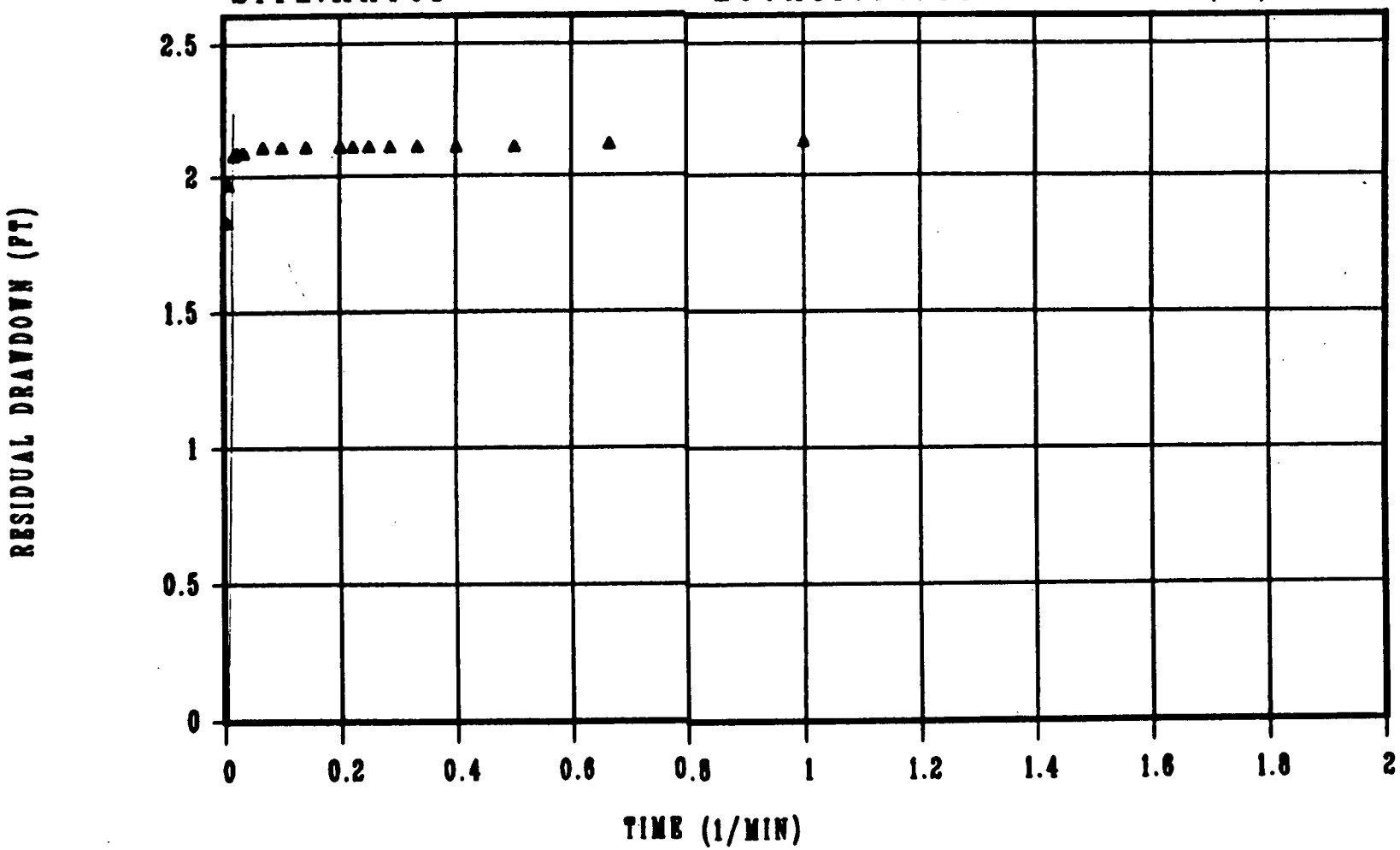
FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

UMTRA*EZPLOTJ008
UMTRA*EZPLOTJ009
UMTRA*EZPLOTJ010
UMTRA*EZPLOTJ011

c/01

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:935 DATE:11/02/85

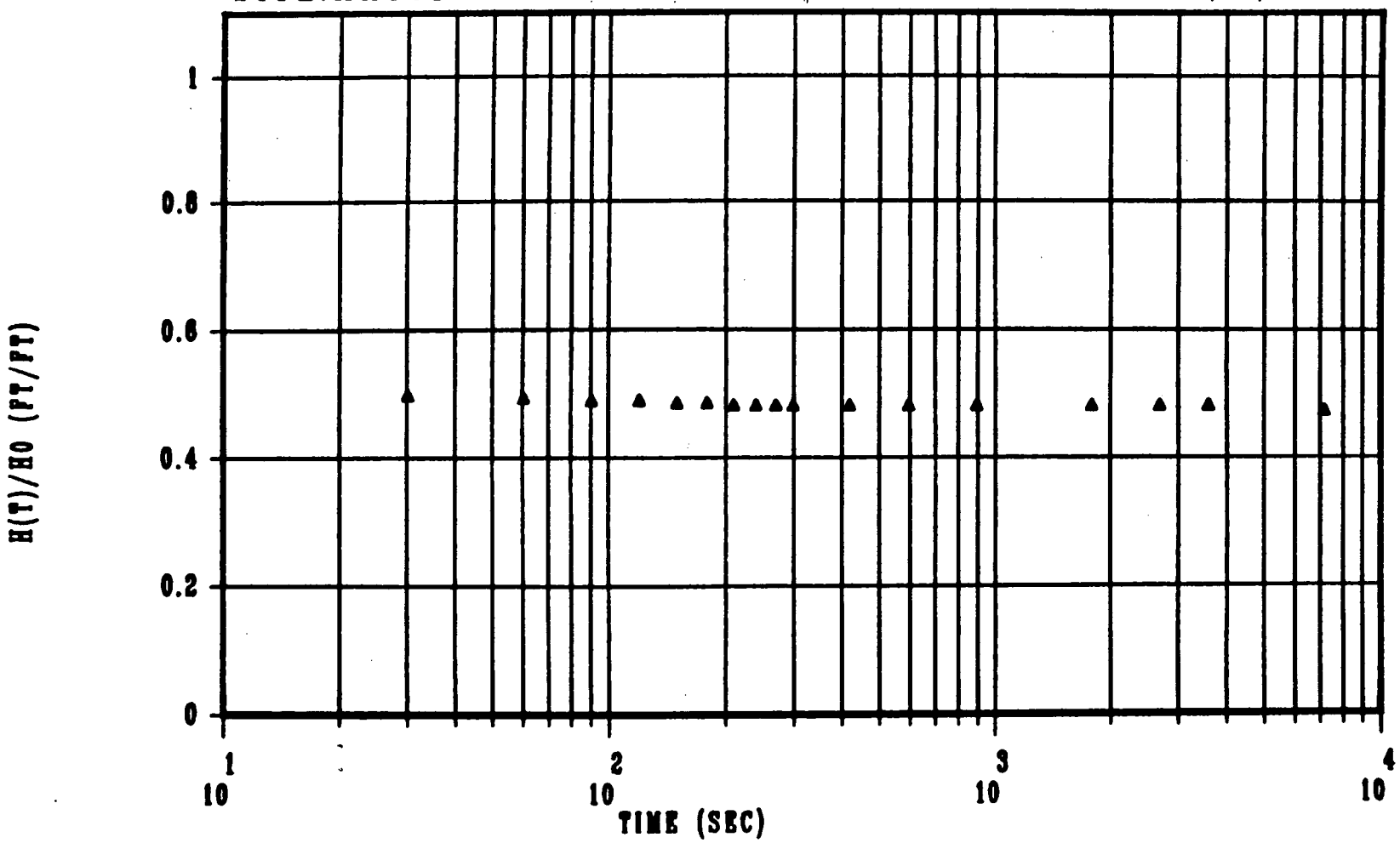


7/30/91

7/31/91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:934 DATE:11/02/85



NRC
7/30/91
Cop
7/31/91

7/30/91

Cap 7/3

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

NOV 26 1985

SLUG TEST DATA

SITE ID: HAT LOCATION ID: 935

SLUG VOLUME (ft.3): .217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/11/1

TIME: 1:10 p

DEPTH (ft FROM TOC): 179.96

STATIC WATER LEVEL:
DATE: 85/11/2 TIME: 240p

DEPTH (ft): 173.35

OPEN INTERVAL (ft.) 170.0 to 187.04

TOTAL DEPTH OF WELL (ft): 189.04

WELL DIAM. (ft): 0.333

FIELD REP: Ed Mignardot / W. Corder

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:0	173.35			
1:00	175.48			
:50	175.47			
2:00	175.46			
:50	175.46			
3:00	175.46			
:50	175.46			
4:00	175.46			
:50	175.46			
5:00	175.46			
7:00	175.46			
10:00	175.46			
15:00	175.46			
30:00	175.44			
45:00	175.44			
60:00	175.43			
120:00	175.32			
180:000	175.18			
	173.35			
	1.83			

COMMENTS: Dropped slug @ 1:10 p, 85/11/1
Pulled slug @ 2:40 p, 85/11/4

JEG-AL-ENG-8 (3/84)

KAL
7/30/91
Cap
7/31/91

SLUG TEST DATA

SITE: HAT01 MEXICAN HAT
LOCATION: 934
DATE: 11/02/85

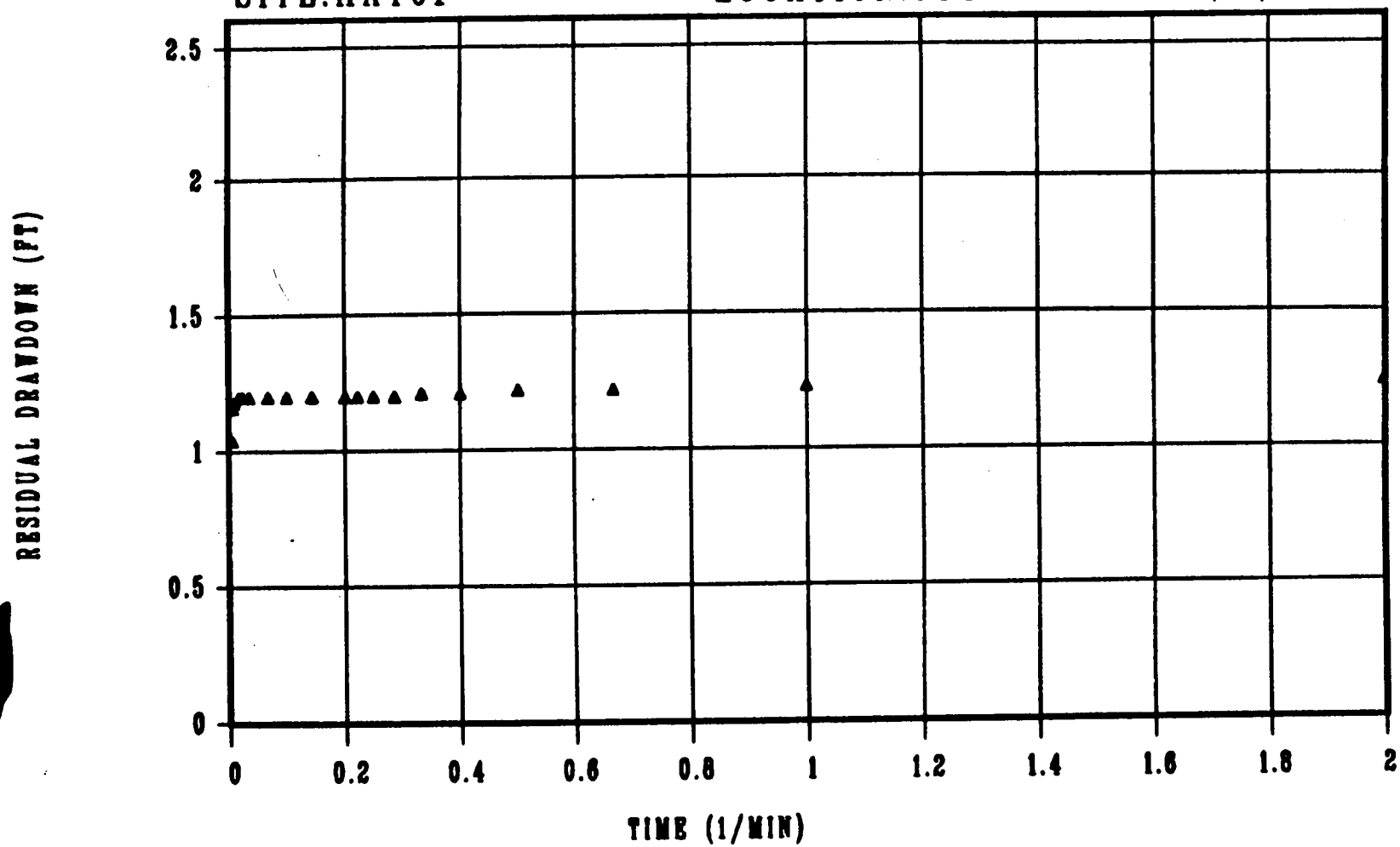
---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HET]/H0 [FT./FT.]
.00	.00000	0	194.16	.00	.0000
.50	2.00000	30	195.40	-1.24	-.4987
1.00	1.00000	60	195.39	-1.23	-.4946
1.50	.66667	90	195.38	-1.22	-.4906
2.00	.50000	120	195.38	-1.22	-.4906
2.50	.40000	150	195.37	-1.21	-.4866
3.00	.33333	180	195.37	-1.21	-.4866
3.50	.28571	210	195.36	-1.20	-.4826
4.00	.25000	240	195.36	-1.20	-.4826
4.50	.22222	270	195.36	-1.20	-.4826
5.00	.20000	300	195.36	-1.20	-.4826
7.00	.14286	420	195.36	-1.20	-.4826
10.00	.10000	600	195.36	-1.20	-.4826
15.00	.06667	900	195.36	-1.20	-.4826
30.00	.03333	1800	195.36	-1.20	-.4826
45.00	.02222	2700	195.36	-1.20	-.4826
60.00	.01667	3600	195.36	-1.20	-.4826
120.00	.00833	7200	195.34	-1.18	-.4745
180.00	.00556	10800	195.32	-1.16	-.4665
240.00	.00417	14400	195.20	-1.04	-.4182

FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
QQNOPR

UMTRA*EZPLOTJ004
UMTRA*EZPLOTJ005
UMTRA*EZPLOTJ006
UMTRA*EZPLOTJ007

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:934 DATE:11/02/85

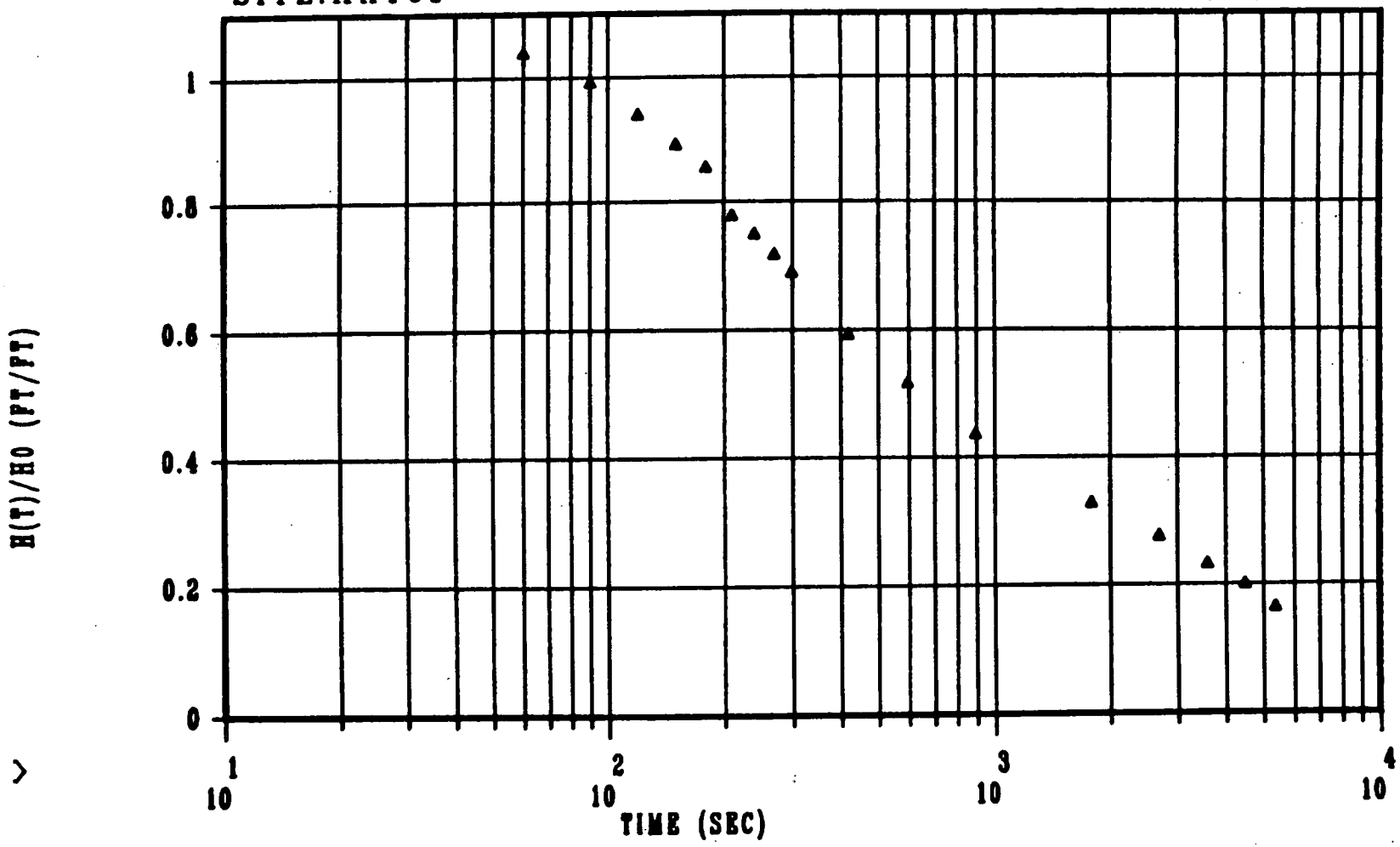


12/4/85

KHL 7/30/91
7/31/91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:930 DATE:11/02/85



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7/30/91
Cap 7/31/

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: HAT-01 LOCATION ID: 934

SLUG VOLUME (ft.^{3}): .217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/11/1

TIME: 5:17p

DEPTH (ft FROM TOC): 194.04

STATIC WATER LEVEL:

DATE: 85/11/2 TIME: 1:30p

DEPTH (ft): 194.16

OPEN INTERVAL (ft.) 142.52 to 196.52

TOTAL DEPTH OF WELL (ft): 198.52

WELL DIAM. (ft): 0.333

FIELD REP: E. Mignardot / W. Corder

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	194.16			
:50	195.40			
1:00	195.39			
:50	195.38			
2:00	195.38			
:50	195.37			
3:00	195.37			
:50	195.36			
4:00	195.36			
:50	195.36			
5:00	195.36			
7:00	195.36			
10:00	195.36			
15:00	195.36			
30:00	195.36			
45:00	195.36			
60:00	195.36			
120:00	195:34			
180:00	195:32			
240:00	195.20			

COMMENTS: Dropped slug @ 5:17p, 85/11/1
Pulled slug @ 1:30p, 85/11/4

JEG-AL-ENG-8 (3/84)

KAL
7/30/91
CBP
7/31/91

SLUG TEST DATA

SITE: HAT01 MEXICAN HAT
LOCATION: 930
DATE: 10/31/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT]/HO [FT./FT.]
.00	.00000	0	56.80	.00	.0000
1.00	1.00000	60	59.39	-2.59	-1.0416
1.50	.66667	90	59.27	-2.47	-.9933
2.00	.50000	120	59.14	-2.34	-.9410
2.50	.40000	150	59.02	-2.22	-.8928
3.00	.33333	180	58.93	-2.13	-.8566
3.50	.28571	210	58.74	-1.94	-.7802
4.00	.25000	240	58.67	-1.87	-.7520
4.50	.22222	270	58.59	-1.79	-.7198
5.00	.20000	300	58.52	-1.72	-.6917
7.00	.14286	420	58.28	-1.48	-.5952
10.00	.10000	600	58.09	-1.29	-.5188
15.00	.06667	900	57.89	-1.09	-.4383
30.00	.03333	1800	57.62	-.82	-.3298
45.00	.02222	2700	57.49	-.69	-.2775
60.00	.01667	3600	57.38	-.58	-.2332
75.00	.01333	4500	57.30	-.50	-.2011
90.00	.01111	5400	57.21	-.41	-.1649

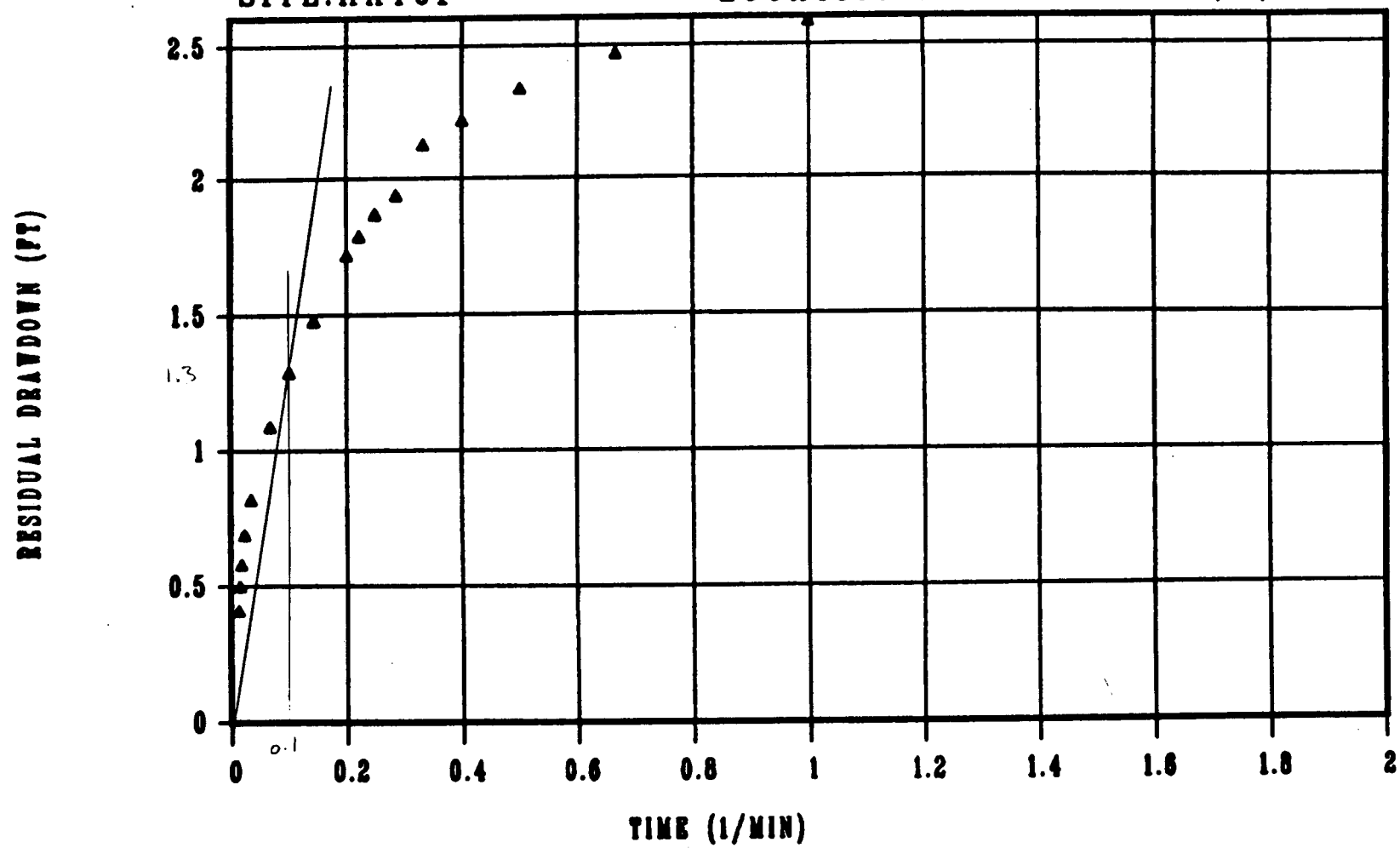
[FERRIS-KNOWLES UMTRA*EZPLOTJ000
[HVORSLEV UMTRA*EZPLOTJ001
[BOWLER-RICE UMTRA*EZPLOTJ002
[COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOTJ003
_@NOPR

CFJOHN F-K
CFJOH1 CBP

KAL 7/30/91
CAP 7/31/91

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:930 DATE:10/31/85



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JACOBS ENGINEERING

KAL
7/30/91

DATE _____ SUBJECT

SHEET NO. Cap

BY _____ CHKD. _____

JOB NO. 7/31/91

ATTACHMENT 3

SLUG TEST FIELD DATA FORMS

DATA PLOTS

COMPUTED SOLUTIONS

FORM 91-005-1 (4/81)

KAL 7/30/91

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

Cap NOV 7/31/91

SLUG TEST DATA

SITE ID: HAT-01 LOCATION ID: 930

SLUG VOLUME (ft.3): .217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/30

TIME: 6:00p

DEPTH (ft FROM TOC): 54.49

STATIC WATER LEVEL:

DATE: 85/10/31 TIME: 3:00p

DEPTH (ft): 56.80

OPEN INTERVAL (ft.) 105.53 to 115.

TOTAL DEPTH OF WELL (ft): 117.53

WELL DIAM. (ft): Ø333

FIELD REP: E. Mignardot

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H}{H-}$
:0	56.80	—	—	
1:00	59.39 2.59	2.59	1	
:50	59.27	2.47	0.67	
2:00	59.14	2.34	0.50	
:50	59.02	2.22	0.40	
3:00	58.93	2.13	0.33	
:50	58.74	1.94	0.29	
4:00	58.67	1.87	0.25	
:50	58.59	1.79	0.22	
5:00	58.52	1.72	0.20	
7:00	58.28	1.48	0.14	
10:00	58.09	1.29	0.10	
15:00	57.89	1.09	0.07	
30:00	57.62	0.82	0.03	
45:00	57.49	0.69	0.02	
60:00	57.38	0.58	0.016	
75:00	57.30	0.50	0.013	
90:00	57.21	0.41	0.011	
	-56.80			

COMMENTS: Dropped slug @ 6:00p, 85/10/30
Pulled slug @ 3:00p, 85/10/31
Check Static @ 12:00a 85/11/4 = 54.87 ft

JEG-AL-ENG-8 (3/84)

KAL 8/1/91 18 cmp 8/1/91

Data required for computing the permeability may not be available until the hole has encountered the water table or a relatively impermeable bed. The required data for each test include:

1. Radius r of the hole, in feet.
2. Length of test section A, the distance between the packer and the bottom of the hole, method 1, or between the packers, method 2, in feet.
3. Depth h_1 from pressure gage to bottom of the hole, method 1, or from gage to upper surface of lower packer in method 2, in feet. If a pressure sensor is used, substitute the pressure recorded in test section prior to pumping for the h_1 value.
4. Applied pressure h_2 at the gage, in feet, or the pressure recorded during pumping in test section if a sensor is used.
5. Steady flow Q into well at 5-minute intervals, in ft^3/s.
6. Nominal diameter in inches and length of intake pipe in feet between the gage and upper packer.
7. Thickness U of unsaturated material above water table, in feet.
8. Thickness S of saturated material above a relatively impermeable bed, in feet.
9. Distance D from the ground surface to the bottom of the test section, in feet.
10. The time that the test is started and time measurements are made.
11. If tests are made in streambeds or lakebeds below water, the effective head is the difference in feet between the elevation of the free water surface in the pipe and the elevation of the gage plus the applied pressure.
12. If a pressure sensor is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using methods 1 and 2 in the different zones shown on figure 10–5. Figure 10–6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

PRESSURE PERMEABILITY TESTS
EXAMPLES OF METHODS 1 AND 2

Example 1:

Zone 1—Method 1

Given: $U=75$ ft, $D=25$ ft, $A=10$ ft, $r=0.5$ ft,
$h_1=32$ ft, $h_2=25$ lb/in$^2=57.8$ ft, and
$Q=20$ gal/min$=0.045$ ft^3/s.

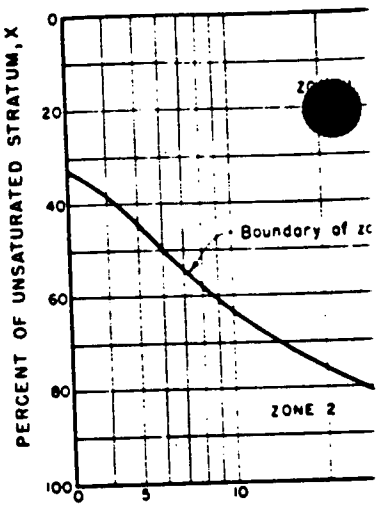


FIGURE 10–6.—Location of zon materials [4].

From figure 10–4: Head los 0.76 foot per 10-foot section. the bottom of the pipe is 22

$H=h_1+h_2-L=32+57.8-1$
$T_u=U-D+H=75-25+58$

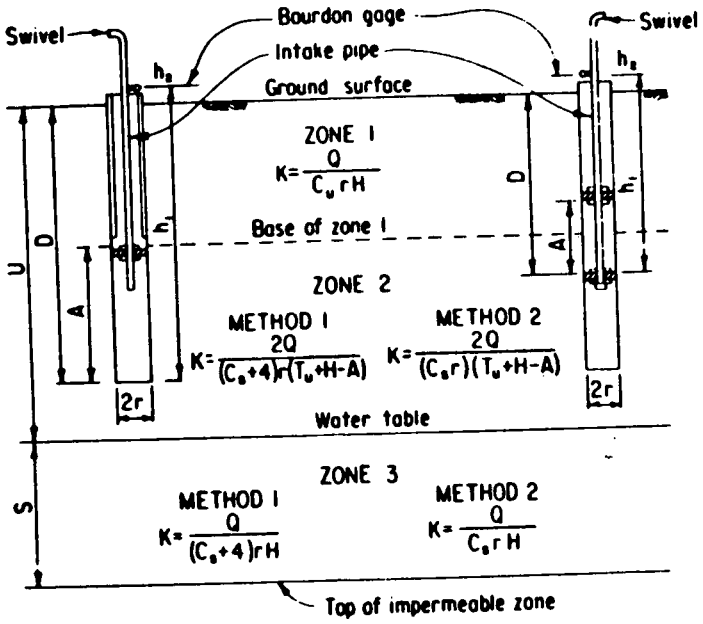
$X=\frac{H}{T_u}(100)=$

The values for X and $\frac{T_u}{A}$ li conductivity coefficient C_u f

$\frac{A}{H}=\frac{10}{88}$

Then,

$K=\frac{Q}{C_u r H}$ (



K = coefficient of permeability, feet per second under a unit gradient
Q = steady flow into well, ft^3/s
$H = h_1 + h_s - L$ = effective head, ft
h_1 (above water table) = distance between Bourdon gage and bottom of hole for method 1 or distance between gage and upper surface of lower packer for method 2, ft
h_1 (below water table) = distance between gage and water table, ft
h_s = applied pressure at gage, 1 lb/in^2 = 2.307 ft of water
L = head loss in pipe due to friction, ft; ignore head loss for Q<4 gal/min in $1\frac{1}{4}$-inch pipe; use length of pipe between gage and top of test section for computations
$X = \frac{H}{T}(100)$ = percent of unsaturated stratum
A = length of test section, ft
r = radius of test hole, ft
C_u = conductivity coefficient for unsaturated materials with partially penetrating cylindrical test wells
C_s = conductivity coefficient for semi-spherical flow in saturated materials through partially penetrating cylindrical test wells
U = thickness of unsaturated material, ft
S = thickness of saturated material, ft
$T_u = U - D + H$ = distance from water surface in well to water table, ft
D = distance from ground surface to bottom of test section, ft
a = surface area of test section, ft^2; area of wall plus area of bottom for method 1; area of wall for method 2

Limitations:
$Q/a \leq 0.10$, $S \geq 5A$, $A \geq 10r$, thickness of each packer must be $\geq 10r$ in method 2

FIGURE 10-5.—Permeability test for use in saturated or unsaturated consolidated rock [4]. 103-D-1474.

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TABLE 10-2.—*Conversion of hydrostatic pressures in pounds per square inch to heads of water in feet.* 103-D-1487.

POUNDS PER SQ INCH	ADDITIONAL UNITS									
	0	1	2	3	4	5	6	7	8	9
0	——	2 31	4 62	6 93	9 24	11 55	13 86	16 17	18 48	20.79
10	23 10	25 41	27 72	30 03	32 34	34 65	36 96	39 27	41.58	43.89
20	46 20	48 51	50 82	53 13	55 44	57 75	60 06	62 37	64 68	66.99
30	69 30	71 61	73 92	76 23	78 54	80 85	83 16	85 47	87 78	90.09
40	92 40	94 71	97 02	99 33	101 64	103 95	106 26	108 57	110.88	113.19
50	115 50	117 81	120 12	122 43	124 74	127 05	129 36	131 67	133 98	136.29
60	138 60	140 91	143 22	145 53	147 84	150 15	152 46	154 77	157.08	159.39
70	161.70	164 01	166 32	168 63	170 94	173 25	175 56	177 87	180.18	182.49
80	184 80	187 11	189 42	191 73	194 04	196 35	198 66	200 97	203 28	205.59
90	207 90	210 21	212 52	214.83	217 14	219 45	221 76	224 07	226 38	228 69
100	231 00	233 31	235 62	237 93	240 24	242 55	244 86	247 17	249.48	251.79
110	254 10	256 41	258 72	261 03	263 34	265 65	267 96	270 27	272.58	274 89
120	277 20	279 51	281 82	284 13	286 44	288 75	291 06	293 37	295 68	297 99
130	300 30	302 61	304 92	307 23	309 54	311 85	314 16	316 47	318 78	321 09
140	323 40	325 71	328 02	330 33	332 64	334 95	337 26	339 57	341 88	344 19
150	346 50	348 81	351 12	353 43	355 74	358 05	360 36	362 67	364 98	367.29
160	369.60	371 91	374 22	376 53	378 84	381 15	383 46	385 77	388 08	390 39
170	392.70	395.01	397 32	399.63	401 94	404 25	406 56	408 87	411 18	413 49
180	415.80	418 11	420 42	422 73	425 04	427 35	429 66	431 97	434 28	436 59
190	438 90	441 21	443 52	445 83	448 14	450 45	452 76	455 07	457 38	459 69
200	462.00	464 31	466 62	468.93	471 24	473.55	475 86	478 17	480.48	482.79

Method 1: This method is primarily applicable to testing in consolidated rock which requires casing as the hole is drilled, although it may be used in stable material if desired. The hole is drilled, the tools removed, a packer seated a given distance above the bottom of the hole, water under pressure is pumped into the test section, and the readings recorded. The packer is then removed, the hole drilled deeper, the packer is inserted so as to leave the full length of the newly drilled hole within the test section, and the test repeated.

Method 2: This method is applicable in consolidated rock which is stable and does not require cementing. The hole is drilled to the final depth, cleaned, and blown out or bailed. Two packers, spaced on pipe or drill stem to isolate the desired test section, are used. Tests should be started at the bottom of the hole. After each test, the pipe is lifted a distance equal to the A dimension shown on figure 10-5 and the test repeated until the entire hole is tested.

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CGP 8/1/91

PERMEABILITY TE

K = coefficient of permeability, feet per second under a unit gradient

Q = steady flow into well, ft^3/s

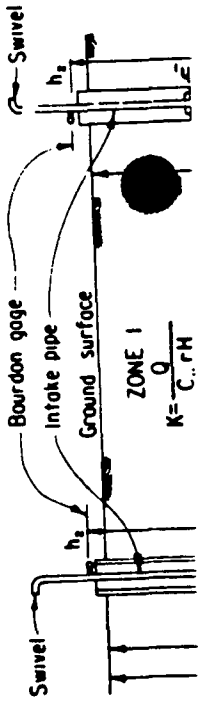
$H = h_1 + h_2 - L$ = effective head, ft

h_1 (above water table) = distance between Bourdon gage and bottom of hole for method 1 or distance between gage and upper surface of lower packer for method 2, ft

h_1 (below water table) = distance between gage and water table, ft

h_2 = applied pressure at gage, 1 lb/in^2 = 2.307 ft of water

L = head loss in pipe due to friction, ft; ignore head loss for [illegible] gal/min [illegible] test in 1½-inch pipe; use length of pipe between gage and to[illegible]



KK 8/1/91 15 Cap 8/1/91

TABLE 10-1.—*Conversion of heads of water in feet to hydrostatic pressures in pounds per square inch.* 103-D-1486.

Weight of Water - 62.4 pounds per cubic foot

HEAD IN FEET	ADDITIONAL UNITS									
	0	1	2	3	4	5	6	7	8	9
0	——	0.43	0.87	1.30	1.73	2.17	2.60	3.03	3.47	3.90
10	4.33	4.77	5.20	5.64	6.07	6.50	6.94	7.37	7.80	8.24
20	8.67	9.10	9.54	9.97	10.40	10.84	11.27	11.70	12.14	12.57
30	13.00	13.44	13.87	14.31	14.74	15.17	15.61	16.04	16.47	16.91
40	17.34	17.77	18.21	18.64	19.07	19.51	19.94	20.37	20.81	21.24
50	21.67	22.11	22.54	22.98	23.41	23.84	24.28	24.71	25.14	25.58
60	26.01	26.44	26.88	27.31	27.74	28.18	28.61	29.04	29.48	29.91
70	30.34	30.78	31.21	31.65	32.08	32.51	32.95	33.38	33.81	34.25
80	34.68	35.11	35.55	35.98	36.41	36.85	37.28	37.71	38.15	38.58
90	39.01	39.45	39.88	40.32	40.75	41.18	41.62	42.05	42.48	42.92
100	43.35	43.78	44.22	44.65	45.08	45.52	45.95	46.38	46.82	47.25
110	47.68	48.12	48.55	48.99	49.42	49.85	50.29	50.72	51.15	51.59
120	52.02	52.45	52.89	53.32	53.75	54.19	54.62	55.05	55.49	55.92
130	56.36	56.79	57.22	57.66	58.09	58.52	58.96	59.39	59.82	60.26
140	60.69	61.12	61.56	61.99	62.42	62.86	63.29	63.72	64.16	64.59
150	65.02	65.46	65.89	66.33	66.76	67.19	67.63	68.06	68.49	68.93
160	69.36	69.79	70.23	70.66	71.09	71.53	71.96	72.39	72.83	73.26
170	73.69	74.13	74.56	75.00	75.43	75.86	76.30	76.73	77.16	77.60
180	78.03	78.46	78.90	79.33	79.76	80.20	80.63	81.06	81.50	81.93
190	82.36	82.80	83.23	83.67	84.10	84.53	84.97	85.40	85.83	86.27
200	86.70	87.13	87.57	88.00	88.43	88.87	89.30	89.73	90.17	90.60

(k) *Arrangement of Equipment.*—Recommended arrangement of test equipment starting at the source of water is as follows:

> Source of water, suction line, pump, waterline to settling and storage tank or basin, suction line, centrifugal test pump, line to watermeter adapter (if required) or to watermeter, short length of pipe, plug valve, waterline to swivel, sub for gage, and pipe or rod to packer. All connections should be kept as short and straight as possible with a minimum number of changes in diameter of hose, pipe, etc.

All joints, connections, and hose between the watermeter and the packer or casing should be tight so no water loss occurs between the meter and the test section.

(l) *Pressure Permeability Test Methods.*—A schematic drawing of the following two methods is shown on figure 10-5.

(g) *Location of Pressure Gage in Tests.*—The ideal location for a pressure gage is near the well head, preferably between the packer and the swivel.

(h) *Recommended Watermeters.*—Required water deliveries in pressure tests may range from less than 1 gallon per minute to as much as 400 gallons per minute. No one meter is sufficiently accurate at all ranges to be reliably used. Therefore, two meters are recommended: (1) a 4-inch propeller or impeller-type meter to measure flows between 50 and 350 gallons per minute; and (2) a 1-inch disk-type meter for flows between 1 and 50 gallons per minute. Ideally, each meter should be equipped with an instantaneous flow indicator as well as a totalizer. Watermeters should be tested frequently to assure reliability.

Inlet pipe adapters should be available for each meter to minimize turbulent inflow. The adapters should be at least 10 times as long as the diameter of the rated size of the meter.

(i) *Length of Time for Tests.*—The minimum length of time to run a test depends upon the nature of the material tested. Tests should be run until stabilization occurs; that is, until three or more readings of water intake and pressure taken at 5-minute intervals are essentially equal. In tests above the water table, water should be pumped into the test section at the desired pressure for about 10 minutes in coarse materials or 20 minutes in fine-grained materials before making measurements.

Stability is obtained more rapidly in tests below the water table than in unsaturated material. When multiple pressure tests are made, each pressure theoretically should be maintained until stabilization occurs. This is not practicable in some cases, however, but good practice requires that each pressure stop be maintained for at least 20 minutes with intake and pressure readings made at 5-minute intervals as the pressure is increased and for 5 minutes as pressure is decreased.

(j) *Pressures to be Used in Testing.*—Where subsurface conditions for proposed reservoirs or other water-impounding or storage facilities are being investigated, the theoretical minimum pressure used in the test section should equal the head imposed by the maximum reservoir level. However, when tests are made in locations where the ground surface is below the proposed maximum pool level, the use of such test pressures may be impractical because of the danger of blowouts or fracturing the hole face. Under these conditions, a safe pressure in consolidated rock is 0.5 pound per square inch, or 1.15 feet of water per foot of depth from the ground surface to the top of the test section. In all other locations, the same criterion is a good rule-of-thumb guide. Tables 10–1 and 10–2 are provided for converting pounds per square inch to feet of water and vice versa, respectively.

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cap 8/1/91

TABLE 10–1.—*Conversion of sures in pounds p*

Weight of Wat

HEAD IN FEET	0	1	2	3
0	——	0.43	0.87	1.3
10	4.33	4.77	5.20	5.6
20	8.67	9.10	9.54	9.9
30	13.00	13.44	13.87	14.3
40	17.34	17.77	18.21	18.6
50	21.67	22.11	22.54	22.9
60	26.01	26.44	26.88	27.3
70	30.34	30.78	31.21	31.6
80	34.68	35.11	35.55	35.9
90	39.01	39.45	39.88	40.3
100	43.35	43.78	44.22	44.6
110	47.68	48.12	48.55	48.9
120	52.02	52.45	52.89	53.3
130	56.36	56.79	57.22	57.6
140	60.69	61.12	61.56	61.9
150	65.02	65.46	65.89	66.3
160	69.36	69.79	70.23	70.6
170	73.69	74.13	74.56	[illegible]
180	78.03	78.46	78.90	79.3
190	82.36	82.80	83.23	83.6
200	86.70	87.13	87.57	88.0

(k) *Arrangement of Equip* test equipment starting at th

Source of water, suctio storage tank or basin, su watermeter adapter (if r of pipe, plug valve, wate rod to packer. All connect as possible with a minin hose, pipe, etc.

All joints, connections, and packer or casing should be ti meter and the test section.

(l) *Pressure Permeability T* the following two methods is

KAL 8/1/91 13 CGP 8/1/91

the casing when making a test unless the casing has been grouted in the hole. Except under the most adverse conditions, the use of test sections greater than 20 feet in length is inadvisable. Longer test sections may not permit sufficient localization of permeable zones and may complicate computations.

(d) *Size of Rod or Pipe to Use in Tests.*—Drill rods are commonly used as intake pipes to make pressure and permeability tests. NX and NW rods can be used for this purpose without seriously affecting the reliability of the test data, if the intake of the test section does not exceed 12 to 15 gallons per minute and the depth to the top of the test section does not exceed 50 feet. For general use, 1¼-inch or larger pipe is more satisfactory. Figures 10–1 through 10–4 show head losses per 10-foot section at various deliveries of water for different sizes of drill rod and 1¼-inch pipe. These figures were compiled from experimental tests. The desirability of using the 1¼-inch pipe, particularly where holes 50 feet or more in depth are to be tested, is obvious from study of the graphs. The couplings on the 1¼-inch pipe must be turned down to an outside diameter of 1.8 inches for use in AX holes.

(e) *Pumping Equipment.*—Tests are commonly run using a mud pump for pumping the water. Such pumps are generally of the multiple cylinder type with a uniform fluctuation in pressure. Many of these pumps have a maximum capacity of about 25 gallons per minute and, if not in good condition, the capacities may be as small as 17 to 18 gallons per minute. Tests are often difficult, if not impossible, to analyze because such pumps do not have sufficient capacity to develop back pressure in the length of hole being tested. When this happens, the tests are generally reported: "took capacity of pump, no pressure developed." This result does not permit determination of permeability of the material tested other than it is probably high. The fluctuating pressures of multiple cylinder pumps, even when an air chamber is used, are often difficult to read accurately because the high and low readings must be averaged to determine the approximate true effective pressure, a difficulty which may be a source of error. In addition, such pumps occasionally develop instantaneous excessively high pressures which may fracture the rock or blow out a packer.

Permeability tests made in drill holes ideally should be performed using centrifugal pumps having sufficient capacity to develop back pressure. A pump with a capacity of up to 250 gallons per minute against a total head of 160 feet would be adequate for most testing. Head and discharge of such pumps are easily controlled by changing engine speed or with a control valve on the discharge.

(f) *Swivels for Use in Tests.*—Swivels used for testing should be selected for minimum head losses.

ATTACHMENT 2 - Conclude

```
660 INPUT "WELL RADIUS(r)";RW
680 INPUT "BOREHOLE RADIUS(R)";RB
690 INPUT "TIME LAG- TIME AT WHICH (H-h)/(H-Ho)=10E-.4343(To)";TO
700 K=RW*RW*LOG(L/RB)/2./L/TO
710 LPRINT "FOR WELL RADIUS(r)= ";RW
740 LPRINT "BOREHOLE RADIUS(R)= ";RB
750 LPRINT "AND TIME LAG(To)= ";TO
755 LPRINT "*****************************************************************"
760 LPRINT "THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= ";K
765 PRINT "THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= ";K
770 INPUT "DO YOU WANT ANOTHER RUN(YES OR NO)";A$
772 LPRINT "*****************************************************************"
773 LPRINT ""
775 LPRINT ""
777 LPRINT ""
780 IF A$="YES" THEN 100
790 IF A$<>"NO" THEN 770
810 END
820 PRINT "FERRIS-KNOWLES METHOD"
830 LPRINT "FERRIS-KNOWLES METHOD"
840 INPUT "VOLUME DISCHARGED(Q)=";Q
850 INPUT "RECIPROCAL OF TIME(1/t)=";RT
860 INPUT "DRAWDOWN AT 1/t (t)=";S
880 K=Q*RT/S/L/12.566371
890 LPRINT "FOR: DISCHARGE(Q)= ";Q
900 LPRINT "RECIPROCAL TIME(1/t)= ";RT
910 LPRINT "DRAWDOWN (s)= ";S
930 GOTO 755
940 PRINT "COOPER-BREDEHOEFT-PAPADOPULOS METHOD"
950 LPRINT "COOPER-BREDEHOEFT-PAPADOPULOS METHOD"
960 INPUT "RADIUS OF WELL CASING(Rc)=";RC
970 INPUT "TIME FOR POINT ON MATCHED TYPE CURVE(t)=";T
990 K=RC*RC/T/L
1000 LPRINT "FOR:WELL RADIUS (Rc)= ";RC
1010 LPRINT "TIME(t)= ";T
1030 GOTO 755
```

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JACOBS ENGINEERING

KAL 7/30/91

DATE _____ SUBJECT Verification of Slug Test Results SHEET NO 1 7/31/

BY _____ CHKD. _____ JOB NO _____

Test cases are on previous page

1. Skibitske:

$$K = \frac{q}{4\pi s t L} = \frac{0.054}{4\pi(0.02)(4.5\times10^{-3})5} = 9.5493$$

2a. Bower-Rice with impermeable boundary deeper than bottom of well screen:

$$\ln[(H-L_w)/r_w] = \ln[(2000-16.75)/0.25] = 8.98$$

Substitute 6.0 for 8.98, see Bower, 1978, p.115 last sentence

For $L_e/r_w = 5/0.25 = 20$,

$A = 2.2$, $B = 0.3$ see Bower, 1978, p.116 fig 5.11

Equa 5.42, p.115: $\ln \frac{R_e}{r_w} = \left\{ \frac{1.1}{\ln(L_w/r_w)} + \frac{A + B\ln[(H-L_w)/r_w]}{(L_e/r_w)} \right\}^{-1} =$

$$\left[\frac{1.1}{\ln(16.75/0.25)} + \frac{2.2 + 0.3(6)}{(5/0.25)}\right]^{-1} = 2.165$$

Equa 5.41, p.115: $K = \frac{r_c^2 \ln(R_e/r_w)}{2L_e} \frac{1}{t} \ln\left(\frac{y_0}{y_t}\right) =$

$$\frac{(0.083)^2(2.165)}{2(5)} \frac{1}{347\times10^{-3}} \ln\left(\frac{2.5}{0.0522}\right) = 1.623$$

ratio of $\frac{\text{computer value}}{\text{longhand value}} = \frac{1.57556}{1.623} = 0.983$

ATTACHMENT 2

```
**********************************************************
**********************************************************
*****************SLUG/BAS*****************************************
**********************************************************

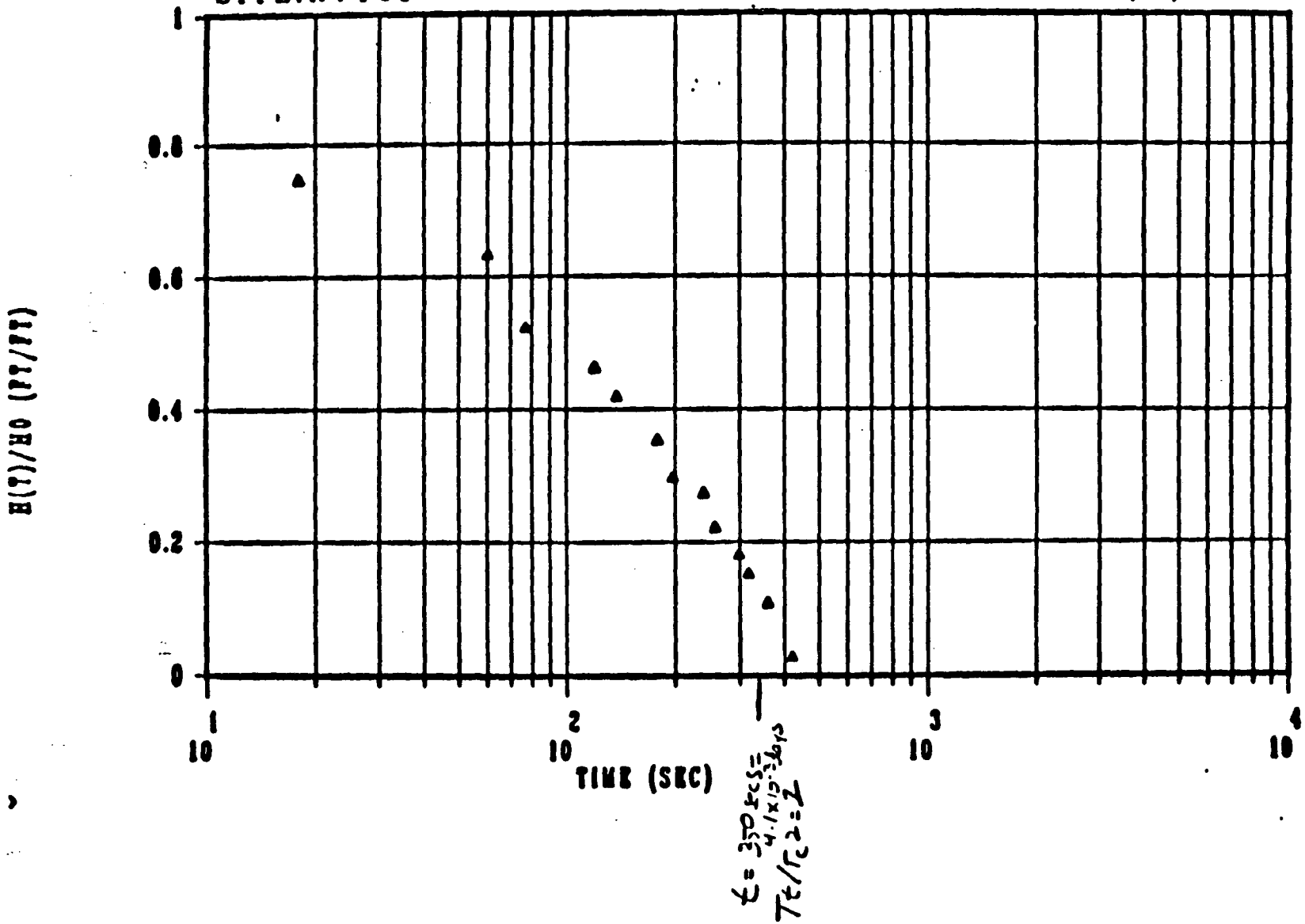
' THIS PROGRAM SOLVES FIVE SLUG TEST METHODS: SKIBITSKE,BOUWER-RICE,
' HVORSLEV,FERRIS-KNOWLES AND COPPER-BREDEHOEFT-PAPADOPULOS.
' IT WAS WRITTEN BY JIM BRINKMAN OF SH&B
LPRINT "SLUG TEST SOLUTIONS"
LPRINT " "
LPRINT "*****************************************************************"
INPUT "WELL IDENTIFICATION- ";N$
LPRINT "WELL IDENTIFICATION- ";N$
INPUT " DATE OF TEST RUN:";D$
LPRINT "DATE OF FIELD TEST- "; D$
INPUT "LENGTH OF CONTRIBUTING INTERVAL,(L)";L
LPRINT "LENGTH OF CONTRIBUTING INTERVAL,(L)=   ";L
INPUT "CHOSE METHOD OF ANALYSIS,SKIBITSKE(1),BOUWER(2),HVORSLEV(3),FERRIS-KNOWLES(4) OR COPPER-BREDEHOEFT-PAPADOPULOS(5)";MA
IF MA<1 OR MA>5 THEN 150
ON MA GOTO 190,290,640,820,940
PRINT "SKIBITSKE METHOD"
LPRINT "SKIBITSKE METHOD"
INPUT "INPUT VOLUME DISCHARGE(Q)";Q
INPUT "INPUT RESIDUAL DRAWDOWN(s')";S
INPUT "INPUT TIME OF RESIDUAL DRAWDOWN MEASUREMENT(t)";T
K=Q/T/S/12.566371/L
LPRINT "FOR DISCHARGE(Q)= ";Q
LPRINT "RESIDUAL DRAWDOWN(s')= ";S
LPRINT "TIME TO RESIDUAL DRAWDOWN(t)= ";T
GOTO 755
PRINT "BOUWER-RICE METHOD"
LPRINT "BOUWER-RICE METHOD"
INPUT "WELL RADIUS(Rc)";RC
INPUT "BOREHOLE RADIUS (Rw)";RW
INPUT "HEAD AT To(Yo)";YO
INPUT "TIME TO HEAD MEASUREMENT(t)";T
INPUT "HEAD AT TIME t(Yt)";YT
INPUT "DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)";LW
INPUT "DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)";H
IF H=LW THEN 480
D=LOG((H-LW)/RW)
IF D>6. THEN D=6.
X=LOG(L/RW)
IF X>4.7875 THEN A=-.3655*X*X+5.9206*X-15.2747 ELSE A=.491*X*X-2.045*X+3.691
IF X>5.247 THEN B=-.12*X*X+2.5128*X-8.7825 ELSE B=.0659*X*X-.217*X+.4261
LRR=1./(1.1/LOG(LW/RW)+(A+B*D)*RW/L)
GOTO 520
X=LOG(L/RW)
IF X>5.0106 THEN C=-.7887*X*X+12.7088*X-37.8922 ELSE C=.5511*X*X-2.0829*X+2.5992
LRR=1./(1.1/LOG(LW/RW)+C*RW/L)
K=RC*RC*LRR/2./L/T*LOG(YO/YT)
LPRINT "FOR WELL RADIUS(Rc)= "; RC
LPRINT"BOREHOLE RADIUS(Rw)= ";RW
LPRINT "HEAD AT To(Yo)= "; YO
LPRINT "TIME TO HEAD MEASUREMENT(t)= ";T
LPRINT "HEAD AT TIME t(Yt)= ";YT
LPRINT "DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)= ";LW
LPRINT "DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)= ";H
GOTO 755
PRINT "  RSLEV METHOD"
LPRINT   ORSLEV METHOD"
```

KAL 7/30/91 cap 7/31/91

ATTACHMENT 1 - Continued

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:RVT01 LOCATION:704 DATE:01/16/85



KAL
7/30/91
Cap
7/31/91

SLUG TEST SOLUTIONS

```
**********************************************************
1  WELL IDENTIFICATION- LKVD1-501
   DATE OF FIELD TEST- 8/26/1984
   LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
   BIBITSKE METHOD
   FOR DISCHARGE(Q)=  .054
   RESIDUAL DRAWDOWN(s')=  .02
   TIME TO RESIDUAL DRAWDOWN(t)=  4.5E-03
**********************************************************
   THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  9.5493
**********************************************************

**********************************************************
2a. WELL IDENTIFICATION- LKVD1-501
   DATE OF FIELD TEST- 8/26/1984
   LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
   BOUWER-RICE METHOD
   FOR WELL RADIUS(Rc)=  .083
   BOREHOLE RADIUS(Rw)=  .25
   HEAD AT To(Yo)=  2.5
   TIME TO HEAD MEASUREMENT(t)=  3.67E-03
   HEAD AT TIME t(Yt)=  .0573
   DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  16.75
   DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  2000
**********************************************************
   THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.59556
**********************************************************

**********************************************************
2b. WELL IDENTIFICATION- LKVD1-501
   DATE OF FIELD TEST- 8/26/1984
   LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
   BOUWER-RICE METHOD
   FOR WELL RADIUS(Rc)=  .083
   BOREHOLE RADIUS(Rw)=  .25
   HEAD AT To(Yo)=  2.5
   TIME TO HEAD MEASUREMENT(t)=  3.67E-03
   HEAD AT TIME t(Yt)=  .0573
   DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  16.75
   DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  16.75
**********************************************************
   THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.29325
**********************************************************

**********************************************************
3. WELL IDENTIFICATION- LKVD1-503
   DATE OF FIELD TEST- 9/5/1984
   LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
   HVORSLEV METHOD
   FOR WELL RADIUS(r)=  .083
   BOREHOLE RADIUS(R)=  .25
   AND TIME LAG(To)=  3.67E-03
**********************************************************
   THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  .594744
**********************************************************

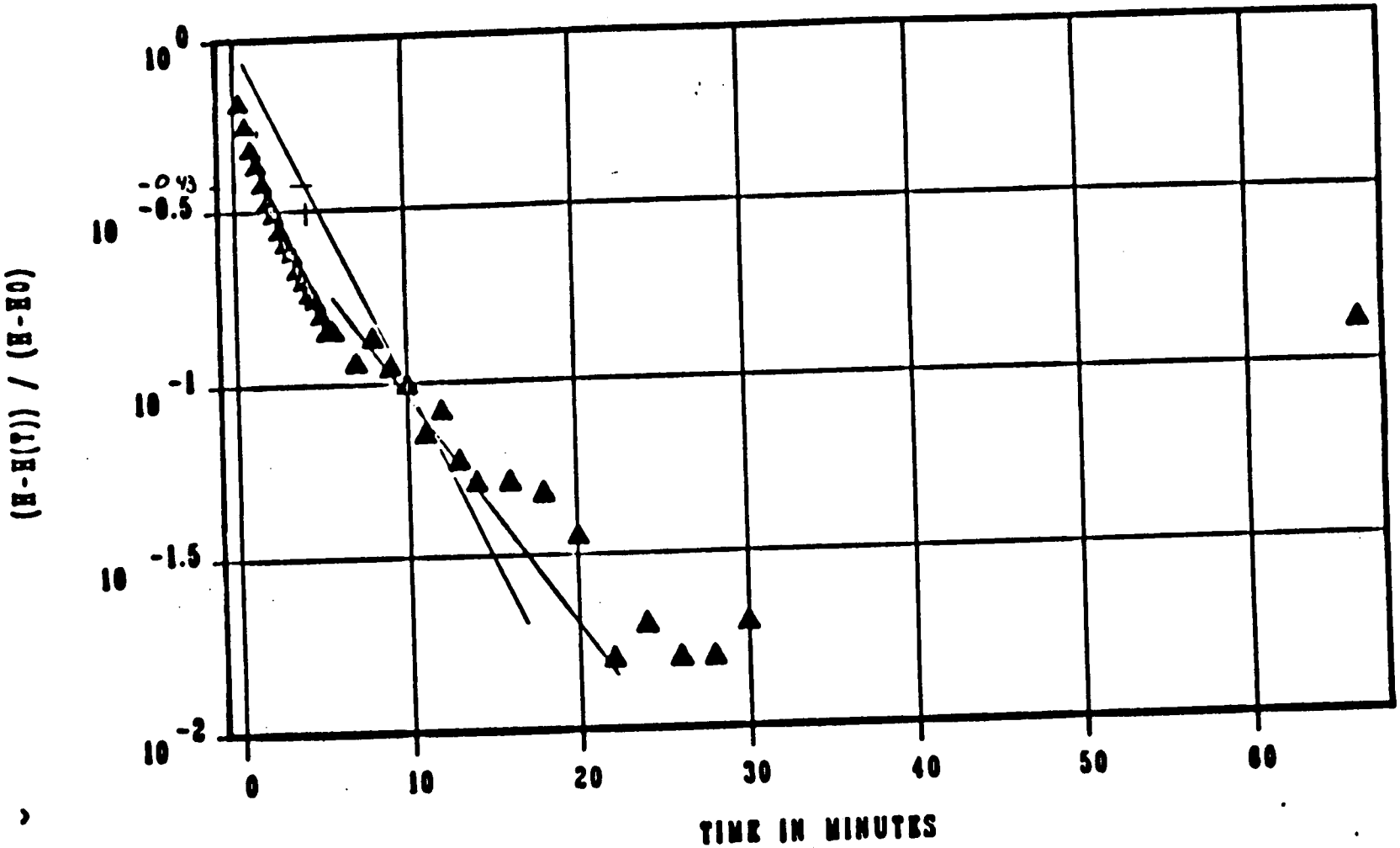
**********************************************************
4. WELL IDENTIFICATION- RVTD1-704
   DATE OF FIELD TEST- 1/16/1985
   LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
   FERRIS-KNOWLES METHOD
   FOR: DISCHARGE(Q)=  .054
   RECIPROCAL TIME(1/t)=  57.6
   DRAWDOWN (s)=  .5
**********************************************************
   THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  .0990071
**********************************************************

**********************************************************
5  WELL IDENTIFICATION- RVTD1-704
   DATE OF FIELD TEST- 1/16/1985
   LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
   COOPER-BREDE-DEFT-PAPADOPULOS METHOD
   FOR:WELL RADIUS (Rc)=  .083
   TIME(t)=  4.1E-03
**********************************************************
   THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  .336049
**********************************************************
```

KAC 7/30/91
7/31/91

ATTACHMENT 1 - Continued

LKV01 SLUG TEST- WELL 503



T_0 = 5 mins = 3.47×10^{-3} days

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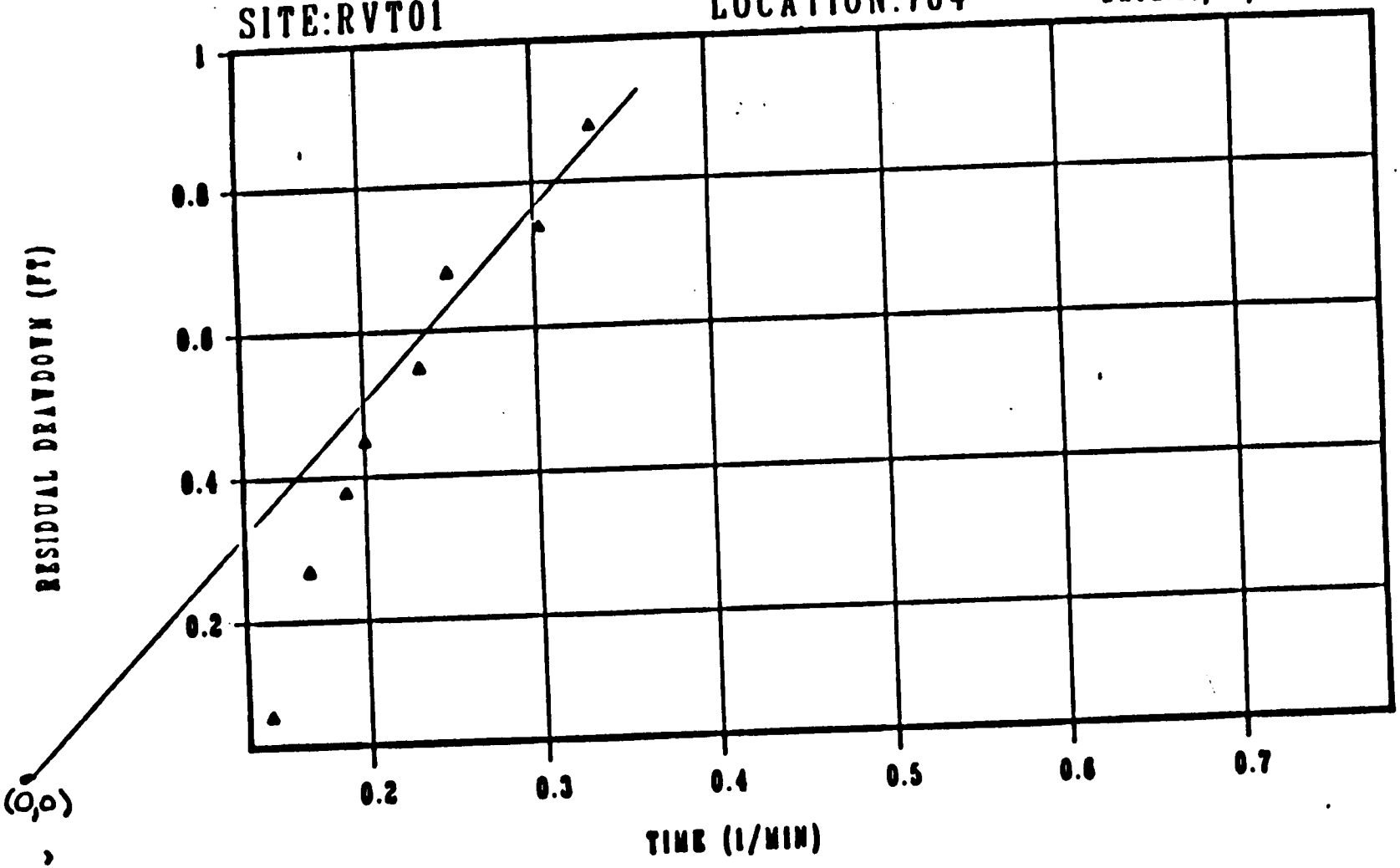
11/31/91

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:RVT01 LOCATION:704 DATE:01/16/85



For $\frac{1}{t}$ = 0.2 min^{-1} : 5 7.6 day^{-1}

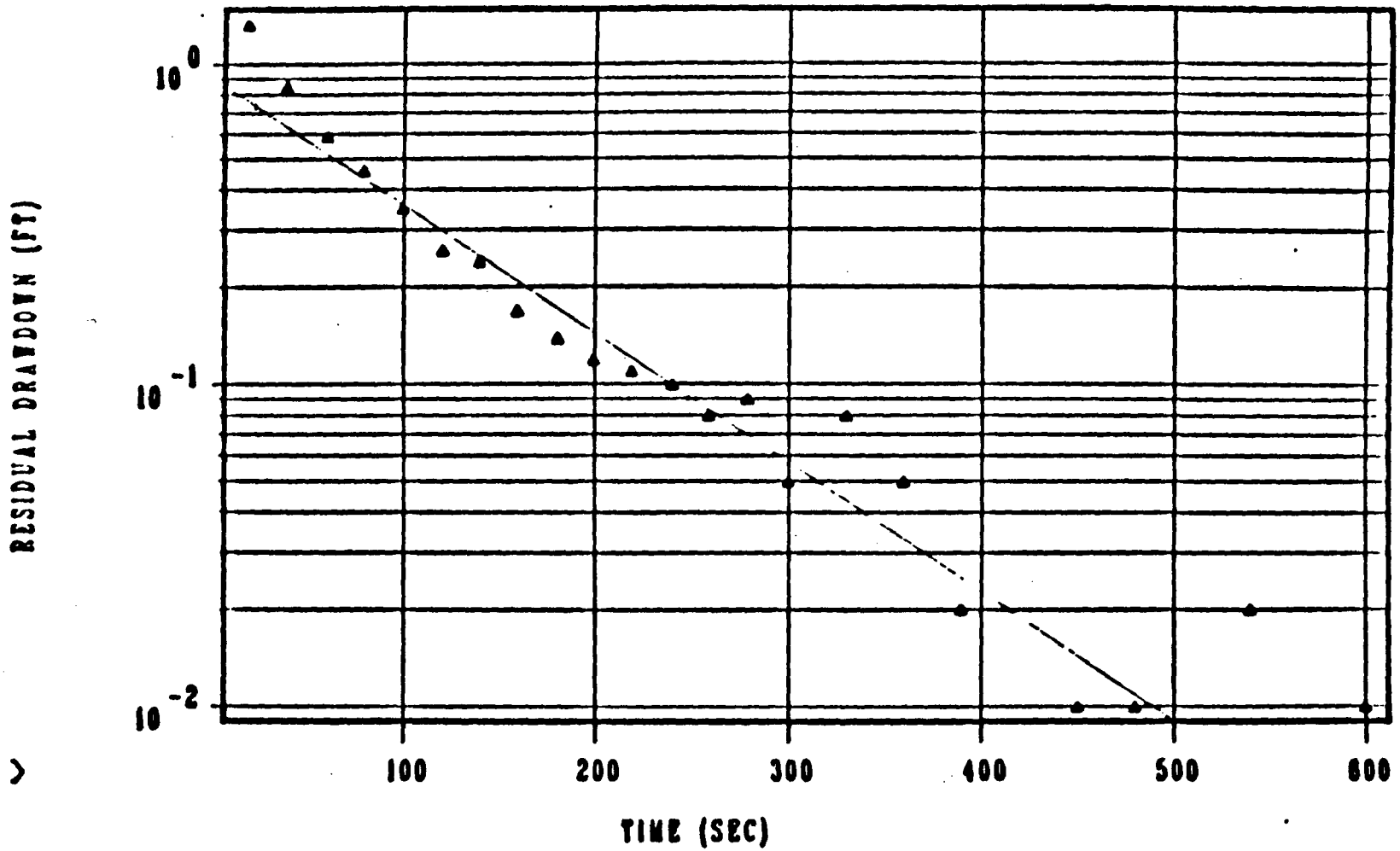
S = 0.5 ft.

RAC 7/30/91 CAF 7/31/91

ATTACHMENT 1

BOUWER-RICE SLUG TEST ANALYSIS

SITE:LKV01 LOCATION:501 DATE:08/26/84



$Y_0 = 2.5$ ft.

$t = 3 \times 23 \times 60 = 3.472 \times 10^{-3}$ days

$Y_t = 5.729 \times 10^{-2}$ ft.

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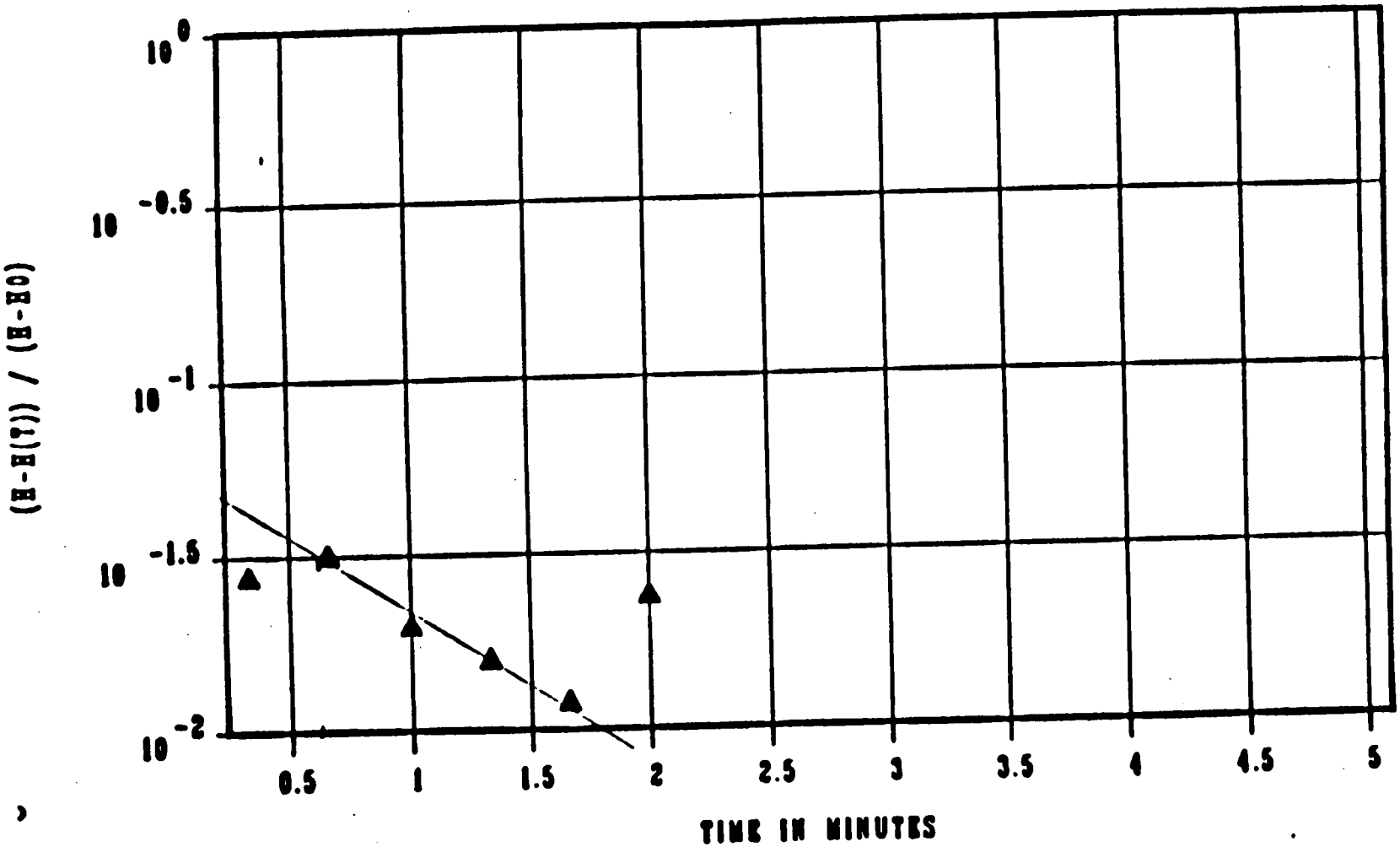
ATTACHMENT T Continued

LKV01 SLUG TEST- WELL 505



HVORSLEV METHOD
INVALID

7/30/91
caf
9/31/91

The greatest relative error due to matching of the curves occurs when the published value of C=1.05 and the numerical value = 0.72. For test cases with L_w ranging from 10 to 200, L_e ranging from 2 to 10 and R_w ranging from 0.083 to 0.25, the maximum relative error was approximately 16 percent with L_w=200, L_e=2 and R_w = 0.25. For most cases, the relative should be much less than 5 percent.

o Hvorslev Method

- Used for unconfined units. This method is valid only if a reasonably fit straight line through the data curve of log (residual drawdown/initial residual drawdown) vs. time passes through the point (1,0).

- Input data are:

  1. Well radius (r)
  2. Borehole radius (R)
  3. Time lag (T_o), T_o is the time when (residual drawdown/initial residual drawdown) = $10^{-10.4343}$

  The equation solved is:

$$K=\frac{r^2 \ln (L/R)}{2 L T_o}$$

o Ferris - Knowles Method

- Used for confined units with K<0.5 cm/sec

- Input data are:

  1. Volume discharge (q)
  2. Reciprical of time (1/t)
  3. Residual drawdown at time, t (s)

  The values of 1/t and s are taken from a straight line fit through the data points. To be valid, this straight line fit must pass through the origin.

- The equation solved is:

$$K= \frac{q\ (1/t)}{4\pi s L}$$

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o Cooper-Bredhehoeft-Papadopulos Method

- Used for confined unit with K<0.5 cm/sec.

- Input data are:

  1. Radius of well (r)
  2. Time representing point on matched type curve (t).

  t is obtained from matching the data points of residual drawdown/initial residual drawdown vs. log of time to a type curve found in the referenced report.

- The equation solved is:

$$K = \frac{r_c^2}{tL}$$

C. User's Manual

SLUG/BAS is very easy to use. All input is prompted by explicit commands. The information supplied in Part B is a User's Manual.

D. Code Assessment and Support

To assess and verify the computer code, examples of each method with hand calculation checks are supplied (Attachment 1). Given the simplicity of the calculations, these checks are sufficient verification. The present version of SLUG/BAS is the only presently available version.

E. Continuing Documentation and Code Listings

The code listing is supplied as Attachment 2.

JP/11

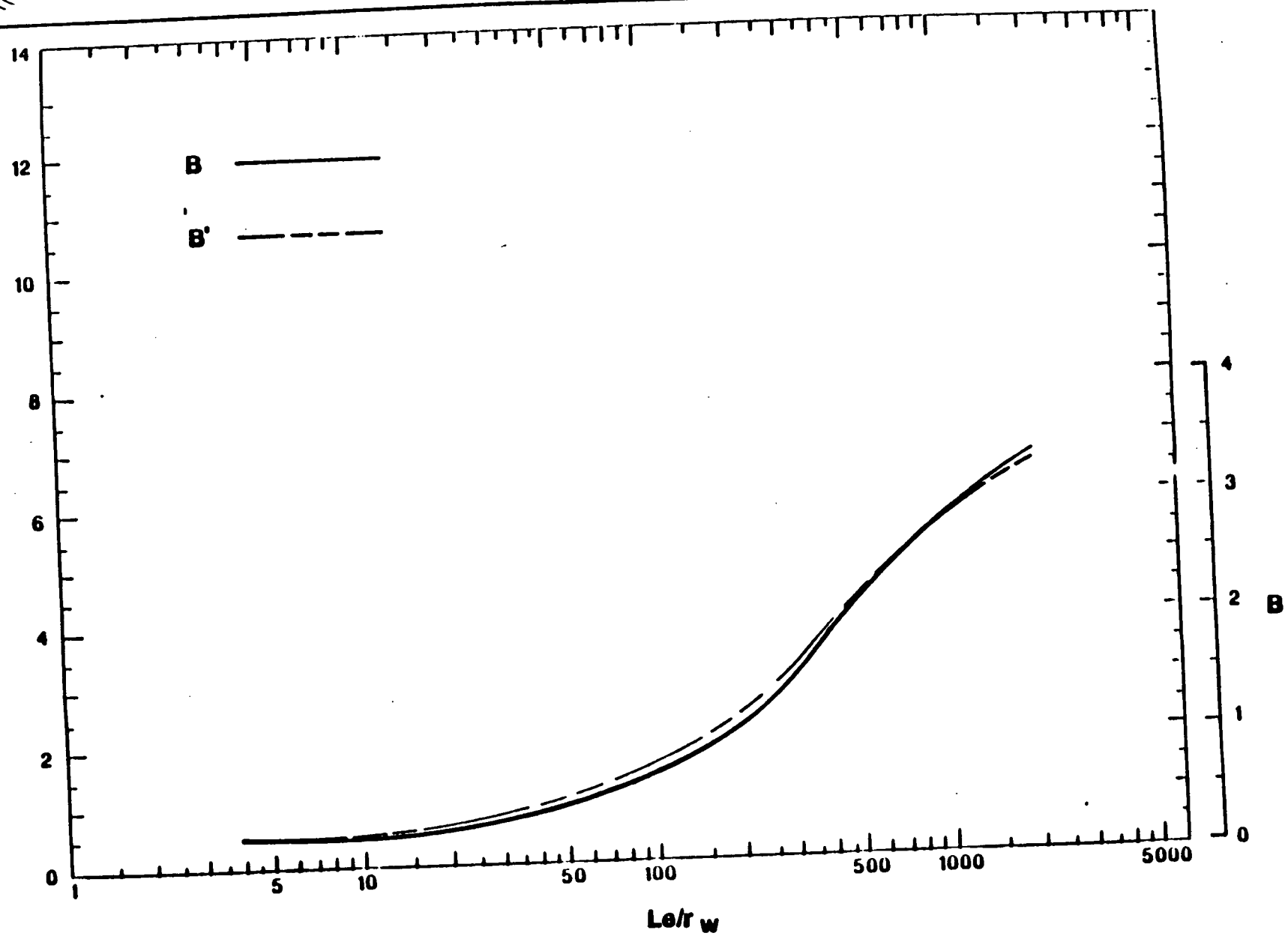

FIGURE 2

COMPARISON OF PUBLISHED AND NUMERICALLY PRODUCED COEFFICIENT RELATIONSHIPS (B,B')

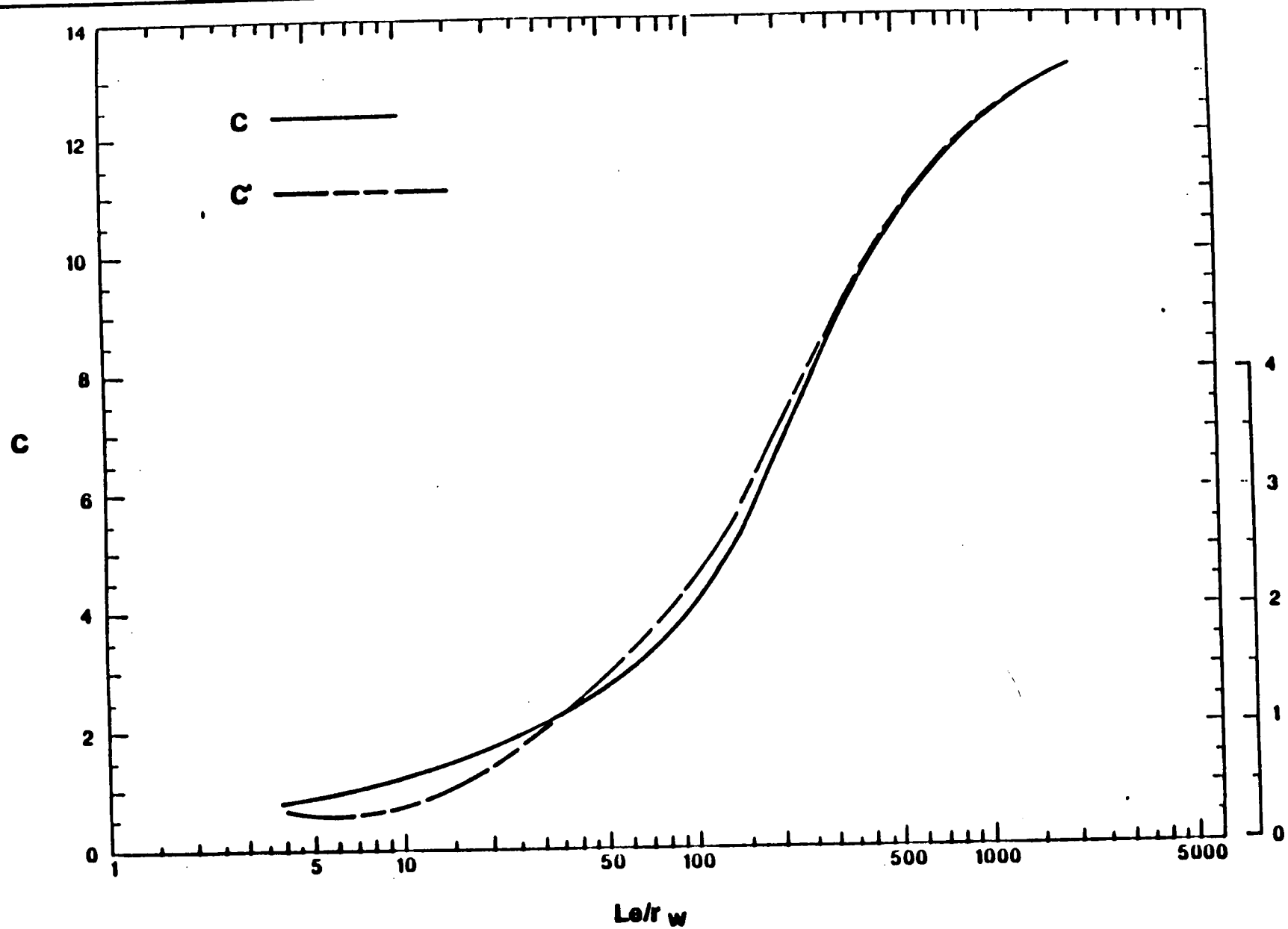

FIGURE 3

COMPARISON OF PUBLISHED AND NUMERICALLY PRODUCED COEFFICIENT RELATIONSHIPS (C,C')

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7/31/9

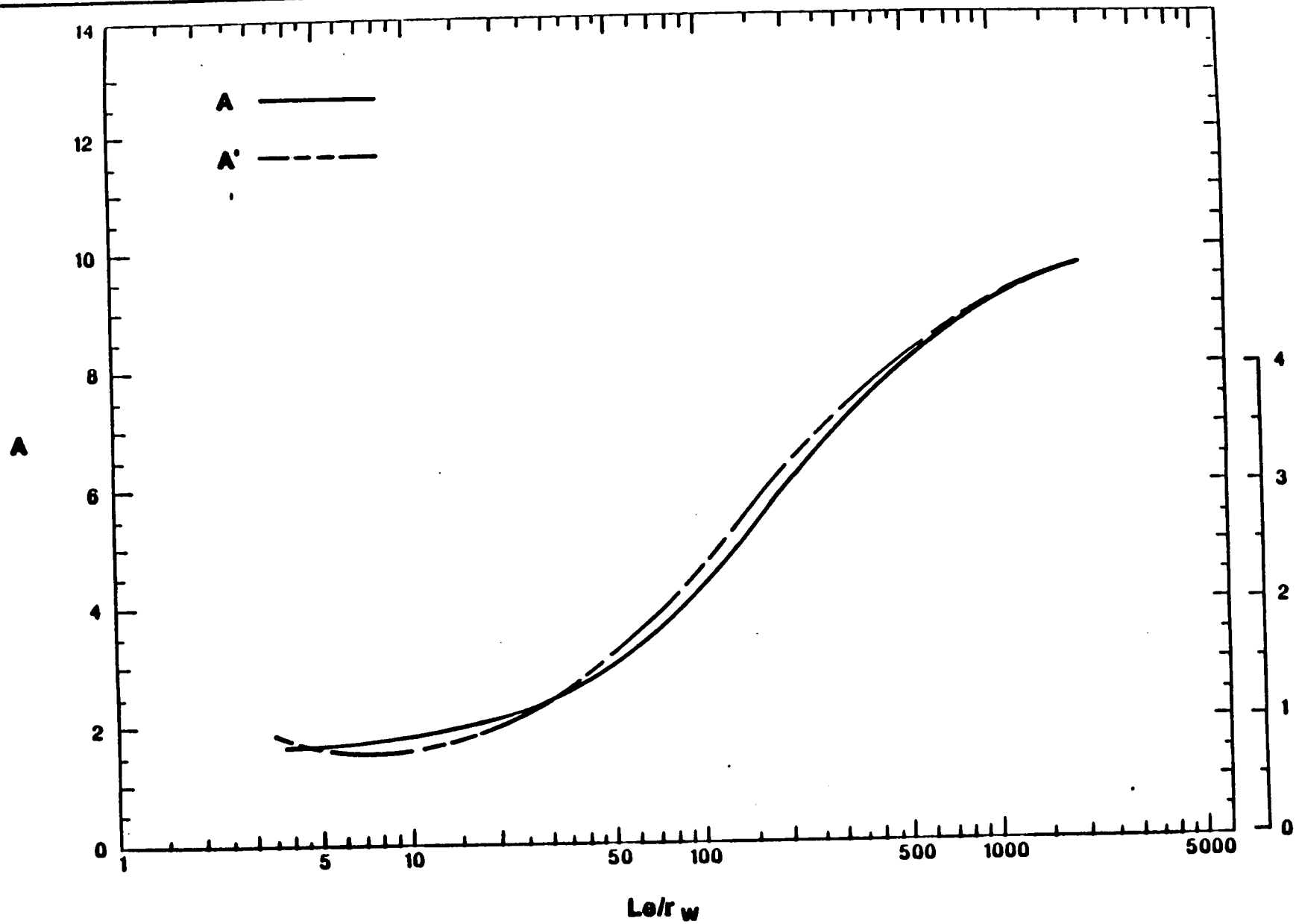

FIGURE 1

COMPARISON OF PUBLISHED AND NUMERICALLY PRODUCED COEFFICIENT RELATIONSHIPS (A,A')

RAC 7/30/91 Caf 7/31/91

Curve A

L_e/r_w	$X = Ln(L_e/r_w)$	A	
4	1.386	1.8	Parabola 1
32	3.466	2.5	
120	4.787	5.15	
120	4.787	5.15	Parabola 2
450	6.109	8.0	
1600	7.378	9.6	

Parabola 1: $A=0.491x^2-2.045x+3.691$

Parabola 2: $A=0.3455x^2+5.9206x-15.2747$

Curve B

L_e/r_w	$X = Ln(L_e/r_w)$	B	
4	1.386	0.25	Parabola 1
27	3.296	0.43	
190	5.247	1.1	
190	5.247	1.1	Parabola 2
525	6.263	2.3	
1650	7.409	3.3	

Parabola 1: $B= 0.0659x^2 - 0.217x+0.4241$

Parabola 2: $B= 0.12x^2+2.5128x-8.7825$

Curve C

L_e/r_w	$X = Ln(L_e/r_w)$	C	
3.8	1.335	0.8	Parabola 1
32	3.466	2.0	
150	5.011	6.0	
150	5.011	6.0	Parabola 2
370	5.914	9.7	
1650	7.409	13.0	

Parabola 1: $C = 0.5511x^2 - 2.0829x+2.5992$

Parabola 2: $C = -0.7882x^2+12.7088x-37.8922$

Figures 1, 2 and 3 show a comparison of the published curves and the curves developed with the numerical approximations.

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7/30/91
Cef
7/31/91

1. Well Identification - it is recommended that a nine space identifier be used.

   Example:

   LKV02-508
   a b c

   a Is three letter site designation

   b Is two number designation for processing site or a specific alternate disposal or borrow site.

   c Is three number well designation.

2. The day the field test was initiated.

3. Length of contributing, i.e., screened, packed, etc., interval (L).

4. Which one of the five methods will be applied.

A description of the use of the five methods follow:

o Skibitzke Method

- Used for well completed in confined units with low permeability; residual drawdown should be at last measurement before complete recovery.

- Input data are:

  1. Volume discharged or added (q).

  2. Time from test initiation until residual drawdown measurement (t).

  3. Residual drawdown measurement at time, t (s).

- The equation solved is:

$$K = \frac{q\cancel{t}}{4\pi sL\cancel{t}}$$ KAL 7/10/91

o Bouwer-Rice Method

- Used for wells completed in unconfined units.

7/30/91
Cap
7/31/91

- Input data are:

1. Well radius (r_c)
2. Borehole radius (r_w)
3. Residual drawdown at the initiation of test (Y_o)
4. Time to residual drawdown measurement (t)
5. From straight line fit of log (residual drawdown) vs. time, residual drawdown at time, t (Y_t).
6. Distance from the watertable to the bottom of the contributing interval (L_w).
7. Distance from the watertable to an impermeable boundary (H).

- The equation solved is:

$$K = \frac{r_c^2 \ln (R_e/r_w)}{2L\ (t)} \ln \frac{y_o}{y_t}, \text{ where}$$

R_e is effective radius.

The term, $\ln (R_e/r_w)$ is determined with one of two empirical relationships.

For partially penetrating wells, $$\ln \frac{R_e}{r_w} = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \dfrac{A + B \ln[(H-L_w)/r_w]}{(L_e/r_w)}}$$

for fully penetrating wells, $$\ln \frac{R_e}{r_w} = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \dfrac{C}{(L_e/r_w)}}$$

A, B and C are empirical coefficients derived from curves based on the value of L_e/r_w (Figures 1, 2 and 3)

Each of the three curves was matched numerically with two parabolas fit to the curve. The points used for the parabolic numerical fits and the resulting parabolas follow:

KHL
7/30/91
Caf
7/31/91

A. FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

1. Summary date: Yr. 815 Mo. 06 Day 013

2. Summary prepared by (Name and Phone): Jim Brinkman (505) 846-1250

3. Software title: SLUG/BAS

4. Software date: Yr. 815 Mo. 06 Day 013

5. Short title:

6. Summary action: New [X] Replacement [ ] Deletion [ ] Previous Internal Software ID:

7. Internal Software ID:

8. Software type: Automated Data System [ ] Computer Program [X] Subroutine/Module [ ]

9. Processing mode: Interactive [X] Batch [ ] Combination [ ]

10. Application area — General: Computer Systems Support/Utility [ ] Scientific/Engineering [X] Bibliographic Textual [ ] Management/Business [ ] Process Control [ ] Other [ ] — Specific: Program to solve 5 Slug test calculations.

11. Submitting organization and address:
Technical Assistance Contractor
UMTRA Project
5301 Central Avenue NE, Suite 1400
Albuquerque, New Mexico 87108

12. Technical contact(s) and phone:
Jim Brinkman or John Thackston
(505) 846-1250

13. Narrative:
This program solves 4 very simple slug test methods and one rather involved method. For four methods, a value or values obtained from a graphical representation of the test data is required input. The program is user-friendly and interactive. All input and the calculated value of hydraulic conductivity are printed.

14. Keywords: Slug Test

15. Computer manufacturer and model	16. Computer operating system	17. Programming language(s)	18. Number of source program statements
TRS-80	TRSDOS	BASIC	97

19. Computer memory requirements	20. Tape drives	21. Disc Drive units	22. Terminals
	None	None	One

23. Other operational requirements: Printer

24. Software availability: Available [X] Limited [ ] Inhouse only [ ]

25. Documentation availability: Available [X] Inadequate [ ] Inhouse only [ ]

26. FOR SUBMITTING ORGANIZATION USE

7/30/91

Cop 7/31/91

B. Mathematical Models and Numerical Methods

SLUG/BAS is a user-friendly BASIC program to analysis slug test data. This program can be used directly on the TRS microprocessors linked with a printer. Five slug test methods can be solved.

- o Skibitske

  Reference: Methods of Determining Permeability, Transmissibility and Drawdown 1963, USGS Water-Supply paper 1536-I, pp-293-298.

- o Bouwer-Rice
  Reference: Groundwater Hydrology, 1978, Herman Bouwer, p-114-118.

- o Hvorslev
  Reference: Time Lag and Soil Permeability in Ground-Water Observations, 1951, M. Joul Hvorslev, Bulletin No-36, Waterways Experiment Station, Corps of Engineers, U.S. Army, Vicksburg, Mississippi.

- o Ferris-Knowles
  Reference: Methods of Determining Permeability, Transmissibility and Drawdown, 1963, USGS Water-Supply paper 1536-I, pp-299-304.

- o Cooper-Bredehoeft-Papadopulos
  Reference: Ground-water Hydraulics, 1972, S.W. Lohman, USGS Professional Paper 708, p-27-30 and Plate 2.

For all the methods except Bouwer-Rice, very simple equations are solved. The Bouwer-Rice method is much more complicated and empirical than the other methods and the solution by hand is rather time consuming. The primary benefit to using this program is that all input data are printed in a uniform format and documentation and certification, i.e., calculation checking, is very easy and quick. For all methods consistent units must be used.

The following Section satisfies all applicable requirements of parts, 2, 3, 4, and 5 of Section B and also serves as a User's Manual.

To run:

1. Insert diskette into TRS microprocessor.
   Be sure printer is attached and on-line.

2. After initializing microprocessor, i.e., entering date and time, enter BASIC by typing BASIC return.

3. Wait until micro response, then load program by typing LOAD "SLUG/BAS" return.

For all five methods, first input:

4. After program is loaded, then run program by typing RUN return.

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BY _____ CHKD. _____

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ATTACHMENT 2

SLUG TEST CALCULATIONS

FORM 91-005-1 (4/81)

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TO: Hydrology Staff

FROM: JBrinkman J.B.

DATE: June 10, 1985

SUBJECT: Technical Memo #5
Slug Test Calculations

This memo is a rerelease of a memo entitled "Slug Tests" released on May 20, 1985. It has been reformatted and some information has been added to make it consistent with "Final Technical Position on Documentation of Computer codes for High-Level Waste Management", NUREG 0856

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The time required for a slug test to be completed is a function of the volume of the "slug", the hydraulic conductivity of the formation and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.

If the well is to be used as a monitoring well, precautions should be taken that the wells are not contaminated by material introduced into the well. If water is added to the monitoring well, it should be from an uncontaminated source and transported in a clean container. Bailers or measuring devices should be cleaned prior to the test. If tests are performed on more than one monitoring well, care must be taken to avoid cross contamination of the wells.

1.1.5 DATA ANALYSIS

The analysis of slug test data is based on the modification of well-known ground water flow equations (either the Thiem equation, the Theis equation, or subsequent modification). Several authors have presented analytical solutions for the analysis of slug test data. Most solutions require a semi-logarithmic plot of the data collected: dimensionless head (logarithmic scale) or residual head (logarithmic scale) versus time (arithmetic scale).

Hvorslev (1951) was one of the first researchers to publish techniques of analysis of either constant or slug (falling head) tests in near-surface saturated soils. His analysis for slug tests involves a semi-logarithmic plot of the falling head (or water level) divided by the initial head against time. Basic algebraic equations are presented for different configurations of the soil relative to the test hole. In general, the permeability is proportional to a "shape factor" and inversely proportional to a a "time lag". The "shape factor" is determined from the test well characteristics or dimensions. "Time lag" is determined from the semi-logarithmic plot.

Cooper et al (1967) and Papadopulos et al (1973) developed a set of type curves for analyzing slug test data, particularly for tests run in materials which are confined (under artesian pressure). The field data are plotted as dimensionless head (arithmetic scale) versus time (logarithmic scale) and matched to a set of type curves. The match point values are substituted into simple algebraic formulated to obtain a value for K (Appendix 1-1).

Bower and Rice (1976) and Bower (1978) developed a technique for analyzing slug test data collected from completely or partially penetrating wells in unconfined aquifers. Their analysis involves a plot of residual head (logarithmic scale) versus time (arithmetic scale). A straight line is applied to the early-time data and used to calculate a value for K. An example of the use of this technique is presented in Appendix 1-2. A plot of the data and calculations are included.

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Pressurized slug test methods have been developed for testing extremely low conductivity (10^{-8} cm/sec or lower) materials (Bredehoeft and Papadopulos, 1980). Basically, the pressurized slug technique is a modification of the conventional slug test discussed previously. The advantage of the pressurized slug technique is the reduction of time required to perform a test in tight formations. This method involves creating an instantaneous pressure surcharge on drawdown in the test zone, then closing a valve to shut in the well. Based on the rate of decay of the pressure slug and the geometry of the test zone, the transmissivity, hydraulic conductivity, and storativity may be calculated.

1.2 ~~AQUIFER PUMPING TEST~~

1.2.1 PURPOSE

The purpose of this section is to briefly describe the use of aquifer pumping tests to evaluate aquifer characteristics. Aquifer pumping tests, commonly referred to as pump tests, are used to determine hydraulic characteristics and properties of water-bearing zones. Pumping tests provide results that are often more representative of the aquifer's characteristics than do slug tests.

Aquifer characteristics which may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), and specific yield (S_y) for unconfined aquifers and storage coefficient (S) for confined aquifers.

Equipment, personnel and time commitments needed to conduct pumping tests are greater than those required for slug tests. Briefly, a pumping test consists of pumping one well and recording the drawdown in the pumping well and in other nearby observation wells.

There are advantages and disadvantages of pumping tests. Some of these are listed below.

Advantages of pumping test:

- A greater portion of the aquifer is tested and the results obtained may be more reliable and representative of the aquifer characteristics.
- Coefficient of storage and specific yield values can be determined.

Disadvantages of pumping test:

- In low permeability aquifers long-term pumping may be required to complete the test and obtain reliable aquifer characteristics.
- Disposal of discharged water may require special provisions if the ground water is contaminated.

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A variety of drilling techniques can be used in completing the test well. These may include mud-rotary, air-rotary, coring and auger techniques. The type of drilling method used depends on the behavior of the material being drilled and the specific objectives of the project. Drilling without drilling fluids is preferred because this prevents further contamination of the subsurface. Mud-rotary techniques are sometimes required in order to lubricate the bit and hold up the bore hole walls when relatively thick, coarse, unconsolidated materials are encountered. Augering is normally performed without the use of drilling fluids and used in the drilling of relatively shallow holes with relatively cohesive materials.

The construction of the test well is relatively simple and involves the assembly of the appropriate diameter casing (usually PVC because of lower cost) for insertion into the bore hole. A pre-slotted screened section is prepared and attached to the casing string, normally with a cap on the bottom (to prevent material from entering the bottom of the screen), and the whole assembly is lowered into the hole. If a gravel pack is necessary as a filter due to the aquifer containing very fine unconsolidated sand, then it should be placed opposite the screened interval using a tremie pipe. The annulus is then grouted from the top of the gravel pack up to the ground surface in order to allow hydraulic connection only between the test well and the zone to be tested. The hole should be flushed or bailed before grouting if drilling fluid remains in the hole. If the ground water in the hole is highly contaminated, special safety precautions should be taken to control the discharge water before test well development.

1.1.3 EQUIPMENT

Equipment necessary to conduct a slug test include:

- Well or bore hole
- Water level measuring device
- Known solid volume of particular shape (slug) that will easily fit into the well or bore hole or container to add or remove a known volume of water
- Watch with second hand
- Semi-log graph paper
- Indelible pen or pencil and paper

A number of water level measuring devices can be used for measuring the depth to water in a well. An excellent device for measuring the depth to water during a slug test is the pressure transducer. An example strip chart data record is shown in Appendix 1-2. Accurate readings may also be obtained with electric water level indicators or weighted tapes with ploppers. Water level measurement by the wetted-tape method should be avoided as it may be difficult to obtain a sufficient number of readings for analysis of the test if the water level recovers quickly in a short amount of time.

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1.1.4 PROCEDURE

Before beginning the slug test, the following information should be recorded:

- Site ID and well or bore hole location
- Location and elevation of reference point from which water depth measurements are made
- Elevation of ground water with respect to the reference point
- Date and time of test
- Well depth, screen length, riser pipe radius, well screen radius, and radius of the gravel pack plus the well screen or bore hole depth and radius
- Aquifer or ground water zone being tested
- Volume of water added or withdrawn or volume of solid cylinder (slug)
- Type of measuring device used
- Names of personnel conducting test

The following procedures will apply to most slug tests. The field procedures required for a particular slug test may be slightly different, however, and the procedures should be modified to that test as necessary.

- Determine the static water level in the well by measuring the depth to water periodically for several minutes and taking the average of the readings.
- "Instantaneously" introduce or remove a known volume of water to the well. Another method is to introduce a solid cylinder of known volume to displace and raise the water level, allow the water level to restabilize and remove the cylinder. It is important to remove or add the volumes as quickly as possible because the analysis assumes an "instantaneous" change in volume is created in the well.
- With the moment of volume addition or removal assigned time zero, measure and record the depth to water and the time at each reading. Depths should be measured to the nearest 0.01 foot. The number of depth-time measurements necessary to complete the test are variable. It is critical to make as many measurements as possible in the early part of the test.
- Continue measuring and recording depth-time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a semi-log plot of time versus depth.

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TECHNICAL MEMORANDUM NO. 1
BORE HOLE HYDRAULIC TESTING FOR AQUIFER CHARACTERIZATION

1.0 INTRODUCTION

This technical memorandum provides guidelines and procedures for determining the hydraulic parameters of aquifers using slug tests and pumping tests. The hydraulic conductivity (K) of an aquifer is a measure of the aquifer's ability to conduct water. The greater the value of hydraulic conductivity, the more readily the aquifer conducts water. Figure 1 illustrates the typical range of hydraulic conductivity values associated with a variety of earth materials. The transmissivity (T) of an aquifer is defined as the ability of the aquifer to transmit water through its entire thickness and is equal to the hydraulic conductivity (K) times the saturated thickness of the aquifer (b); this can be stated as $T = Kb$, for cases in which K is constant with depth. Otherwise, transmissivity is equal to the integration of hydraulic conductivity over depth, $T = \quad K(Z)dz$.

Specific yield of an aquifer is the ratio of the volume of water drained by gravity from a unit volume of aquifer material. The storage coefficient of an aquifer is the volume of water in storage released from a column of aquifer with unit cross section under a unit decline of head.

1.1 SLUG TEST

1.1.1 PURPOSE

The purpose of this section is to outline procedures for the conduction and evaluation of slug tests which are a quick and inexpensive method of estimating the hydraulic conductivity or transmissivity of many aquifer systems.

A slug test will generally work in aquifers where K is less than or equal to 10^{-2} cm/sec. In aquifers of greater hydraulic conductivity the water level may return to static level before a sufficient number of water level readings can be made. In aquifers of low K (10^{-4} to 10^{-7} cm/sec), slug tests are generally a reliable field method of determining hydraulic conductivity or transmissivity near the screened zone of the well.

The advantages of using slug tests to estimate hydraulic conductivities are:

1. Estimates can be made in situ and errors incurred in laboratory testing of disturbed samples are avoided.

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2. Tests can be performed quickly at relatively low cost because a pumping well and observation wells are not required.

3. The hydraulic conductivity of small discrete portions of an aquifer can be made, for example, such as sand layers in a clay.

There are disadvantages in using slug tests which must be evaluated before the test is conducted. These include:

1. Only the hydraulic conductivity of the area immediately surrounding the well is estimated. These results may not be representative of the average hydraulic conductivity of the area.

2. Often only a range of hydraulic conductivity values rather than an average value can be deduced from test results.

3. Certain assumptions are made in the analysis process. If the assumptions made are inappropriate for the geologic conditions at the site, the results may be erroneous.

4. The storage coefficient, S, usually cannot be determined.

5. Data sufficient for analysis may not be collected if the hydraulic conductivity is relatively high.

This technical memorandum explains procedures and equipment commonly used in conducting most slug tests and a list of analysis techniques used under different geologic conditions and for different bore hole or well systems. Also included are example calculations of typical slug tests (Appendices 1-1 and 1-2).

1.1.2 DESIGN, DRILLING AND CONSTRUCTION OF SLUG TEST WELL

Several factors enter into the design of a well for the performance of slug testing. These include depth and diameter of the test well, length of screened interval and size of screen openings. Some of these factors can be chosen as drilling proceeds or be predetermined from previous borings. Well design is generally determined from a combination of drill cuttings, corings, and geophysical logging.

The depth and screened interval of the hole are determined by the location of the zone of interest. The diameter of the hole and casing to be inserted in the hole should be large enough in order that the volume of the slug does not overflow the top of casing. This may be a problem when the water level in the bore hole is relatively close to the ground surface. The screened interval should consist of screen with a percentage of open intervals large enough so as not to excessively restrict water flowing from the bore hole to the subsurface materials tested. Wells with screened intervals which require a gravel pack should be packed with material of a grain size distribution that would result in approximately an order of magnitude of higher hydraulic conductivity than the subsurface materials being tested.

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ATTACHMENT 1

BOREHOLE HYDRAULIC TESTING FOR AQUIFER CHARACTERIZATION

FORM 91-005-1 (4/81)

Hal Clayton
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ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

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Slug & Purge Tests

To: Hydrological Services Group

From: John Thackston

Date: May 15, 1985

Subject: Bore Hole Hydraulic Testing for Aquifer Characterization
Technical Memorandum No. 1

The purpose of the attached technical memo is to provide guidelines for conducting hydraulic tests in boreholes or wells in order to characterize the hydraulic properties of aquifers for the UMTRA Project.

Guidelines provided herein are intended to be supplementary to the standard operating procedures (SOP) for these activities currently in effect for the UMTRA Project. In the event there is overlap or conflicts in direction regarding procedures or methodology between this technical memo and the project SOP documents, please advise me. In all such cases, assume that the SOP directives take precedence.

JT:mas
Attachment

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TABLE 2 – Hydraulic Conductivities from Slug Test Analysis (ft/day)

Well ID-Date	Skibitsky	Ferris-Knowles	C-B-P	Bouwer-Rice	Hvorslev	Average	Hydro-Stratigraphic Unit
908							
4/11/85	0.96	0.10	0.41	—	—	0.4[a]	HONAKER TRAIL
7/31/85	0.48	0.10	0.40				
909							
4/10/85	0.002	0.10	0.12	—	—	0.03[b]	HONAKER TRAIL
8/14/85	0.80	0.23	0.31				
912							
8/14/85	—	—	—	0.67	1.56	0.6[b]	HALGAITO SHALE
				0.22			
930							
10/30/85	6.7×10^{-2}	1.9×10^{-1}	—	—	—	0.1[b]	HONAKER TRAIL
934							
11/1/85	7.6×10^{-3}	1.7×10^{-2}	—	—	—	0.04[b]	HONAKER TRAIL
	5.9×10^{-1}						
935							
11/1/85	1.0×10^{-2}	1.2×10^{-2}	—	—	—	0.04[b]	HONAKER TRAIL
	5.9×10^{-1}						

Average b.

HONAKER TRAIL Confined = 0.07 ft/day

HALGAITO SHALE Unconfined = 0.6 ft/day

a: Arithmetic Mean

b: Geometric Mean

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Attachment 2 - Slug Test Calculations

Attachment 3 - Slug Test Field Data Forms, Data Plots, and Computed Solutions.

Slug Test Analysis Input Data

TABLE 1 - SLUG TEST ANALYSES INPUT PARAMETERS

							Skibitzke		Bouwer-Rice					Hvorslev	Ferris-Knowles		C-B-P
WELL ID	DATE	METHOD	L^a(ft)	q^b(ft³)	r_c^a(ft)	R^a(ft)	t^b(min)	s^b(ft)	Y_0	$t_{(\phi)}$	Y_t	L_w(ft)	H(ft)	T_0	$1/t^b$(min⁻¹)	s^b(ft)	t^b(sec)
HAT01-908	04/11/85	S F-K C-B-P	15	0.05	0.083	0.2344	20	0.02	N/A	N/A	N/A	N/A	N/A	N/A	0.4	1.5	100
HAT01-909	04/10/85	S F-K C-B-P	20	0.05	0.083	0.2344	1860	0.09	N/A	N/A	N/A	N/A	N/A	N/A	0.2	0.6	250
HAT01-908	07/31/85	S F-K C-B-P	15	0.05	0.083	0.2344	20	0.04	—	—	—	—	—	—	0.4	1.6	100
HAT01-909	08/14/85	S F-R C-B-P	20	0.05	0.083	0.2344	36	0.01	—	—	—	—	—	—	0.4	0.5	95
HAT01-912	08/14/85	B-R H	8.0*	0.05	0.083	0.2344	—	—	0.47	360	0.042	8.0	8.0	1.4	—	—	—
							—	—	0.47	1440	0.02	8.0	8.0	—	—	—	—

a well completion records (UMTRA PDCS file HAT 9.19.2.5, JEG/JEG-0785-1983)

b Slug Test Data (UMTRA PDCS file HAT 9.19.2.5, no JEG number)

HAT01 930	10/30/85	S F-K C-B-P	10	0.217	0.167	0.3281	90	0.41	N/A	N/A	N/A	N/A	N/A	N/A	0.1	1.3	20 (s)
HAT01 934	11/1/85	S F-K C-B-B	10	0.217	0.167	0.6563	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.01	1.5	N/A
HAT01 935	11/1/85	S F-K C-B-P	10	0.217	0.167	0.6563	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.01	2.0	N/A

L = contributing interval length
q = volume discharged
r = well radius

R = borehole radius
C-B-P = Cooper-Bredehoeft-Papadopolus

* SCREEN IS 20 ft., HOWEVER ONLY 8 FT. IS SATURATED

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Cooper-Bredehoeft-Papadopulos Method

A detailed description of the Cooper-Bredehoeft-Papadopulos method of slug test analysis is presented in Lohman, 1972. The equation used to calculate the hydraulic conductivity is:

$$K = \frac{r_c^2}{tL}$$

where t is obtained from matching the data points of residual drawdown/ initial residual drawdown versus log of time to a type curve found in Lohman, 1972.

Ferris-Knowles Method

A detailed description of the Ferris-Knowles method of slug test analysis is presented in the USGS Water-Supply paper 1536-I, 1963. The equation used to calculate the hydraulic conductivity is:

$$K = \frac{q\,(1/t)}{4\pi s L}$$

The values of 1/t and s are obtained from a straight line fit through the data points. The method is valid for large values of t and the straight line fit passing through the origin.

Skibitske Method

A detailed description of the Skibitske method of slug test analysis is presented in the USGS Water-Supply paper 1536-I, 1963. The equation used to calculate the hydraulic conductivity is:

$$K = \frac{q}{4\pi S L t}$$

The method is used in wells completed in confined units with low permeability. The residual drawdown should be at the last measurement before complete recovery.

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RESULTS:

Table 1 shows the input data for the slug test calculations for each monitor well tested and for each applicable analysis technique. Table 2 shows the hydraulic conductivities for each slug test method for the respective monitor wells tested.

CONCLUSIONS:

Based on analyses of slug tests conducted in monitor wells at the Mexican Hat site, the average hydraulic conductivity in the Halgaito Shale unconfined hydrostratigraphic unit is approximately 0.6 ft/day. The average hydraulic conductivity in the Honaker Trail confined hydrostratigraphic unit is approximately 0.07 ft/day.

Slug tests yield only a rough approximation of the hydraulic conductivity of an aquifer, and these values should be considered to be an order-of-magnitude estimate of the hydraulic conductivity. Furthermore, the area of influence of a slug test extends only a short distance from the borehole. Therefore, results from slug tests should not be inferred to be valid at a significant distance away from the area of influence.

Because pumping tests are usually more accurate than slug tests for estimating hydraulic conductivity , any critical engineering design should be based primarily on the results of pumping tests, rather than slug tests.

REFERENCES: Computer Program in BASIC - Slug/BAS, On file w/ UMTRA TAC KAL 8/6/91

Bouwer, H., 1978, Groundwater Hydrology, McGraw-Hill Company, N.Y., N.Y., pp. 114-118.

Bouwer, H. and R. C. Rice, 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, 12:423-428.

Hvorslev, M. J., 1951, Time Lag and Soil Permability in Ground Water Observations, Bullentin 36, 50pp., U.S. Army Corps of Engineers Waterways Experimentation Station, Vicksburg, Miss.

Lohman, S.W., 1972, Groundwater Hydraulics, USGS Professional Paper 708, pp. 27-30.

U.S. Geological Survey, 1963, Methods of Determining Permeability, Transmissibility, and Drawdown, USGS Water-Supply Paper 1536-I, pp. 299-304

ATTACHMENTS

Attachment 1 - Technical Memo No. 1: Borehole Hydraulic Testing for Aquifer Characterization.

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MEXICAN HAT CALCULATION HAT-07-91-14-02-00

SLUG TEST ANALYSES FOR MONITOR WELLS: MEXICAN HAT PROCESSING/DISPOSAL SITE

PURPOSE:

The purpose of this calculation is to estimate the hydraulic conductivity of the hydrostratigraphic units at the Mexican Hat site. The results of these calculations will be used in groundwater velocity calculations for the Mexican Hat site.

METHOD AND PROCEDURES:

Slug test data were collected from monitor wells 908, 909, 912, 930, 934, and 935 in 1985. Slug test data were evaluated using the following methods:

Unconfined System

Bouwer-Rice and Hvorslev

Confined System

Cooper-Bredehoeft-Papadopulos, Ferris-Knowles, and Skibitske

For further information refer to Technical Memo No. 1 (May 15, 1985; Attachment 1) and Technical Memo No. 5 (June 10, 1985; Attachment 2) on slug test analysis.

ASSUMPTIONS:

Refer to Technical Memo No. 1 and No. 5 for specifics to each slug test method.

DATA SOURCES:

All slug test data was collected by UMTRA Technical Assistance Contractor (TAC) staff in April, July, August, October, and November 1985. Slug test field data forms, graphical plots, and computed solutions are included in Attachment 3.

CALCULATIONS AND ANALYSES:

BOUWER-RICE METHOD

A detailed description of the Bouwer-Rice method of slug test analysis is presented in Bouwer and Rice, 1976. The equation used to calculate the hydraulic conductivity is:

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L(t)} \ln\left(\frac{Y_0}{Y_t}\right)$$

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where y_0 is y-intercept at time zero, y_t is y-intercept at time t, and all other parameters are indicated in Tech Memo No. 5.

The dimensionless ratio $\ln(R_e/r_w)$ is fitted using two equations, one for the case where $L_w<H$, and one for the case where $L_w=H$. These equations are, respectively,

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{A+B\ln[(H-L_w)/r_w]}{(L_e/r_w)}\right]^{1/2}$$

$$\ln \frac{R_e}{R_w} = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{C}{(L_e/r_w)}\right]^{1/2}$$

where A, B, and C are dimensionless numbers, plotted a function of L_e/r_w (see Tech Memo No. 5).

The parameter $[\ln(y_0/y_t)]/t$ is determined by plotting the residual drawdown versus time on semilog paper, fitting a straight line to the curve, then estimating y_0 (y at time zero), and then selecting a point on the line and determining y_t at time t.

Occasionally, the water table is located below the top of the gravel pack. In this case, the thickness and porosity of the gravel pack should be taken into account when calculating the equivalent value of r_c, the casing radius. The equation used to calculate the equivalent value of r_c for this situation is:

$$r_c = [(1-n)r_c^2 + nr_w^2]^{.5}$$

Note also that slug injection tests should be considered invalid for this particular case, as these tests will overestimate the hydraulic conductivity due to the influence of the gravel pack.

HVORSLEV METHOD

A detailed description of the Hvorslev method of slug test analysis is presented in Hvorslev, 1951. The equation used to calculate the hydraulic conductivity is:

$$K = \frac{r^2 \ln(L/R)}{2 L T_0}$$

where T_0 is the time it takes for the water level to rise or fall to 37 percent of the initial change. All other parameters are indicated in Tech Memo No. 5.

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. HAT-079-1402-00 **DISCIPLINE** Hydro **NO. OF SHEETS** 92

PROJECT: UMTRA

SITE: HAT 01 - Mexican HAT Processing Site / Disposal Site (SOS)
- Stabilization On Site

FEATURE: Slug Test Analysis - Used to determine hydraulic conductivity of hydrostratigraphic units at the site

SOURCES OF DATA: Slug Test Data collected on the following monitor wells along with dates the test were conducted.

HAT 01	Dates	HAT 01	Dates	HAT 01	Dates
908	4/11/85 7/31/85	912	8/14/85	934	11/1/85
909	4/10/85 8/14/85	930	10/30/85	935	11/1/85

SOURCES OF FORMULAE & REFERENCES:

USGS Water Supply Paper 1536-I, Methods [illegible]
[illegible] and Drawdown [illegible]
[illegible] by Bentall

Bouwer, H. Groundwater Hydrology 1978.
Computer Program in BASIC - Slug/BAS, On file w/ UMTRA-TAC
U.S.G.S. Professional Paper 708, Groundwater Hydraulics 1972, by S.W. Lohman
Hvorslev M.J. 1951, Bulletin No. 36 U.S. Corps Engineers [illegible]

PRELIMINARY CALC. ☑ **FINAL CALC.** ☐ **SUPERSEDES CALC. NO.** _____

REV. NO	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
		K Lambert	7/19/91	[illegible]	7/31/91	KTB	[illegible]

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JACOBS ENGINEERING

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

MTL 7/30/91 Cap 7/31/91

Skibitzc Method

HAT01-908 :

$$K = \frac{q}{4\pi s L t}$$

$$= \frac{0.05\ ft^3}{4\pi (0.02\ ft)(15\ ft)(20\ min)}$$

$$= 6.63146 \times 10^{-4}\ \frac{ft}{min}\left(\frac{1440\ min}{1\ day}\right)$$

$$= 0.96\ \frac{ft}{day}$$ ✓ KAL 7/10/91 ✓ Cap

HAT01-909 :

$$K = \frac{q}{4\pi s L t}$$

$$= \frac{0.05\ ft^3}{4\pi (0.09\ ft)(20\ ft)(1860\ min)}$$

$$= 1.18843 \times 10^{-6}\ \frac{ft}{min}\left(\frac{1440\ min}{day}\right)$$

$$= 0.002\ \frac{ft}{day}$$ ✓ KAL 7/10/91 ✓ Cap

FORM 91-006-1 (4/81)

JACOBS ENGINEERING

KAL 7/30/91 Cap

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. 7/31/91

Ferris-Knowles Method

HAT01-908:

$$K = \frac{q(1/t)}{4\pi s L}$$

$$= \frac{0.05\ ft^3\ (0.4\ min^{-1})}{4\pi\ (1.5\ ft)(15\ ft)}$$

$$= 2.07355 \times 10^{-5}\ \frac{ft}{min}\left(\frac{1440\ min}{1\ day}\right)$$

$$= 0.1\ \frac{ft}{day}$$ ✓ KAL 7/10/91 ✓ Cap

HAT01-909:

$$K = \frac{q(1/t)}{4\pi s L}$$

$$= \frac{(0.05\ ft^3)(0.2\ min^{-1})}{4\pi\ (0.6\ ft)(20\ ft)}$$

$$= 6.63146 \times 10^{-5}\ \frac{ft}{min}\left(\frac{1440\ min}{1\ day}\right)$$

$$= 0.1\ ft/day$$ ✓ KAL 7/10/91 ✓ Cap

FORM 91-006-1 (4/81)

JACOBS ENGINEERING

DATE _____ SUBJECT _____ SHEET NO. Cap

BY _____ CHKD. _____ JOB NO. 7/31/91

Cooper - Bredehoeft - Papadopolous Method

HAT01-908 :

$$K = \frac{r_c^2}{tL}$$

$$= \frac{(0.083\ ft)^2}{(100\ sec)(13\ ft)}$$

$$= 4.59267 \times 10^{-6}\ \frac{ft}{sec}\left(\frac{86400\ s}{1\ day}\right)$$

$$= 0.40\ ft/day$$

✓ KAL 9/10/91
✓ Cap

HAT01-909 :

$$K = \frac{r_c^2}{tL}$$

$$= \frac{(0.083\ ft)^2}{(250\ sec)(20\ ft)}$$

$$= 1.3778 \times 10^{-6}\ \frac{ft}{sec}\left(\frac{86400\ sec}{1\ day}\right)$$

$$= 0.12\ ft/day$$

✓ KAL 7/10/91
✓ Cap

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

7/30/
9/31/91

SLUG TEST DATA

SITE ID: Hat 01 LOCATION ID: 912

SLUG VOLUME (ft.³): 0.05 FT³

INITIAL WATER LEVEL:

DATE: 85/07/28

TIME: 1:30 P

DEPTH (ft FROM TOC): 74.48

STATIC WATER LEVEL:

DATE: 85/8/14 TIME: 3:40p

DEPTH (ft): 74.13

OPEN INTERVAL 62.0 FT to 82.0 FT

TOTAL DEPTH OF WELL (ft): 81.50

WELL DIAM. (ft): .167

OBSERVERS: Fritts

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
:00	74.13			
.5	74.60			
1.00	74.49			
.5	74.39			
2.00	74.33			
.5	74.32			
3.00	74.27			
.5	74.24			
4.00	74.23			
.5	74.20			
5.00	74.20			
6.00	74.18			
7.00	74.18			
8.00	74.18			
10.00	74.18			
12.00	74.16			
14.00	74.16			
18.00 19.00	74.16			
24.00	74.15			
29.00	74.15			

COMMENTS: dropped slug 85/7/29 5:30 pm
pulled slug 85/8/14 3:40p

Page 1 of 2

Note: Water samplers not working 85/8/2 - 8/13

KAL
7/30/91
Cap
7/31

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Hot Ø1 LOCATION ID: 912

STATIC WATER LEVEL:
DATE: 85/8/14 TIME:

SLUG VOLUME (ft.^{3}):

DEPTH (ft):

INITIAL WATER LEVEL (AT t_o):

OPEN INTERVAL (ft.) to

DATE:

TOTAL DEPTH OF WELL (ft):

TIME:

WELL DIAM. (ft):

DEPTH (ft FROM TOC):

FIELD REP:

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
35.00	74.16			
40.00	74.16			

COMMENTS:
page 2 of 2

JEG-AL-ENG-8 (3/84)

SLUG TEST SOLUTIONS

KAL 7/30/91
cap 7/31/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-912   EARLY TIME DATA
DATE OF FIELD TEST- 08/14/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     8
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=   .083
BOREHOLE RADIUS(Rw)=   .2344
HEAD AT To(Yo)=   .47
TIME TO HEAD MEASUREMENT(t)=   360 SEC
HEAD AT TIME t(Yt)=   .042
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=   8
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=   8
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  7.73255E-06 FT/SEC = 0.67 FT/DAY
*****************************************************************
```

$\frac{Le}{r_w} = 34.13$

$C \cong 2.2$

$\ln \frac{Re}{r_w} = 2.66$

$\ln\left(\frac{y_0}{y_t}\right) = 2.415$

KAL 7/12/91
✓cap

```
*****************************************************************
WELL IDENTIFICATION- HAT01-912   LATE TIME DATA
DATE OF FIELD TEST- 08/14/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     8
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=   .083
BOREHOLE RADIUS(Rw)=   .2344
HEAD AT To(Yo)=   .47
TIME TO HEAD MEASUREMENT(t)=   1440 SEC
HEAD AT TIME t(Yt)=   .02
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=   8
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=   8
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.52702E-06 FT/SEC = 0.22 FT/DAY
*****************************************************************
```

$\frac{Le}{r_w} = 34.13$

$C = 2.2$

$\ln \frac{Re}{r_w} = 2.66$

$\ln\left(\frac{y_0}{y_t}\right) = 3.16$

✓cap KAL 7/12/91

```
*****************************************************************
WELL IDENTIFICATION- HAT01-912
DATE OF FIELD TEST- 08/14/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=     8
HVORSLEV METHOD
FOR WELL RADIUS(r)=   .083
BOREHOLE RADIUS(R)=   .2344
AND TIME LAG(To)=   1.4 MIN
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.08568E-03 FT/MIN = 1.56 FT/DAY
*****************************************************************
```

✓ KAL
✓cap 7/11/91

RAL
7/30/91
CAP
7/31/91

SLUG TEST DATA

SITE: HAT01 MEXICAN HAT
LOCATION: 912
DATE: 08/14/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	74.13	.00	.0000
.50	2.00000	30	74.60	-.47	-.2051
1.00	1.00000	60	74.49	-.36	-.1571
1.50	.66667	90	74.39	-.26	-.1134
2.00	.50000	120	74.33	-.20	-.0873
2.50	.40000	150	74.32	-.19	-.0829
3.00	.33333	180	74.27	-.14	-.0611
3.50	.28571	210	74.24	-.11	-.0480
4.00	.25000	240	74.23	-.10	-.0436
4.50	.22222	270	74.20	-.07	-.0305
5.00	.20000	300	74.20	-.07	-.0305
6.00	.16667	360	74.18	-.05	-.0218
7.00	.14286	420	74.18	-.05	-.0218
8.00	.12500	480	74.18	-.05	-.0218
10.00	.10000	600	74.18	-.05	-.0218
12.00	.08333	720	74.16	-.03	-.0131
14.00	.07143	840	74.16	-.03	-.0131
19.00	.05263	1140	74.16	-.03	-.0131
24.00	.04167	1440	74.15	-.02	-.0087
29.00	.03448	1740	74.15	-.02	-.0087
35.00	.02857	2100	74.16	-.03	-.0131
40.00	.02500	2400	74.16	-.03	-.0131

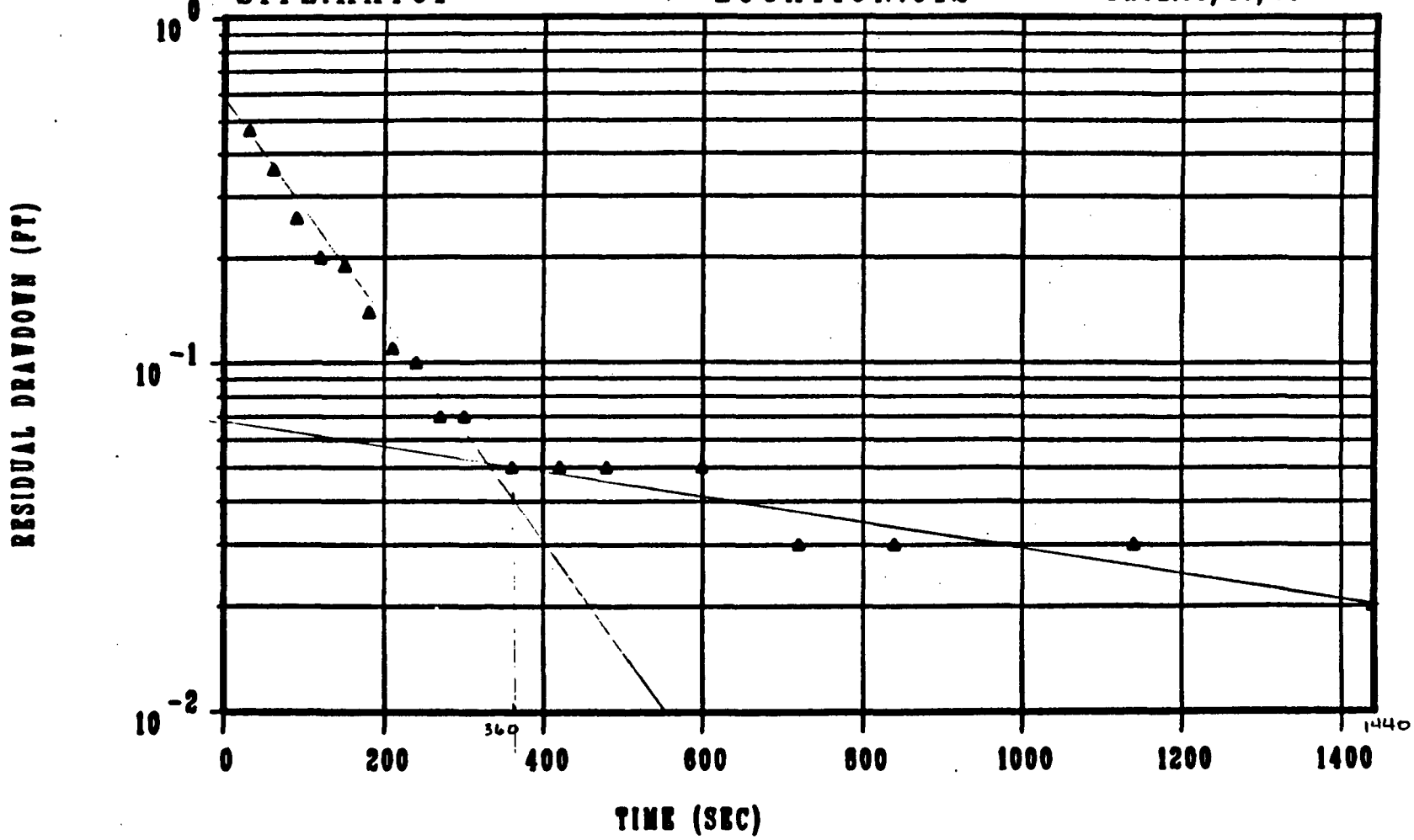
FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

UMTRA*EZPLOTJD09
UMTRA*EZPLOTJD10
UMTRA*EZPLOTJD11
UMTRA*EZPLOTJD12

@1

BOUWER-RICE SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:912 DATE:08/14/85

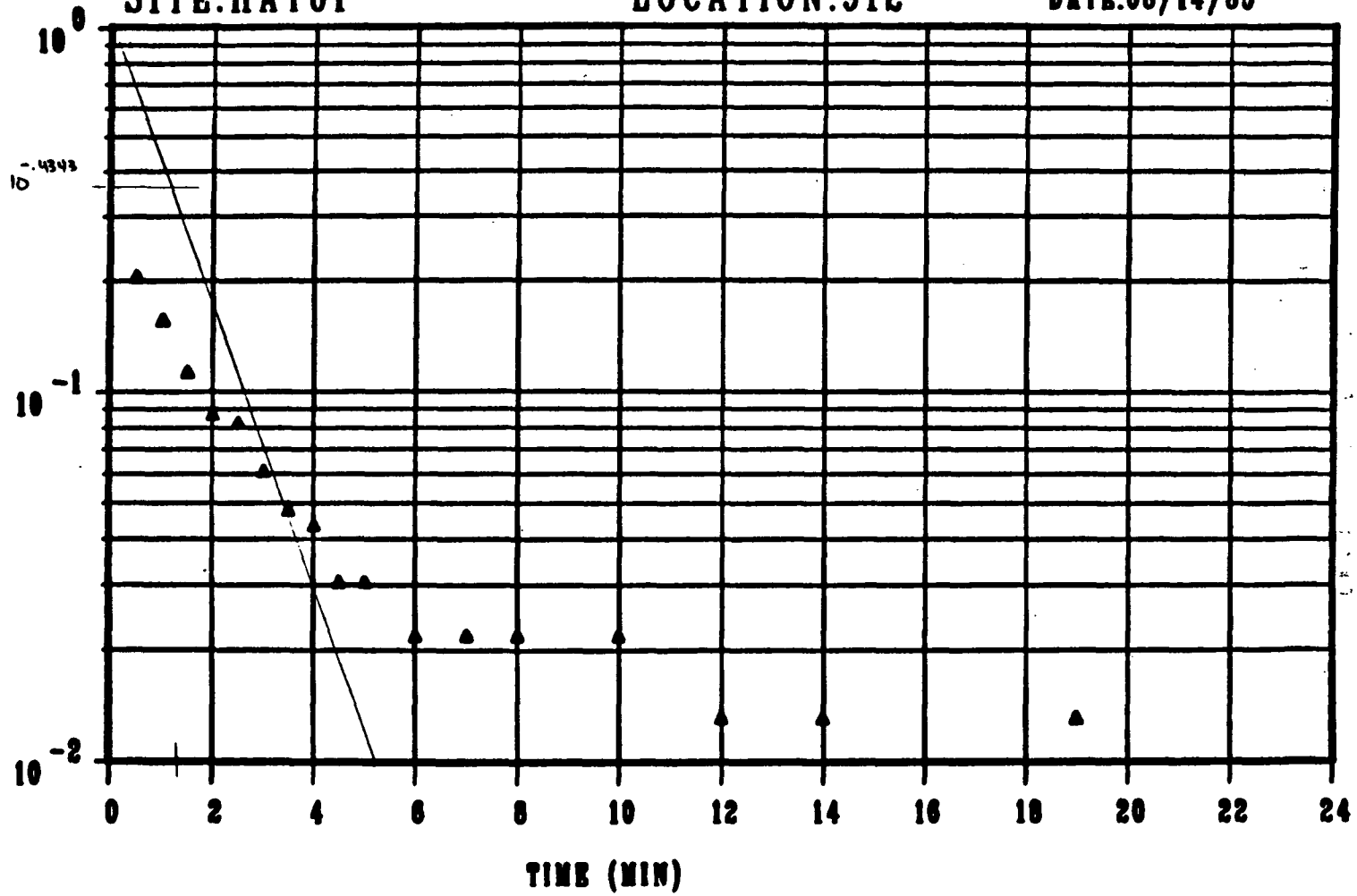


KAL 7/30/91

7/31/91

HVORSLEV SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:912 DATE:08/14/85



RAC 7/30/91

7/31/91

KAL
7/30/91
caf
7/31/91

SLUG TEST DATA

SITE: HAT01 MEXICAN HAT
LOCATION: 909
DATE: 08/14/85

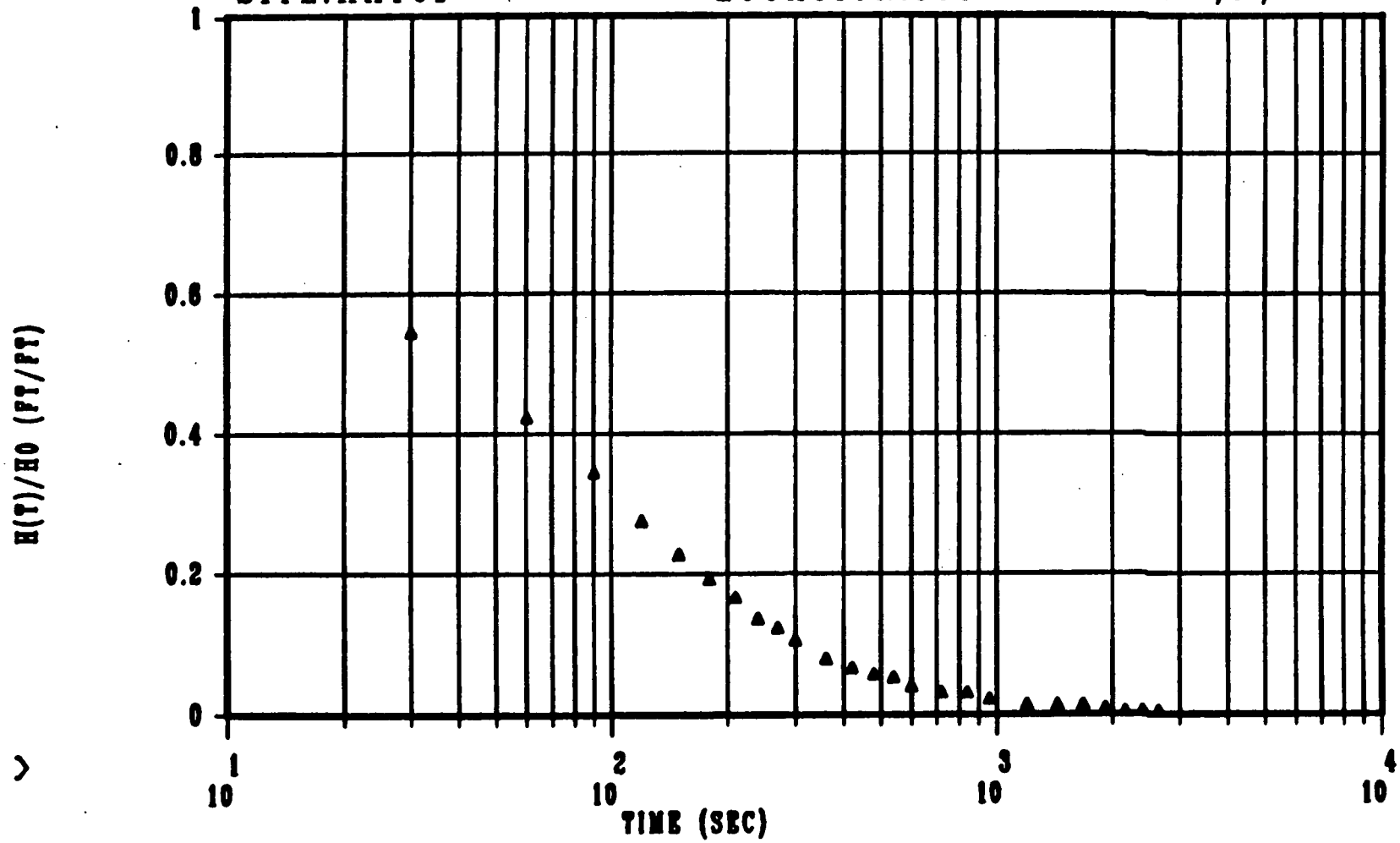
---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT]/HO [FT./FT.]
.00	.00000	0	35.96	.00	.0000
.50	2.00000	30	37.21	-1.25	-.5454
1.00	1.00000	60	36.93	-.97	-.4232
1.50	.66667	90	36.75	-.79	-.3447
2.00	.50000	120	36.59	-.63	-.2749
2.50	.40000	150	36.48	-.52	-.2269
3.00	.33333	180	36.40	-.44	-.1920
3.50	.28571	210	36.34	-.38	-.1658
4.00	.25000	240	36.27	-.31	-.1353
4.50	.22222	270	36.24	-.28	-.1222
5.00	.20000	300	36.20	-.24	-.1047
6.00	.16667	360	36.14	-.18	-.0785
7.00	.14286	420	36.11	-.15	-.0654
8.00	.12500	480	36.09	-.13	-.0567
9.00	.11111	540	36.08	-.12	-.0524
10.00	.10000	600	36.05	-.09	-.0393
12.00	.08333	720	36.03	-.07	-.0305
14.00	.07143	840	36.03	-.07	-.0305
16.00	.06250	960	36.01	-.05	-.0218
20.00	.05000	1200	35.99	-.03	-.0131
24.00	.04167	1440	35.99	-.03	-.0131
28.00	.03571	1680	35.99	-.03	-.0131
32.00	.03125	1920	35.98	-.02	-.0087
36.00	.02778	2160	35.97	-.01	-.0044
40.00	.02500	2400	35.97	-.01	-.0044
44.00	.02273	2640	35.97	-.01	-.0044

FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

UMTRA*EZPLOTJD05
UMTRA*EZPLOTJD06
UMTRA*EZPLOTJD07
UMTRA*EZPLOTJD08

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:HAT01 LOCATION:909 DATE:08/14/85



7/31/91
7/31/91

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JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. HAT079H40300 DISCIPLINE Hydro NO. OF SHEETS 37

PROJECT: UMTRA

SITE: HAT 01 - Mexican Hat Processing/Disposal site
SOS - Stabilization On Site

FEATURE: Packer Test Analyses - Used to determine hydraulic conductivity of hydrostratigraphic unit (Halgaito Shale Member) at the site

SOURCES OF DATA: Packer Test Data

HAT 01 - 911
2/22/85
2/27/85
2/28/85

SOURCES OF FORMULAE & REFERENCES:

USBR, 1981 Ground Water Manual
SOP 16.1.4 - Zone 3
Computer Program in BASIC - Packer/BAS, on file w/ UMTRA-TAC

PRELIMINARY CALC. ☑ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

REV. NO	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
		K. Tomlinson	7/23/91	[illegible]	8/1/91	KB	8/7/91

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KAL 8/1/91 1 Cap 8/1/91

MEXICAN HAT CALCULATION HAT-07-91-14-03-00

ANALYSES OF PACKER TESTS AT MEXICAN HAT UMTRA SITE

PURPOSE

The purpose of this calculation is to estimate the change in hydraulic conductivity with depth in the Halgaito Shale in the Mexican Hat tailings pile area. This was done by conducting packer tests at different depths in borehole 911. The primary control on hydraulic conductivity in the Halgaito Shale is probably from fractures. An east-west trending fracture pattern was observed in outcrop at the site.

METHOD AND PROCEDURES

Pressure permeability tests, using packers to segregate the test section in a borehole, are used to the estimate hydraulic conductivity of the interval being tested. The borehole is drilled to a given depth and a packer is seated at prescribed distances above the bottom of the borhole. Water is forced into the test section (between the packer and the bottom of the borehole) through combined applied pressure and gravity head.

The test method utilized is in conformance with the SOP from the Albuquerque Operations Manual and described in the U.S. Bureau of Reclamation Ground Water Manual (1981) (Attachment 1).

ASSUMPTIONS

Laminar flow exists within the test section.

Test water is clear and silt-free

The test water is a few degrees warmer than ground temperature. More detail on conditions specific to packer tests is given in Attachment 1.

DATA SOURCES

Field data was collected by UMTRA staff during February, 1985.

CALCULATIONS AND ANALYSES:

The packer tests were conducted on borehole 911 at the Mexican Hat site. A total of 12 tests were completed in the borehole. Input parameters for each packer test grouped according to the test interval are shown in Table 1. The field data is included in Attachment 2.

RESULTS

The input data and packer test hydraulic conductivity solutions are shown in Table 2. A summary of the resulting hydraulic

TABLE 1 - INPUT DATA FOR PACKER TESTS

Well ID: HAT01-911
Date: 02/22/85

Interval (ft)	Pressure[a] (psi)	Pressure Head (ft)	Elevation Head[a] (ft)	Total Head (ft)	Flow Rate[ab] (gpm)	Interval Length A (ft)	Borehole ~~Bath~~ Radius[a] r (ft)	A/r	Cond. Coef. Cs
64.5-74.5	21.5	49.2	68.2	117.65	2.16	10	0.125	80	105
74.5-84.5	10.0	23.0	68.2	91.20	0.8	10	0.125	80	105
	15.0	34.5	68.2	102.70	1.9	10	0.125	80	105
	20.0	46.0	68.2	114.20	1.5	10	0.125	80	105
84.5-94.5	25.0	57.5	68.2	125.70	1.5	10	0.125	80	105
	30.0	69.0	68.2	137.2	0	10	0.125	80	105
94.5-104.5	20.0	46.0	68.2	114.2	1.4	10	0.125	80	105
	22.0	50.6	68.2	118.8	0.1	10	0.125	80	105
	25.0	57.5	68.2	125.7	0.02	10	0.125	80	105
	30.0	69.0	68.2	137.2	0.09	10	0.125	80	105
53.5-64.5	11.0	25.3	62.2-68.2	87.5-93.5	5.17	11	0.125	88	110
	12.0	27.6	62.2-68.2	89.8-95.8	4.86	11	0.125	88	110

a Packer Test Data (UMTRA PDCS File HAT 9.19.2.5, JEG/JEG-0285-914)
b Σ volume removed ÷ elapsed time

JACOBS ENGINEERING
DATE ____ BY ____ CHKD. ____ SUBJECT ____ JOB NO. ____ SHEET NO. ____

FORM B1-005-1 (4/81)

KAL 8/11/91

TABLE 2 INPUT AND SOLUTIONS FOR PACKER TESTS

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/22/85
TEST INTERVAL 53.5 TO 64.5
NET TEST PRESSURE, FT OF WATER = 94.65
FLOW RATE (GPM) = 5.11 = 0.0114 cfs
A/R = 88
CONDUCTIVITY COEFFICIENT = 110

r = 0.125 ft

METHOD 1
PERMEABILITY (FT/SEC) = 8.44175E-06 = 0.73 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 2.57305E-04 ✓ cap

METHOD 2
PERMEABILITY (FT/SEC) = 8.74873E-06 = 0.76 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 2.66661E-04 ✓ cap
PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/22/85
TEST INTERVAL 64.5 TO 74.5
NET TEST PRESSURE, FT OF WATER = 117.65
FLOW RATE (GPM) = 2.16 = 0.005 cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 3.00243E-06 = 0.26 FT/DAY ✓ KAL 7/11/91 ✓ cap
PERMEABILITY (CM/SEC) = 9.1514E-05

METHOD 2
PERMEABILITY (FT/SEC) = 3.11681E-06 = 0.27 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 9.50002E-05 ✓ cap
PACKER TEST PERMEABILITY

****

TABLE 2 CONT.

8/11/91 C

8/11

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/21/85
TEST INTERVAL 64.5 TO 74.5
NET TEST PRESSURE, FT OF WATER = 117.65
FLOW RATE (GPM) = 5.11
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 7.10296E-06 = 0.61 FT/DAY
PERMEABILITY (CM/SEC) = 2.16498E-04

METHOD 2
PERMEABILITY (FT/SEC) = 7.37355E-06 = 0.64 FT/DAY
PERMEABILITY (CM/SEC) = 2.24746E-04

NOT VALID

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/22/85
TEST INTERVAL 74.5 TO 84.5
NET TEST PRESSURE, FT OF WATER = 91.2
FLOW RATE (GPM) = .8 = 0.002 cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 1.43452E-06 = 0.12 FT/DAY ✓ KAL 7/11/91 . cap
PERMEABILITY (CM/SEC) = 4.37241E-05

METHOD 2
PERMEABILITY (FT/SEC) = 1.48917E-06 = 0.13 FT/DAY ✓ KAL 7/11/91 ✓ cap
PERMEABILITY (CM/SEC) = 4.53898E-05

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/22/85
TEST INTERVAL 74.5 TO 84.5
NET TEST PRESSURE, FT OF WATER = 102.7
FLOW RATE (GPM) = 1.9 = 0.004 cfs
10/125 A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 3.02548E-06 = 0.26 FT/DAY ✓ KAL 7/11/91 ✓
PERMEABILITY (CM/SEC) = 9.22165E-05

METHOD 2
PERMEABILITY (FT/SEC) = 3.14073E-06 = 0.27 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 9.57295E-05

TABLE 2 CONT.

KAL 8/1/91 CG 8/1/9

PACKER TEST PERMEABILITY

****
SITE: HAT01
BOREHOLE: 911
DATE: 02/22
TEST INTERVAL 74.5 TO 84.5
NET TEST PRESSURE, FT OF WATER = 114.2
FLOW RATE (GPM) = 1.5 = 0.003 cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 2.14801E-06 = 0.19 FT/DAY ✓ KAL 7/11/91 ✓ cap
PERMEABILITY (CM/SEC) = 6.54713E-05

METHOD 2
PERMEABILITY (FT/SEC) = 2.22984E-06 = 0.19 FT/DAY ✓ KAL 7/11/91 ✓ cap
PERMEABILITY (CM/SEC) = 6.79654E-05
PACKER TEST PERMEABILITY

****
SITE: HAT01
BOREHOLE: 911
DATE: 02/27/85
TEST INTERVAL 84.5 TO 94.5
NET TEST PRESSURE, FT OF WATER = 125.7
FLOW RATE (GPM) = 1.5 = 0.003 cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 1.95149E-06 = 0.17 FT/DAY ✓ KAL 7/11/91 ✓ cap
PERMEABILITY (CM/SEC) = 5.94815E-05

METHOD 2
PERMEABILITY (FT/SEC) = 2.02583E-06 = 0.18 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 6.17474E-05
PACKER TEST PERMEABILITY ✓ cap

****
SITE: HAT01
BOREHOLE: 911
DATE: 02/27/85
TEST INTERVAL 84.5 TO 94.5
NET TEST PRESSURE, FT OF WATER = 137.2 ✓ KAL 7/11/91
FLOW RATE (GPM) = 0
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 0
PERMEABILITY (CM/SEC) = 0

METHOD 2
PERMEABILITY (FT/SEC) = 0
PERMEABILITY (CM/SEC) = 0

8/11/91 C.

8/11

TABLE 2 - CONT

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/28/85
TEST INTERVAL 94.5 TO 104.5
NET TEST PRESSURE, FT OF WATER = 114.2
FLOW RATE (GPM) = 1.4 = 0.003 cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 2.00481E-06 = 0.17 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 6.11065E-05

METHOD 2
PERMEABILITY (FT/SEC) = 2.08118E-06 = 0.18 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 6.34344E-05

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/28/85
TEST INTERVAL 94.5 TO 104.5
NET TEST PRESSURE, FT OF WATER = 118.8
FLOW RATE (GPM) = .1 = 0.0002 cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 1.37656E-07 = 0.01 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 4.19575E-06

METHOD 2
PERMEABILITY (FT/SEC) = 1.429E-07 = 0.01 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 4.35558E-06

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/28/85
TEST INTERVAL 94.5 TO 104.5
NET TEST PRESSURE, FT OF WATER = 125.7
FLOW RATE (GPM) = .02 = 4.5×10^{-5} cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 2.60199E-08 = 0.002 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 7.93086E-07

METHOD 2
PERMEABILITY (FT/SEC) = 2.70111E-08 = 0.002 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 8.23299E-07

7/11/91 c 8/1

TABLE 2-CONT.

PACKER TEST PERMEABILITY

****

SITE: HAT01
BOREHOLE: 911
DATE: 02/28/85
TEST INTERVAL 94.5 TO 104.5
NET TEST PRESSURE, FT OF WATER = 137.2
FLOW RATE (GPM) = .09 = 2×10^{-4} cfs
A/R = 80
CONDUCTIVITY COEFFICIENT = 105

METHOD 1
PERMEABILITY (FT/SEC) = 1.07275E-07 = 0.01 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 3.26975E-06 ✓ cap

METHOD 2
PERMEABILITY (FT/SEC) = 1.11362E-07 = 0.01 FT/DAY ✓ KAL 7/11/91
PERMEABILITY (CM/SEC) = 3.39431E-06 ✓ cap

8/1/91 CL
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conductivities by depth interval is shown in Table 3.

CONCLUSIONS

Based on analyses of packer tests conducted in monitor well 911 at different depths in the Halgaito Shale, there is a decrease in hydraulic conductivity with depth (Table 3). There is over an order of magnitude decrease in hydraulic conductivity from the shallowest section tested (53.5 - 64.5 feet) to the deepest section tested (94.5 to 104.5 feet). This provides evidence that either fracture density decreases with depth or fracture width decreases with depth due to occlusion from crystal growth or other means. Given the very low hydraulic conductivity of the lower Halgaito Shale, this zone may act as an aquitard to the underlying Honaker Trail Formation.

REFERENCES

Albuquerque Operations Manual, SOP 16.1.4

U.S. Bureau of Reclamation, 1981, Ground Water Manual, Water Resources Technical Publication, pp. 249 - 264.

Computer Programs BASIC - Packer/BAS, On file w/ UMTRA-TAC
KAL 8/6/91

✓ KAL 7/23/91 C 8/1

TABLE 3 — Summary Packer Test Results

7/23/91 SITE ID: HAT01-911

Date	Interval (ft)	Hydraulic Conductivity (ft/day) Method 1	Method 2	Average
2/22/85	53.5 - 64.5	0.73	0.76	0.745 a.
	64.5 - 74.5	0.26	0.27	0.265 a.
	74.5 - 84.5	0.12	0.13	
		0.26	0.27	0.194 a.
		0.19	0.19	
2/27/85	84.5 - 94.5	0.17	0.18	0.175 a.
		0	0	
2/28/85	94.5 - 104.5	0.17	0.18	
		0.01	0.01	0.014 b.
		0.002	0.002	
		0.01	0.01	

GEOMETRIC MEAN FOR TOTAL HALGAITE SHALE THICKNESS: 0.16 ft/day

a: ARITHMETIC MEAN

b: GEOMETRIC MEAN

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JACOBS ENGINEERING

RAF 8/1/91 CA 8/14

DATE _____ SUBJECT

SHEET NO. _____

BY _____ CHKD. _____

JOB NO. _____

ATTACHMENT 1

PACKER TEST (PRESSURE PERMEABILITY)

METHODOLOGY

FORM 91-005-1 (4/81)

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section in the hole. In pressure tests, water is forced into the test section through combined applied pressure and gravity head, although the tests can be performed using gravity head only. In falling head tests, gravity head only is used. Constant head gravity tests are those in which no packers are used, and a constant water level is maintained [1].[1]

10-2. Pressure Permeability Tests in Stable Rock.—Pressure permeability tests are run using one or two packers to isolate various zones or lengths of drill hole in stable rock. Hole diameters usually do not exceed 3½ inches, but larger holes can also be tested if suitable equipment is available. The tests may be run in vertical, angled, or horizontal holes and analyzed if the head and zone relationships can be determined. Pressure tests are often the only practical tests to use when it is necessary to determine permeability of streambeds or lakebeds below water.

Compression packers, inflatable packers, leather cups, and similar types of packers have been used for pressure testing. Inflatable packers are usually more economical because they reduce testing time and assure a tighter seal, particularly in rough-walled or out-of-round holes. The packers are inflated through tubes extending to a cylinder of air or nitrogen at the surface. If a pressure sensing instrument is included, pressure in the test section is sensed by the instrument and is transmitted to the surface by an electrical circuit where it is either read from a register at the surface or is recorded on a chart. Although this arrangement permits an accurate determination of test pressures, other observations outlined in this section should still be made to permit an estimate of permeability should the pressure sensor fail. This double packer arrangement permits successive tests at different depths in a completed hole without having to remove the packer between each test. The pressure sensor can also be adapted where a single packer is used.

(a) *Methods of Testing.*—The most common testing practice by the Bureau is the drilling of about 10 feet of hole and pressure testing the newly drilled section. In rock that tends to ravel or bridge the hole and which must be cemented to permit continuation of drilling, this is the only practical method of testing. In such rock, long lengths of open hole are impractical and the test sections must be kept short because the tests must be made before the hole is cemented if good test data are to be obtained.

Where the rock is stable and does not require cementing, the following method of testing may offer distinct advantages. The hole

[1] Numbers in brackets refer to items in the bibliography, section 10-5.

is drilled to the total depth without testing. Two inflatable packers 5 to 10 feet apart are mounted near the bottom of the rod or pipe used for making the test. The bottom of the rod or pipe is sealed, and the section between the packers is perforated. The perforations should be at least one quarter of an inch in diameter, and the total area of all perforations should be greater than two times the inside cross-sectional area of the pipe or rod. Tests are made beginning at the bottom of the hole. After each test, the packers are raised the length of the test section and another test made. This procedure is followed until the entire length of the hole has been tested.

(b) *Cleaning Test Sections Before Testing.*—Before each test, the test section should be surged with clear water and bailed out to clean cuttings and drilling fluid from the face of the hole. If the test section is above the water table and will not hold water, water should be poured into the hole during the surging, then bailed out as rapidly as possible. When a completed hole is tested using two packers, the entire hole can be cleaned in one operation. Cleaning the hole is frequently omitted from testing procedures; however, this omission may result in a permeable rock appearing to be impermeable because the hole face is sealed by cuttings or drilling fluid. In such cases, the computed permeability will be lower than the true permeability.

Alternative methods to surging and bailing a drill hole in consolidated formations before pressure testing include the use of a rotating, stiffly bristled brush while washing and jetting with water. An average jet velocity of 150 feet per second is desirable. This is approximated by a rate of pumping equal to 1.4 gallons per minute per $\frac{1}{16}$-inch-diameter hole in the rod. On completion of jetting, the hole should be blown or bailed out to the bottom, if possible.

(c) *Length of Test Section.*—The length of the test section is governed by the character of the rock, but generally a length of 10 feet is desirable. At times, a good seal cannot be obtained for the packer at the planned elevation because of bridging, raveling, or the presence of fractures. Under these circumstances, the test section length should be increased or decreased or test sections overlapped to assure that the test is made with well-seated packers. On some tests, a 10-foot section will take more water than the pump can deliver; hence, no back pressure can be developed. When this occurs, the length of the test section should be shortened until back pressure can be developed, or the falling head test (sec. 10–4) might be tried.

The test sections should never be shortened to where the ratio $\frac{A}{D}$ is less than 5, where D is the diameter of the hole and A is the length of the test section. Under no circumstances should a packer be set inside

12 KH 9/1/9. Cap 8/1/91

the casing when
the hole. Excep
sections greater tha
sections may not pe
and may complicate

(d) *Size of Rod or*
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(e) *Pumping Equ*
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(f) *Swivels for U*
selected for minimun

A. Grottman

JACOBS ENGINEERING

DATE _____ SUBJECT

BY _____ CHKD. _____

SHEET NO. KHL 8/1/91 19 CAP

JOB NO. 8/1/91

ATTACHMENT 2

PACKER TEST FIELD DATA

FORM 91-005-1 (4/81)

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RAL 8/1/91 Cog 8/1/91

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

Page 1 of 2

PACKER (DRILL STEM) TEST

SITE ID: HAT-01 LOCATION ID: 911 LOG DATE: 2-21-85

LOGGING COMPANY: Jacobs/SHB FIELD REP.: R. Holland

TESTED INTERVAL:

BEGINNING DEPTH 64.5 END DEPTH 74.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL Siltstone 64.5-74.5

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 74.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) NA

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) NA

(AT START OF FIRST TEST)

TIME INTERVAL (MIN)	VOLUME REMOVED ~~(GAL)~~ ft³	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
0.5	1.15		200
1.0	1.3	~~22~~ 21.5	
1.5	1.4		
2.0	1.5		
2.5	1.55		
3.0	1.7	~~22~~ 21.5.	
3.5	1.8		
4.0	1.9		
4.5	2.02		
5.0	2.15		
5.5	2.26		
6.0	2.37		
6.5	2.50		
7.0	2.62	~~22~~ 21.5	
7.5	2.73		
8.0	2.84		
8.5	2.95		

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

Not reading in water 2361.0

RAL 8/1/91 Cay 8/1/

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

Page 2 of 2

PACKER (DRILL STEM) TEST

SITE ID: HAT-01 LOCATION ID: 911 LOG DATE: 2/21/55

LOGGING COMPANY: Jacobs/SHB FIELD REP.: R. Holland

TESTED INTERVAL:

BEGINNING DEPTH 44.5 END DEPTH 74.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) DIA. (IN.)

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM)

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM)
(AT START OF FIRST TEST)

TIME INTERVAL (MIN)	VOLUME REMOVED (GAL) ft³	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
9.0	3.06	21.5	200
9.5	3.16		
10.0	3.27		
10.5	3.39		
11.0	3.50		
11.5	3.61		
12.0	3.72		
12.5	3.82		
13.0	3.92		
13.5	4.02		
14.0	[illegible]	20	
14.5	4.23		
15.0	4.34		

EQUIPMENT DESCRIPTION: air wire line Packer
Tigre Tiera Regest. Inc. Bimbar II

TOP PACKER: DEPTH (FT. BELOW DATUM) 44.5 LENGTH (FT.) 9'

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS: End of Packer Test @ 3:00 pm

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

JUN 28 1985

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

KAL 8/1/91

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PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850221

LOGGING COMPANY: JEG FIELD REP.: R. Holland

TESTED INTERVAL:

BEGINNING DEPTH 64.5 END DEPTH 74.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST-3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 74.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 3

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2

(AT START OF FIRST TEST)

4292.0

ELAPSE TIME (MIN)	VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
0.5	8.60	21.5	200
1.0	1.12		
1.5	0.75		
2	0.75		
2.5	0.37		
3	1.12		
3.5	0.75		
4	0.75		
4.5	0.90		
5	0.97		
5.5	0.82		
6	0.82		
6.5	0.97		
7	0.90		
7.5	0.83		
8	0.82		
8.5	0.82		

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

KAL 8/1/91

CG 8/1/9

PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850221

LOGGING COMPANY: JEG FIELD REP.: R. Holland

TESTED INTERVAL:

BEGINNING DEPTH 64.5 END DEPTH 74.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST-3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 74.5 DIA. (IN.) _____

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 3

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2

(AT START OF FIRST TEST)

ELAPSE TIME (MIN)	VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
9.0	0.82	21.5	200
9.5	0.75		
10	0.82		
10.5	0.90		
11	0.82		
11.5	0.82		
12	0.82		
12.5	0.75		
13	0.75		
13.5	0.75		
14	0.75		
14.5	0.82		
15	0.82		

EQUIPMENT DESCRIPTION: _____

TOP PACKER: DEPTH (FT. BELOW DATUM) _____ LENGTH (FT.) _____

PACKER TYPE: (S)INGLE/(D)OUBLE _____ TEST INTERVAL LENGTH (FT.) _____

COMMENTS: _____

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

ENTER

KAL 8/1/91

Cg 8/11

JUN 25 1985

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850222

LOGGING COMPANY: JEG FIELD REP.: R. Holland

TESTED INTERVAL:

BEGINNING DEPTH 74.5 END DEPTH 84.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST - 3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 84.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 3

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2

(AT START OF FIRST TEST)

Meas. Ref. Pt. 4292.0

ELAPSE TIME (MIN)	VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
0	0	10	200
0.5	.75	10	200
1	~~1.12~~ 0.37	10	200
1.5	~~1.12~~ 0	10	200
2	~~1.12~~ 0	10	200
		10	

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

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JUN 2 8 1985

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850222

LOGGING COMPANY: JEG FIELD REP.:

TESTED INTERVAL:

BEGINNING DEPTH 74.5 END DEPTH 84.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST-3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 84.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 3.0

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2

(AT START OF FIRST TEST)

ELAPSE TIME (MIN)		VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
0	~~2.5~~	0	15	200
0.5	3	1.12		
1	3.5	~~2.02~~ 0.90		
1.5	4	~~2.99~~ 0.97		
2	4.5	~~3.89~~ 0.9		
2.5	5	~~4.79~~ 0.9		
3	5.5	~~5.76~~ 0.97		
3.5	6	~~6.58~~ 0.82		
4	6.5	~~7.48~~ 0.9		
4.5	7	~~8.30~~ 0.82		
5	7.5	~~9.20~~ 0.9		
5.5	8	~~10.32~~ 1.12		
6	8.5	~~11.07~~ 0.75		
6.5	9	~~11.89~~ 0.82		
7	9.5	~~12.79~~ 0.9		
7.5	10.	~~13.61~~ 0.82		
	10.5			

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

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JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

PACKER (DRILL STEM) TEST

SITE ID: HAT61 LOCATION ID: 911 LOG DATE: 850222

LOGGING COMPANY: JEG FIELD REP.: B. HOLLAND

TESTED INTERVAL:

BEGINNING DEPTH 74.5 END DEPTH 84.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST-3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 84.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 3.0

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2

(AT START OF FIRST TEST)

ELAPSE TIME (MIN)		VOLUME REMOVED (GAL)		WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
0	11	0		20	200
0.5	10.5	0.6			200
1	12.5	~~1.72~~	1.12		200
1.5	12.5	~~2.47~~	0.75		200
2	13.5	~~3.22~~	0.75		200
2.5	13.0	~~4.11~~	0.89		400
3	14.5	~~4.86~~	0.75		400
3.5	13.5	~~5.61~~	0.75		200
4	13.5	~~6.43~~	0.82		
4.5	~~14.5~~	~~7.11~~	0.68		
5	14.5	~~7.63~~	0.52		
5.5	~~16.5~~	~~8.30~~	0.67		
6	15.5	~~9.05~~	0.75		
6.5	~~16.5~~	~~9.65~~	0.6		
7.0	18.5	~~10.25~~	0.6		
7.5	~~18.5~~	~~10.55~~	0.3		

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

Borehole 911 Packer test #3

RRC 8/1/91 Cof 8/1/91

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

Pg 1 of 2

PACKER (DRILL STEM) TEST

SITE ID: HM-01 LOCATION ID: 911 LOG DATE: 2/22/85

LOGGING COMPANY: Jacobs/SHB FIELD REP.: B. Holland

TESTED INTERVAL:

BEGINNING DEPTH 74.5 END DEPTH 84.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL Rock 74.5-84.5 From 39 feet

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 84.5 DIA. (IN.) 3" ~~5.875~~

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 3'

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) ~~55.43~~ ~~100.93~~ 68.2

(AT START OF FIRST TEST)

TIME INTERVAL (MIN)			VOLUME REMOVED ~~(GAL)~~ CU FT			WATER PRESSURE (PSI)			AIR PRESSURE (PSI)		
10 psi	15 psi	20 psi	10 psi	15 psi	20 psi	10 psi	15 psi	20 psi	10 psi	15 psi	20 psi
0	0	0	7.2	8.25	1.92				200	200	200
0.5	0.5	0.5	7.3	8.40 2.0	2.0 1.7						
1	1	1	7.35	8.52	2.15						
1.5	1.5	1.5	7.35	8.65 1.4	2.25 1.5						
2	2	2	7.35	8.71	2.35						↓
2.5	2.5	2.5	Test	8.89 1.8	2.47 1.6						400
3	3	3	Stopped	9.02	2.57						↓
3.5	3.5	3.5	Formation	9.13 1.7	2.67						200
4	4	4	Refusal	9.25	2.78						
4.5	4.5	4.5		9.36	2.87						
5	5	5		9.48	2.94						
5.5	5.5	5.5		9.63	3.03						
6	6	6		9.73	3.13						
6.5	6.5	6.5		9.84	3.21						
7	7	7		9.96	3.29						
7.5	7.5	7.5		10.02	3.23			↓	↓	↓	↓

EQUIPMENT DESCRIPTION: Wireline Packer

TOP PACKER: DEPTH (FT. BELOW DATUM) 74.5-30" LENGTH (FT.) 7'

PACKER TYPE: (S)INGLE/(D)OUBLE D TEST INTERVAL LENGTH (FT.) 10'

COMMENTS: Test run @ 10, 15, 20 psi

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-8 (8/84)

Borehole 911 Packer test # 3 KAL 8/1/91 Cap 8/11

2 of 2

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

PACKER (DRILL STEM) TEST

SITE ID: HAT 01 LOCATION ID: 911 LOG DATE: 2/22/85

LOGGING COMPANY: _____ FIELD REP.: _____

TESTED INTERVAL:

BEGINNING DEPTH _____ END DEPTH _____ (FT. BELOW DATUM)

SOIL/ROCK INTERVAL _____

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) _____ DIA. (IN.) _____

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) _____

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) _____
(AT START OF FIRST TEST)

TIME INTERVAL (MIN)		VOLUME REMOVED (GAL)		WATER PRESSURE (PSI)		AIR PRESSURE (PSI)	
15 psi	20 psi	15 psi	20 psi	15 psi	20 psi	15 psi	20 psi
8	8	10:17	3:50			200	200
8.5	8.5	10:27	3:53				
9	9	10:38	TEST				
9.5	9.5	10:50	STOPPED				
10	10	10:61	@				
10.5	10.5	10:72	8.5 min				
11	11	10:82					
11.5	11.5	10:92					
12	12	11:0					
12.5	12.5	11:12					
13	13	11:20					
13.5	13.5	11:29					
14	14	11:39					
14.5	14.5	11:49					
15	15	11:59					

EQUIPMENT DESCRIPTION: _____

TOP PACKER: DEPTH (FT. BELOW DATUM) _____ LENGTH (FT.) _____

PACKER TYPE: (S)INGLE/(D)OUBLE _____ TEST INTERVAL LENGTH (FT.) _____

COMMENTS: _____

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

OK

JUN 25 1985

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

KAL 8/1/91

PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850227

LOGGING COMPANY: JEG FIELD REP.: R Holland

TESTED INTERVAL:

BEGINNING DEPTH 84.5 END DEPTH 94.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST - 3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 94.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 4.0

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2

(AT START OF FIRST TEST)

ELAPSE TIME (MIN)	VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
.5	1.5	25	200
1.0	0	25	200
1.5	0		
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			
5.5			
6.0			
6.5			
7.0			
7.5			
8.0			
8.5			

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-8 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

KAL 8/1/91 8/11

JUN 2 8 1985

PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850227

LOGGING COMPANY: JEG FIELD REP.:

TESTED INTERVAL:

BEGINNING DEPTH 84.5 END DEPTH 94.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST-3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 94.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 4.0

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2
(AT START OF FIRST TEST)

ELAPSE TIME (MIN)	VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
9.0	0	30	200
9.5	0	30	
10			
10.5			
11			
11.5			
12			
12.5			
13			
13.5			
14			
14.5			
15			
15.5		28	
16		30	
16.5		30	
17		30	

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

8/1/91

Packer Test No. 4

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

Page 1 of 1

PACKER (DRILL STEM) TEST

SITE ID: HAT-01 LOCATION ID: 911 LOG DATE: 2/27/85

LOGGING COMPANY: Jacobs/SHB FIELD REP.: R. Holland

TESTED INTERVAL:

BEGINNING DEPTH 84.5 END DEPTH 94.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL 84.5 - 94.5 From 39 ft.

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 94.5 DIA. (IN.) 3"

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 4.0'

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM)

(AT START OF FIRST TEST)

Initial meter reading 2378

TIME INTERVAL (MIN)			VOLUME REMOVED (GAL) Ft³			WATER PRESSURE (PSI)			AIR PRESSURE (PSI)		
~~.25~~	.5		.2	0		25	30		200	200	200
1.0	1.0		Refused .0	0							
1.5	1.5		.0	0							
2.0	2.0		.0	0			30				
2.5	2.5		.0	0		25					
3.0	3.0		0	0							
3.5	3.5		0	0							
4.0	4.0		0	0							
4.5	4.5		0	0							
5.0	5.0		0	0							
5.5	5.5		0	0							
6.0	6.0		0	0		25					
6.5	6.5		0	0							
7.0	7.0		0	0			28				
7.5	7.5		0	0			30				
8.0	8.0		0	0			30				
8.5	8.5		0	0		25	30				

EQUIPMENT DESCRIPTION: Wire line Double packer

TOP PACKER: DEPTH (FT. BELOW DATUM) 84.5' LENGTH (FT.) 2.0'

PACKER TYPE: (S)INGLE/(D)OUBLE ~~Single~~ D TEST INTERVAL LENGTH (FT.) 10.0'

COMMENTS: Formation refused water at 25 and 30 PSI No higher test was attempted because of fear of frac. of formation

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-8 (3/84)

JUN 25 1985

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

KAL 8/1/91

PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850228
LOGGING COMPANY: JEG FIELD REP.: R Holland
TESTED INTERVAL:
BEGINNING DEPTH 94.5 END DEPTH 104.5 (FT. BELOW DATUM)
SOIL/ROCK INTERVAL ST-3
BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 104.5 DIA. (IN.) 3.0
HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 4.0
STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2
(AT START OF FIRST TEST)

ELAPSE TIME (MIN)	VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
.5	1.87	20	200
1.0	~~2.24~~ 0.37	20	
1.5	~~2.62~~ 0.38	20	
2	~~2.77~~ 0.15	20	
2.5	~~2.77~~ 0	22	
3	~~2.77~~ 0	22	
3.5	~~2.92~~ 0.15	22	
4	~~2.92~~ 0	22	
4.5	~~2.95~~ 0.03	22	
5	~~2.99~~ 0.04	25	
5.5	~~2.99~~ 0	25	
6	~~2.99~~ 0	25	
6.5	~~2.99~~ 0	25	
7	~~2.99~~ 0	25	
7.5	~~3.03~~ 0.04	25	
8	~~3.03~~ 0	25	
8.5	~~3.03~~ 0	25	

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)
PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)
COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

ENTER

JUN 2 8 1985

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

KAL 8/1/91 Cap 8/1/

PACKER (DRILL STEM) TEST

SITE ID: HAT01 LOCATION ID: 911 LOG DATE: 850228

LOGGING COMPANY: JEG FIELD REP.: R Holland

TESTED INTERVAL:

BEGINNING DEPTH 94.5 END DEPTH 104.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL ST-3

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 104.5 DIA. (IN.) 3.0

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 4.0

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2

(AT START OF FIRST TEST)

ELAPSE TIME (MIN)	VOLUME REMOVED (GAL)	WATER PRESSURE (PSI)	AIR PRESSURE (PSI)
9.0	0.64	30	200
9.5	0		
10.0	0		
10.5	0		
11.0	0		
11.5	0.07		
12.0	0		
12.5			
13.0			
13.5			
14.			
14.5			
15.			
15.5			
16.			
16.5			
17.			

EQUIPMENT DESCRIPTION:

TOP PACKER: DEPTH (FT. BELOW DATUM) LENGTH (FT.)

PACKER TYPE: (S)INGLE/(D)OUBLE TEST INTERVAL LENGTH (FT.)

COMMENTS:

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-6 (3/84)

Packer Test No 5

8/1/1

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

Page 1 of 2

PACKER (DRILL STEM) TEST

HOLE ID. HAT-01 LOCATION ID: 911 LOG DATE: 2/28/85

DRILLING COMPANY: Jacobs/SHB FIELD REP.: R. Holland

TESTED INTERVAL:

BEGINNING DEPTH 94.5 END DEPTH 104.5 (FT. BELOW DATUM)

SOIL/ROCK INTERVAL 94.5 - 104.5 Rock from 39.0 ft

BOREHOLE: DEPTH AT TEST (FT. BELOW DATUM) 104.5 DIA. (IN.) 3.0"

HEIGHT OF WATER SWIVEL (FT. ABOVE DATUM) 4

STATIC GROUNDWATER DEPTH (FT. BELOW DATUM) 68.2'

(AT START OF FIRST TEST) 68.2' Initial meter reading 0394.85

TIME INTERVAL (MIN) 20	30		VOLUME REMOVED (GAL) 20	30	Ft³	WATER PRESSURE (PSI)			AIR PRESSURE (PSI)		
.5	.5		95.1	95.34		20	30		200		
1.0	1.0		95.15	95.34			30				
1.5	1.5		95.2	95.34							
2.0	2.0		95.22	95.34							
2.5	2.5		95.22	95.34		22					
3.0	3.0		95.22	95.35							
3.5	3.5		95.24	95.35							
4.0	4.0		95.24	95.35							
4.5	4.5		95.245	95.35							
5.0	5.0		95.25	95.35		25	30				
5.5	5.5		95.25	95.35		25					
6.0	6.0		95.25	95.35							
6.5	6.5		95.25	95.35							
7.0	7.0		95.25	95.35							
7.5	7.5		95.255	95.35							
8.0	8.0		95.255	95.35							
8.5	8.5		95.255	95.35							

EQUIPMENT DESCRIPTION: wireline ~~[illegible]~~ packer (Double)

TOP PACKER: DEPTH (FT. BELOW DATUM) 94.5 LENGTH (FT.) 7.0'

PACKER TYPE: (S)INGLE/(D)OUBLE ~~[illegible]~~ TEST INTERVAL LENGTH (FT.) 10'

COMMENTS: Formation refused water at 20-30 psi

NOTE: DATUM = GROUND SURFACE

JEG-AL-ENG-8 (8/84)

Checked by SColonello 8/6/85

.DATE
.PACKER TEST DATA (PAC)

#SITE #CODE	LOC ID	LOG DATE	(TEST INTRVL) BEG DP (FTBD)	END DP (FTBD)	US/RC	S O	<-BOREHOLE--> DEPTH (FTBD)	DIAM (IN)	WS HGT FTAD	GW LEVEL (FTBD)	ELAPSD TIME (MIN)	H2246 VOL REMOVE (GAL)	WAT PRESS (PSI)
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	0.50	8.60	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	1.00	1.42	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	1.50	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	2.00	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	2.50	0.37	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	3.00	1.42	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	3.50	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	4.00	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	4.50	0.90	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	5.00	0.97	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	5.50	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	6.00	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	6.50	0.97	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	7.00	0.90	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	7.50	0.83	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	8.00	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	8.50	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	9.00	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	9.50	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	10.00	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	10.50	0.90	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	11.00	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	11.50	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	12.00	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	12.50	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	13.00	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	13.50	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	14.00	0.75	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	14.50	0.82	24.5
HAT01	944	850224	64.50	74.50	ST	3	74.50	3.000	3.00	68.20	15.00	0.82	24.5
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	0.00	0.00	40.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	0.50	0.75	40.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	1.00	0.37	40.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	1.50	0.00	40.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	2.00	0.00	40.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	2.50	1.42	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	3.00	0.90	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	3.50	0.97	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	4.00	0.90	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	4.50	0.90	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	5.00	0.97	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	5.50	0.82	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	6.00	0.90	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	6.50	0.82	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	7.00	0.90	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	7.50	1.42	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	8.00	0.75	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	8.50	0.82	45.0
HAT01	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	9.00	0.90	45.0

FLOW RATE — TEST INTERVAL

2.2 gpm — 64.5'-74.5'

0.8 gpm

1.9 gpm — 74.5'-84.5'

KAK 8/1/91

8/1/91

.PACKER TEST DATA (PAC)

SITE CODE	LOC ID	LOB DATE	(TEST INTRVL) BEG DP (FTBD)	END DP (FTBD)	US/RC	S O	(-BOREHOLE--) DEPTH (FTBD)	DIAM (IN)	WS HGT FTAD	GW LEVEL (FTBD)	ELAPSD TIME (MIN)	H2246 VOL REMOVE (GAL)	WAT PRESS (PSI)
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	9.50	0.82	15.0
HA104	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	40.00	0.60	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	40.50	1.12	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	41.00	0.75	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	41.50	0.75	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	42.00	0.89	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	42.50	0.75	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	43.00	0.75	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	43.50	0.82	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	44.00	0.68	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	44.50	0.52	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	45.00	0.67	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	45.50	0.75	20.0
HA104	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	46.00	0.60	20.0
HAT04	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	46.50	0.60	20.0
HA104	944	850222	74.50	84.50	ST	3	84.50	3.000	3.00	68.20	47.00	0.30	20.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	0.50	1.50	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	1.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	1.50	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	2.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	2.50	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	3.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	3.50	0.00	25.0
HA104	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	4.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	4.50	0.00	25.0
HA104	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	5.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	5.50	0.00	25.0
HA104	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	6.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	6.50	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	7.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	7.50	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	8.00	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	8.50	0.00	25.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	9.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	9.50	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	10.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	10.50	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	11.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	11.50	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	12.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	12.50	0.00	30.0
HA104	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	13.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	13.50	0.00	30.0
HA104	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	14.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	14.50	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	15.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	15.50	0.00	28.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	16.00	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	16.50	0.00	30.0
HAT04	944	850227	84.50	94.50	ST	3	94.50	3.000	4.00	68.20	17.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	0.50	1.87	20.0

1.5 gpm
74.5' - 84.5'

1.5 gpm

~~WATA~~ 84.5' - 94.5'

0 gpm

KAL 8/1/91
36
CAG 8/1/91

PACKER TEST DATA (PAC)

SITE CODE	LOC ID	LOG DATE	(TEST INTRVL) BEG DP (FTBD)	END DP (FTBD)	US/RC	B O	(-BOREHOLE--) DEPTH (FTBD)	DIAM (IN)	US HGT FTAD	GW LEVEL (FTBD)	ELAPSD TIME (MIN)	H2216 VOL REMOVE (GAL)	WAT PRESS (PSI)
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	1.00	0.37	20.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	1.50	0.38	20.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	2.00	0.45	20.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	2.50	0.00	22.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	3.00	0.00	22.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	3.50	0.45	22.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	4.00	0.00	22.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	4.50	0.03	22.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	5.00	0.04	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	5.50	0.00	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	6.00	0.00	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	6.50	0.00	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	7.00	0.00	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	7.50	0.04	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	8.00	0.00	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	8.50	0.00	25.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	9.00	0.64	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	9.50	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	10.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	10.50	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	11.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	11.50	0.07	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	12.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	12.50	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	13.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	13.50	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	14.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	14.50	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	15.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	15.50	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	16.00	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	16.50	0.00	30.0
HAT04	944	850228	94.50	104.50	ST	3	104.50	3.000	4.00	68.20	17.00	0.00	30.0

..... END REPORT .....

1.4 gpm

0.1 gpm

0.02 gpm

94.5' - 104.5'

0.09 gpm

8/1/91

8/1/91

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. HAT -09-91-14-06-00 DISCIPLINE HYDRO NO. OF SHEETS 12

PROJECT: UMTRA

SITE: MEXICAN HAT, UTAH

FEATURE: HYDRAULIC GRADIENTS AND GROUNDWATER VELOCITIES FOR HALGAITO SHALE FORMATION AND HONAKER TRAIL FORMATION; AND VERTICAL GRADIENT BETWEEN THESE TWO FORMATIONS

SOURCES OF DATA:

TAC FIELD DATA - WATER LEVEL RECORDS

TAC AQUIFER TEST CALCULATIONS: HAT 01-07-91-14-02-00
HAT 01-07-91-14-03-00

SOURCES OF FORMULAE & REFERENCES:

FREEZE AND CHERRY, 1979, GROUNDWATER

PRELIMINARY CALC. ☑ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
00		Mark Gore	9/11/91	E. Todd Monks	9/16/91		
		~~E. Todd Monks~~	~~9/16/91~~	E. Todd Monks	11/22/91		
01	Error correction	Mark Gore	11/22/91				

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9/11/91

9/16/91
ETM

MEXICAN HAT CALCULATION HAT01-09-90-14-06-00

HYDRAULIC GRADIENTS AND GROUNDWATER VELOCITIES FOR THE HALGATIO SHALE FORMATION AND THE HONAKER TRAIL FORMATION, MEXICAN HAT SITE, UTAH

PURPOSE

The purpose of these calculations is to determine the hydraulic gradients in the Halgaito Shale Formation (unconfined) and in the Honaker Trail Formation (confined uppermost aquifer) at the Mexican Hat site. The calculated hydraulic gradients are used to determine linear groundwater flow velocities for the Honaker Trail Formation and the Halgaito Shale Formation. These velocities will be reported in the Mexican Hat Remedial Action Selection Report. Furthermore, the vertical gradient between the Honaker Trail Formation and the Halgaito Shale Formation will be estimated. The vertical gradient within the Halgaito Shale will also be estimated in the area of the tailings pile.

PROCEDURE

The hydraulic gradient for the Honaker Trail Formation was determined by constructing a map of the potentiometric surface and calculating the loss of head over a given distance in the direction of groundwater flow.

The hydraulic gradient for unconfined groundwater surface in the Halgaito Shale could not be determined by the above procedure since the monitor wells completed in this formation were screened across several different intervals. In an unconfined system, the depth of screened intervals has to be fairly uniform to ensure an accurate depiction of the water table surface. Since a water table map could not be created, it was assumed that the direction of groundwater flow is down dip and the gradient is approximate to the dip magnitude. This assumption is reasonable since the groundwater flows above an interval of very low hydraulic conductivity within the basal section of the Halgaito Shale (see calculation Hat01-07-91-14-03-00) and this interval most likely is oriented parallel the dip of the entire formation.

The linear groundwater velocity is the rate at which the groundwater moves through the pore spaces. The groundwater velocity was determined by the following equation where,

$$V_L = \frac{K\ i}{n}$$

K = hydraulic conductivity

i = hydraulic gradient

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CAP 11/22/91

n = effective porosity

V_L = linear groundwater velocity

The vertical gradient between the Honaker Trail Formation and the Halgaito Shale Formation was determined with data from the monitor well pair 907 and 906 (Figure 1). Monitor well 907 is screened in the Honaker Trail Formation and monitor well 906 is screened in the Halgaito Shale Formation. The vertical gradient was determined by dividing the difference in water levels between the two wells by the distance between the screen midpoints of the two monitor wells. The direction of groundwater flow is towards the formation with the lowest water levels. The vertical gradient within the Halgaito Shale Formation in the tailings pile area was determined in a similar fashion with the monitor well pair 911 and 912.

ASSUMPTIONS

Since the Honaker Trail Formation is a confined aquifer, it is assumed that the vertical separation of screened zones of monitor wells will not affect the the estimations of groundwater gradient.

It is assumed that the hydraulic conductivities, hydraulic gradients, and porosities used in the calculations are representative of the actual aquifer properties.

PROPERTIES

The hydraulic conductivity for the Halgaito Shale Formation used in these calculations is the geometric mean of all slug test data and packer test data. This hydraulic conductivity is 0.20 ft/day.

The hydraulic conductivity for the Honaker Trail Formation aquifer used in these calculations is the geometric mean of all slug test data. This hydraulic conductivity is 0.07 ft/day.

The effective porosities used in these calculations are estimated from ranges of literature values of similar geohydraulic units present at the Mexican Hat site.

DATA SOURCES

Hydraulic conductivities for the Honaker Trail Formation aquifer and for the Halgaito Shale Formation: Mexican Hat calculations HAT01-07-91-14-02-00 and HAT01-07-91-14-03-00.

Effective porosities: Groundwater, by Freeze and Cherry, 1979.

SOLUTION

The potentiometric surface map for the Honaker Trail Formation is shown on Figure 2. The calculation for the groundwater gradient is shown in Table 1. Figure 3 shows the Halgaito Shale monitor wells,

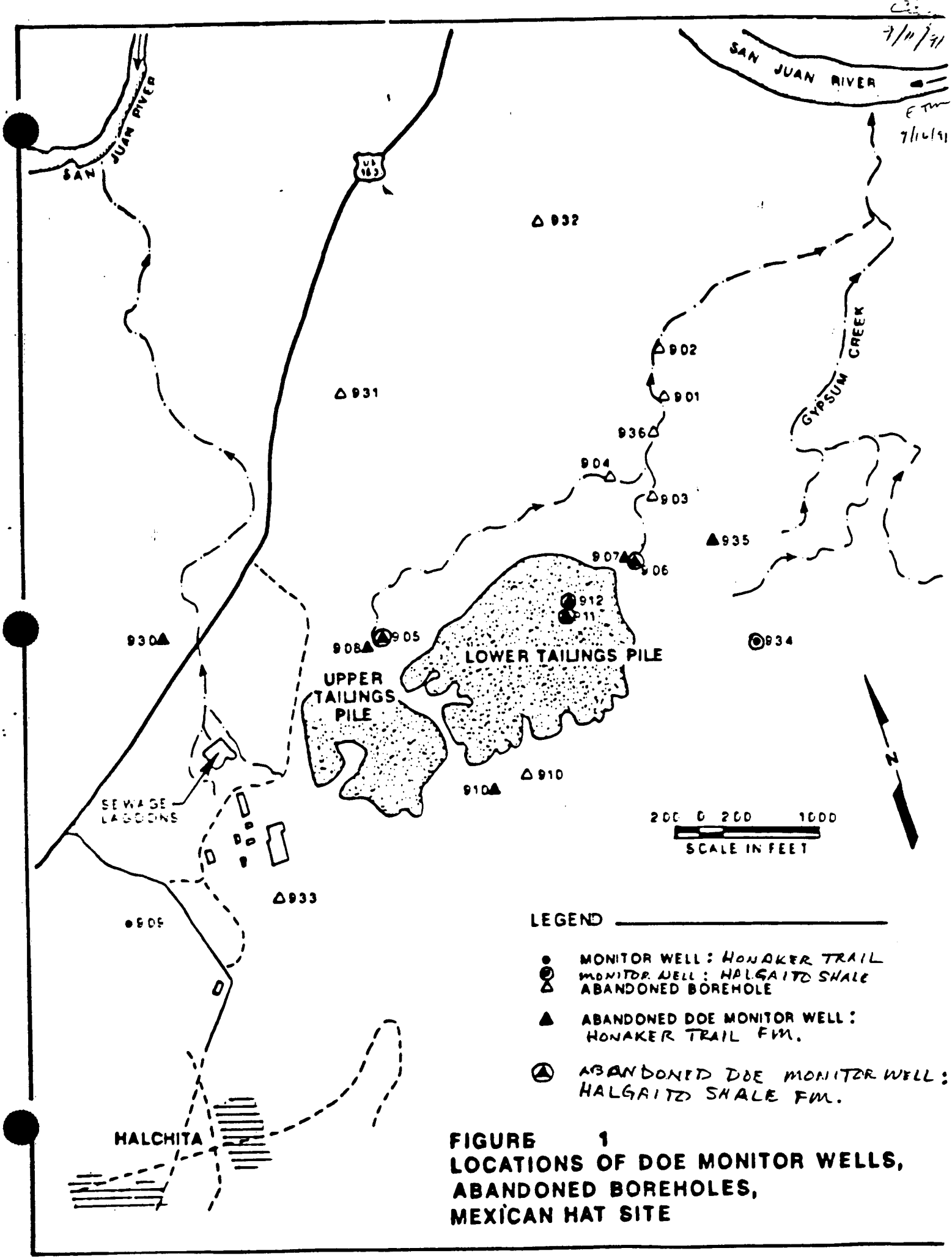
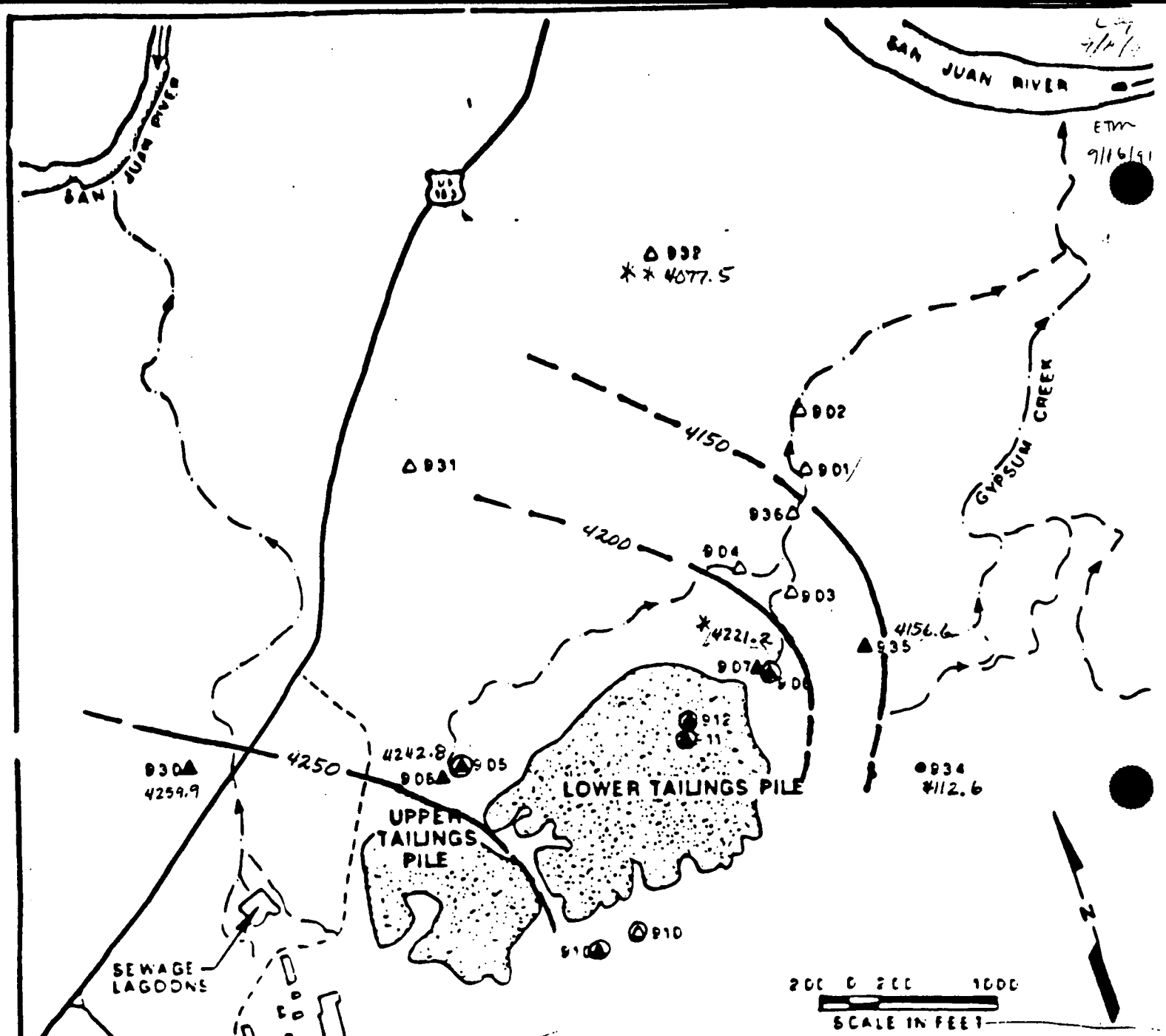


FIGURE 1
LOCATIONS OF DOE MONITOR WELLS, ABANDONED BOREHOLES, MEXICAN HAT SITE



** ONLY ONE WATER LEVEL RECORDED (10/14/85) PRIOR TO ABANDONMENT. INCLUDED ONLY TO SHOW POTENTIOMETRIC SURFACE IS LESS THAN 4150' IN THIS AREA.

* AVERAGE OF PREVIOUS WATER LEVELS SINCE ONLY LISTED AS "FLOWING" ON 5/28/85 FIELD FORM.

LEGEND

- MONITOR WELL: HONAKER TRAIL
- MONITOR WELL: HALGAITO SHALE
- ABANDONED BOREHOLE
- ABANDONED DOE MONITOR WELL: HONAKER TRAIL FM.
- ABANDONED DOE MONITOR WELL: HALGAITO SHALE FM.
- 4301.1 GROUNDWATER LEVEL ELEVATION 8/28/88

FIGURE 2

HONAKER TRAIL GROUNDWATER LEVEL ELEVATIONS AND POTENTIOMETRIC SURFACE

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DATE _____ SUBJECT TABLE 1 SHEET NO. 5/12

BY _____ CHKD. _____ JOB NO. _____

HONAKER TRAIL GRADIENT:

Change in head over site area: 4300 − 4150 = 150 ft. ✓

distance of head change (4300 ft. contour to 4150 contour): 6200 ft.

$$\frac{\Delta \text{ head}}{\text{distance}} = \frac{150 \text{ ft.}}{6200 \text{ ft.}} = \underline{0.024} \checkmark$$

HALGAITO SHALE GRADIENT

Regional dip = 4° convert to feet/foot using arbitrary distance of 100 ft.

$\tan 4° = \frac{x}{100}$

$x = \tan 4° (100)$

$x = 7$

$$\Rightarrow \frac{\Delta \text{ elevation}}{\text{distance}} = \frac{7}{100} = \underline{0.07} \checkmark$$

HONAKER TRAIL VELOCITY

$K = 0.07$ ft/day

$i = 0.024$

ϕ = range 0.10 − 0.20

$$v = \frac{ki}{\phi} = \frac{0.07(0.024)}{0.10} = 0.017 \text{ ft/day} \checkmark$$

$$v = \frac{ki}{\phi} = \frac{0.07(0.024)}{0.15} = 0.011 \text{ ft/day} \checkmark$$

$$v = \frac{ki}{\phi} = \frac{0.07(0.024)}{0.20} = 0.008 \text{ ft/day} \checkmark$$

average velocity with 3 porosities = <u>0.012 ft/day</u> ✓

JACOBS ENGINEERING

6/12

DATE _____ SUBJECT

SHEET NO. _____

BY _____ CHKD. _____

JOB NO. Cap

11/22/91

ETM

11/22/91

HALGAITO SHALE VELOCITY

$K = 0.20$ ft/day

$i = 0.07$

ϕ RANGE = 0.10 – 0.25

$$v = \frac{Ki}{\phi} = \frac{0.20(0.07)}{0.10} = 0.14 \text{ ft/day}$$

$$v = \frac{Ki}{\phi} = \frac{0.20(0.07)}{0.18} = 0.078 \text{ ft/day}$$

$$v = \frac{Ki}{\phi} = \frac{0.20(0.07)}{0.25} = 0.056 \text{ ft/day}$$

average velocity for ϕ range = 0.091 ft/day

7/12
Cay
9/11/91

FTM
9/16/91

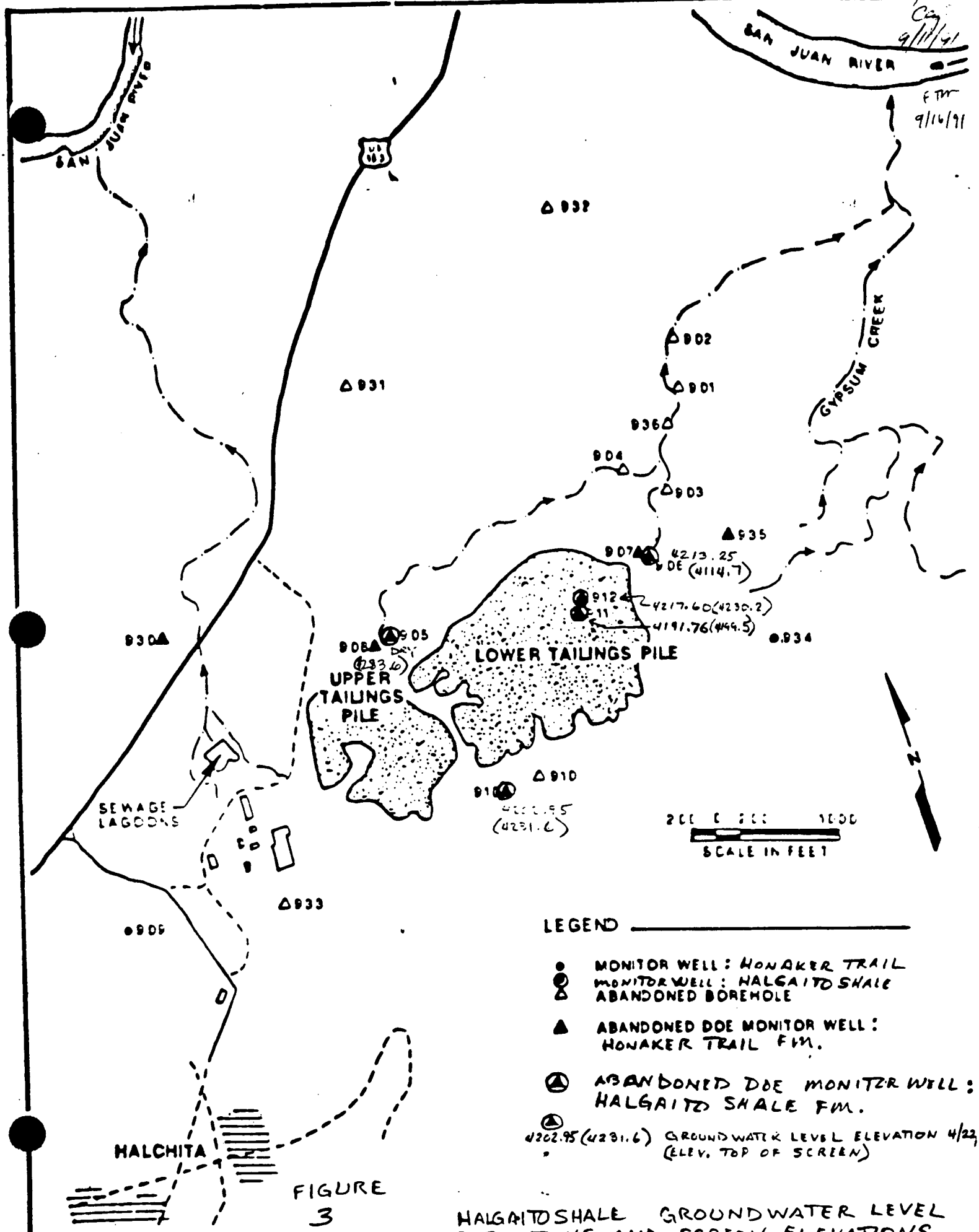

FIGURE 3

HALGAITO SHALE GROUNDWATER LEVEL ELEVATIONS AND SCREEN ELEVATIONS

Cap 9/11/91

EM 9/16/91

their screened intervals, and water level measurements. Table 1 shows the conversion of Halgaito Shale dip to gradient.

The velocity calculations for the Honaker Trail and Halgaito Shale formations are shown in Table 1.

The vertical gradient calculations are shown in Table 2.

RESULTS AND CONCLUSIONS

The average Honaker Trail Formation groundwater gradient for the entire site area is approximately 0.025 ft/ft with groundwater flow direction to the east northeast. The regional dip of the Halgaito Shale Formation is 4 degrees to the east southeast. The equivalent gradient for this dip is 0.07.

The average linear groundwater velocity of the Honaker Trail Formation ranges from 0.01 ft/day to 0.02 ft/day. The average linear groundwater velocity for the Halgaito Shale Formation is estimated to range from 0.1 ft/day to 0.2 ft/day. However, a significant portion of the groundwater flow in the Halgaito Shale probably occurs in fractures and bedding planes since ubiquitous open fracture sets have been observed on site. Groundwater flow velocities, where fracture flow predominates could be an order of magnitude higher than that calculated above.

The vertical gradient between the Honaker Trail Formation and the Halgaito Shale Formation ranges from 0.08 to 0.09 upward. The vertical gradient within the Halgaito Shale Formation ranges from 0.7 to 1.0 downward.

REFERENCES

Freeze, R. A., and Cherry, J. A., 1979, Groundwater, Prentice Hall, New Jersey, 604 pp.

ATTACHMENTS

1. - Water level data for all monitor wells at the Mexican Hat site.

JACOBS ENGINEERING

DATE _____ SUBJECT TABLE 2 SHEET NO. 1/12

BY _____ CHKD. _____ JOB NO. _____

VERTICAL GRADIENT BETWEEN HONAKER TRAIL & HALGAITO SHALE

906 (HALGAITO SHALE) SCREENED INTERVAL ELEVATION: 4209.2 – 4204.2 ✓
midpoint = 4206.7

907 (HONAKER TRAIL) SCREENED INTERVAL ELEVATION: 4114.7 – 4111.7 ✓
midpoint = 4113.2

distance between screen midpoints = 93.5 feet ✓

water level differences April 22, 1985: 4221.6 (907) – 4213.3 (906) = 8.3 ft.
(see Attachment 1 for water level data)

water level difference June 3, 1985: 4220.8 (907) – 4213.3 (906) = 7.5 ft

Gradient 4/22/85: $\frac{\Delta \text{head}}{\text{distance}} = \frac{8.3}{93.6} =$ 0.09 UPWARD ✓

Gradient 6/03/85: $\frac{\Delta \text{head}}{\text{distance}} = \frac{7.5}{93.6} =$ 0.08 UPWARD ✓

VERTICAL GRADIENT WITHIN HALGAITO SHALE

911 SCREENED INTERVAL ELEVATION: 4199.5 – 4189.5 midpoint = 4194.5 ✓

912 SCREENED INTERVAL ELEVATION: 4230.2 – 4210.2 midpoint = 4220.2 ✓

distance between screen midpoints = 25.7 ft. ✓

water level difference April 13, 1985: 4218.2 (912) – 4199.10 (911) = 19.1 ft. ✓

water level difference April 22, 1985: 4217.6 (912) – 4191.8 (911) = 25.8 ft. ✓

Gradient 4/13/85: $\frac{\Delta \text{head}}{\text{distance}} = \frac{19.1}{25.7} =$ 0.7 DOWNWARD ✓

Gradient 4/22/85: $\frac{\Delta \text{head}}{\text{distance}} = \frac{25.8}{25.7} =$ 1.0 DOWNWARD ✓

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DATE _____ SUBJECT

BY _____ CHKD. _____

SHEET NO. _____

JOB NO. _____

ATTACHMENT 1

WATER LEVEL DATA

STATIC GROUNDWATER LEVELS: ALL LOCATIONS AND DATES AVAILABLE
SITE: HAT01 MEXICAN HAT
REPORT DATE: 09/06/91

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0905	10006.3	9544.2	HM	O	4295.63	12.00	5.0	04/22/85	DRY	-
								06/03/85	DRY	-
								07/28/85	DRY	-
0906	10137.5	11703.1	HM	O	4223.04	13.80	5.0	04/22/85	9.79	4213.25
								06/03/85	9.78	4213.26
								07/28/85	DRY	-
0907	10154.1	11692.4	RI	N	4221.66	107.00	3.0	04/11/85	+0.05	4221.61
								04/22/85	+0.05	4221.61
								06/03/85	0.90	4220.76
								07/26/85	+0.90	4220.76
								08/27/88	FLOWING	-
0908	10019.3	9538.7	RI	N	4292.63	145.00	37.0	04/12/85	51.15	4241.48
								04/22/85	51.13	4241.50
								06/03/85	50.86	4241.77
								07/28/85	51.32	4241.31
								08/28/88	49.86	4242.77
0909	7925.5	7134.4	RI	N	4335.30	130.00	20.0	04/10/85	39.58	4295.72
								04/22/85	37.94	4297.36
								06/03/85	36.91	4298.39
								07/27/85	36.07	4299.23
								08/28/88	34.16	4301.14
								11/17/88	34.10	4301.20
								04/25/91	36.71	4298.59
0910	8336.5	10067.7	HM	D	4371.60	140.00	40.0	04/10/85	167.68	4203.92
								04/22/85	168.65	4202.95
								06/03/85	167.97	4203.63
								07/30/85	167.99	4203.61
								10/09/85	168.91	4202.69
								08/28/88	164.65	4206.95
0911	9508.4	11114.0	HM	O	4292.53	93.00	10.0	04/13/85	93.43	4199.10
								04/22/85	100.77	4191.76
								06/03/85	DRY	-
								07/29/85	DRY	-
								10/09/85	DRY	-
								08/28/88	DRY	-

FORMATION OF COMPLETION CODE:
HM - HALGAITO MEMBER
RI - HONAKER TRAIL

FLOW RELATIONSHIP CODE:
O - ON-SITE
N - UNKNOWN
D - DOWN GRADIENT

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. HAT-11-91-12-02 DISCIPLINE Engineering NO. OF SHEETS 5

PROJECT:
UMTRA

SITE: Mexican Hat

FEATURE:
Volume of released water

SOURCES OF DATA:

SOURCES OF FORMULAE & REFERENCES:

- MK Mexican Hat/Monument Valley; Calculations Vol. III Calc no. 9-239-01-06 Tailings Design Parameters (June 1991)
- MK Mexican Hat/Monument Valley; Information for Bidders Vol. III; Tailings Characteristics at Monument Valley; (June 1991)
-

PRELIMINARY CALC. ☐ FINAL CALC. ☑ SUPERSEDES CALC. NO. _____

REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
		T. Zimmerly	11-6-91	J. Caum	11/9/91		

8/86

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JACOBS ENGINEERING

DATE _____ SUBJECT _____ SHEET NO. 1

BY _____ CHKD. _____ JOB NO. _____

I Purpose:

The purpose of this calculation is to estimate the volume of water exiting the cell due to transient drainage.

II Procedure:

Based on the assumptions that the cover flux is low and the climate at the site is arid, very little if any moisture will enter the cell after construction. The procedure is based on a mass balance calculation using the geotechnical data provided by the RAC.

III Assumptions:

1. The natural water contents were used for the Mexican Hat insitu tailings

2. the optimum water contents were used for the Monument Valley tailings

3. Residual moisture contents were obtained from the Colorado State University report on the Gunnison tailings for Sand, Sand/slime and Slimes.

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DATE _____ SUBJECT _____ SHEET NO. 2

BY _____ CHKD. _____ JOB NO. _____

IV Calculation & Analysis

The following pages show the volume of water released from the tailings for each site. The sum of the volumes is taken for the total volume of water released.

JACOBS ENGINEERING

DATE _____ SUBJECT DETERMINE VOLUMES OF RELEASED WATER SHEET NO. 3

BY _____ CHKD. _____ JOB NO. _____

Mexican Hat Insitu tailings

1) TOTAL VOLUME OF INSITU TAILING

2,575,000 yd^3 MKES

2) PERCENTAGE OF SAND, SAND/SLIMES, AND SLIMES

SAND — 4 %
SAND/SLIME — 33 %
SLIME — 63 %

3) MOISTURE CONTENT, RESIDUAL MOISTURE CONTENT, AND DRY DENSITY OF TAILINGS

	W	W_R*	$W-W_R$	γ_d
SAND	18	10	8	107
SAND/SLIME	21	15	6	87
SLIME	37	25	12	75

4) VOLUME OF WATER TO GO FROM INSITO TO RESIDUAL MOISTURE CONTENT

eg SAND

$$2{,}575{,}000\,yd^3 \times \frac{27\,ft^3}{yd^3}(0.04)\,107\,\frac{lb}{ft^3}(0.08)\frac{1}{62.4\,lb/ft^3}$$

$= 381{,}496\,ft^3 \Rightarrow$ 8.76 AC-FT

SAND	8.8
SAND-SLIMES	44.1
SLIMES	145.0
	Σ 198 AC-FT

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DATE _____ SUBJECT _____ SHEET NO. 4

BY _____ CHKD. _____ JOB NO. _____

MONUMENT VALLEY tailings

1) 1,030,000

2) PERCENTAGE OF SAND AND SLIME

SAND — 75%
SLIMES — 25%

3)

	w	w_R*	$w - w_R$	γ_d
SAND	13.5	10	3.5	113.5
SLIME	32.5	25	7.5	75

4)

$$1{,}030{,}000\ yd^3 \times \frac{27\ ft^3}{yd^3}(0.75)\left(113.5\ \frac{lb}{ft^3}\right)(0.035)\frac{1}{62.4\ lb/ft^3}$$

SAND	30.5
SLIMES	14.4
Σ	45

HAT + MON ⟶ 243 AC-FT

JACOBS ENGINEERING

DATE _____ SUBJECT _____ SHEET NO. 5

BY _____ CHKD. _____ JOB NO. _____

V Results

The total volume of water released from the tailings is 243 acre-feet.

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JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. MNV-08-92-14-03-00 DISCIPLINE HYDRO NO. OF SHEETS 1

PROJECT: UMTRA

SITE: MONUMENT VALLEY

FEATURE: AQUIFER [illegible]

SOURCES OF DATA: [illegible]

SOURCES OF FORMULAE & REFERENCES:
[illegible] TEXT

PRELIMINARY CALC. ☐ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
		E. Storms	7/92	R Paul	7/92		

B.S. 7/92
RJP 7/92

A. PURPOSE OF CALCULATION

To calculate the transmissivity in the alluvium watertable aquifer at the Monument Valley Site.

B. METHOD AND PROCEDURES

An aquifer pumping test was performed on monitor well 651. There were no nearby monitor wells that could be used as observation wells. Figure 1 shows the monitor well location at the site. During the pumping test, drawdown and recovery measurements were collected on pumping well manually using an electric sounder. Table 1 summarizes aquifer pumping test parameters which include the depth, screened interval, and static water level of the pumped well, the pumping duration, the discharge rate and maximum drawdown observed in the pumping well.

The aquifer test data were analyzed on an IBM-compatible personal computer using WHIP™, a sophisticated Well Hydraulics Interpretation Program.

C. ASSUMPTIONS

1) The aquifer is homogenous and isotropic.

2) The formation has uniform thickness.

3) The formation receives no recharge from any source.

4) The pumped well penetrates and receives water from the full thickness of the water-bearing formation.

5) The aquifer is infinite in areal extent.

6) The water removed from storage is discharged instantaneously with lowering of the head.

D. MATERIAL PROPERTIES

Attachment A contains the well log and well construction summary for monitor wells 651.

E. DATA SOURCES

The pumping test was performed and data collected by the TAC in October, 1985. The pumping test data is contained in Table 2.

F. CALCULATION AND ANALYSIS

The aquifer test data were analyzed on an IBM-compatible

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personal computer using WHIP™, a sophisticated Well Hydraulics Interpretation Program. This program calculates a computerized best-fit for drawdown and recovery curves to calculate aquifer parameters. Data input parameters for the aquifer test are summarized in Table 3. The parameter estimation function of WHIP was used which applies parameter estimation methods coupled with the analytical homogenous aquifer solution developed by Lai and Su (1974). The plots showing the best fit curve for drawdown and recovery analysis of the pumping well are shown in Figures 2 and 3.

G. CONCLUSIONS AND RECOMMENDATIONS

Transmissivities calculated from the drawdown and recovery analysis are 1220 ft^2/day (9126 gpd/ft) and 1016 ft^2/day (7600 gpd/ft), respectively. Because the calculations were based on drawdown data from the pumping well, it was not possible to calculate storativity.

Hydraulic conductivity : 16.9 - 20.3 ft/day
mean = 19 ft/day
2.2×10^{-4} ft/sec

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TABLE 1.
SUMMARY OF AQUIFER PUMPING TEST PARAMETERS

	Pumped Well No.
	651
Depth (feet)	85
Screened Interval (feet)	23 - 83
Member	Alluvium
Static Water Level (feet)	9.17
Pumping Duration (minutes)	600
Discharge Rate (gal/min)	13.5
Maximum Drawdown	6.3
Distance from pumped well to observation well (feet)	Not Applicable

Monument Valley Site
Well 651

TABLE 2

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Time (minutes)	Drawdown (feet)	
0.5	4.32	
1	5.01	
1.5	5.06	
2	5.15	
2.5	5.17	
3	5.2	
3.5	5.24	
4	5.32	
4.5	5.34	
5	5.38	
6	5.43	
7	5.49	
8	5.58	
9	5.52	
10	5.6	
20	5.82	
30	5.87	
40	5.91	
50	5.96	
60	6	
70	6.03	
80	6.04	
90	6.04	
120	6.09	
150	6.1	
200	6.13	
250	6.16	
300	6.09	
540	6.26	
600	6.28	Pump stopped at 600 minutes
600.5	2.03	Recovery Begins
601	1.35	
601.5	1.25	
602	1.2	
602.5	1.11	
603	1.02	
603.5	0.96	
604	0.91	
604.5	0.86	
605	0.7	
606	0.63	
607	0.6	
608	0.53	
609	0.33	
610	0.3	
620	0.23	
630	0.17	
640	0.17	
650	0.15	
660	0.14	
670	0.17	
680	0.13	
690	0.13	
720	0.13	
750	0.06	
800	0.06	
900	0.06	
970	0.06	

Time since pump stopped (minutes)	Calculated recovery (feet)
0.5	4.27
1	4.95
1.5	5.05
2	5.1
2.5	5.19
3	5.28
3.5	5.34
4	5.39
4.5	5.44
5	5.6
6	5.67
7	5.7
8	5.77
9	5.97
10	6
20	6.07
30	6.13
40	6.13
50	6.15
60	6.16
70	6.13
80	6.17
90	6.17
120	6.17
150	6.24
200	6.24
300	6.24
370	6.24

5

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TABLE 3.
DATA INPUT PARAMETERS USED IN THE WHIP PROGRAM
PARAMETER ESTIMATION METHOD

WELL GEOMETRY

X-coord. of Observation Well	- 0.000
Y-coord. of Observation Well	- 0.000
X-coord. of Pumping Well	- 0.000
Y-coord. of Pumping Well	- 0.000

BOUNDARY OPTION - this option was not used in any of the analyses.

AQUIFER TYPE - Homogenous aquifer type was used in all analysis given the limited zone of influence of the wells.

AQUIFER PARAMETERS - The saturated thickness input is 75 feet.

PUMP WELL PARAMETERS

Pump Well Radius (ft)	- 0.167
Casing Effective Radius (ft)	- 0.167
Wellbore Skin	- 0.000
Well Loss Constant	- 0.000
Well Loss Exponent	- 0.000

DUPUIT CORRECTION - This option was set on for the analyses.

PUMP WELL EFFICIENCY CORRECTION - This option was not used in the analysis.

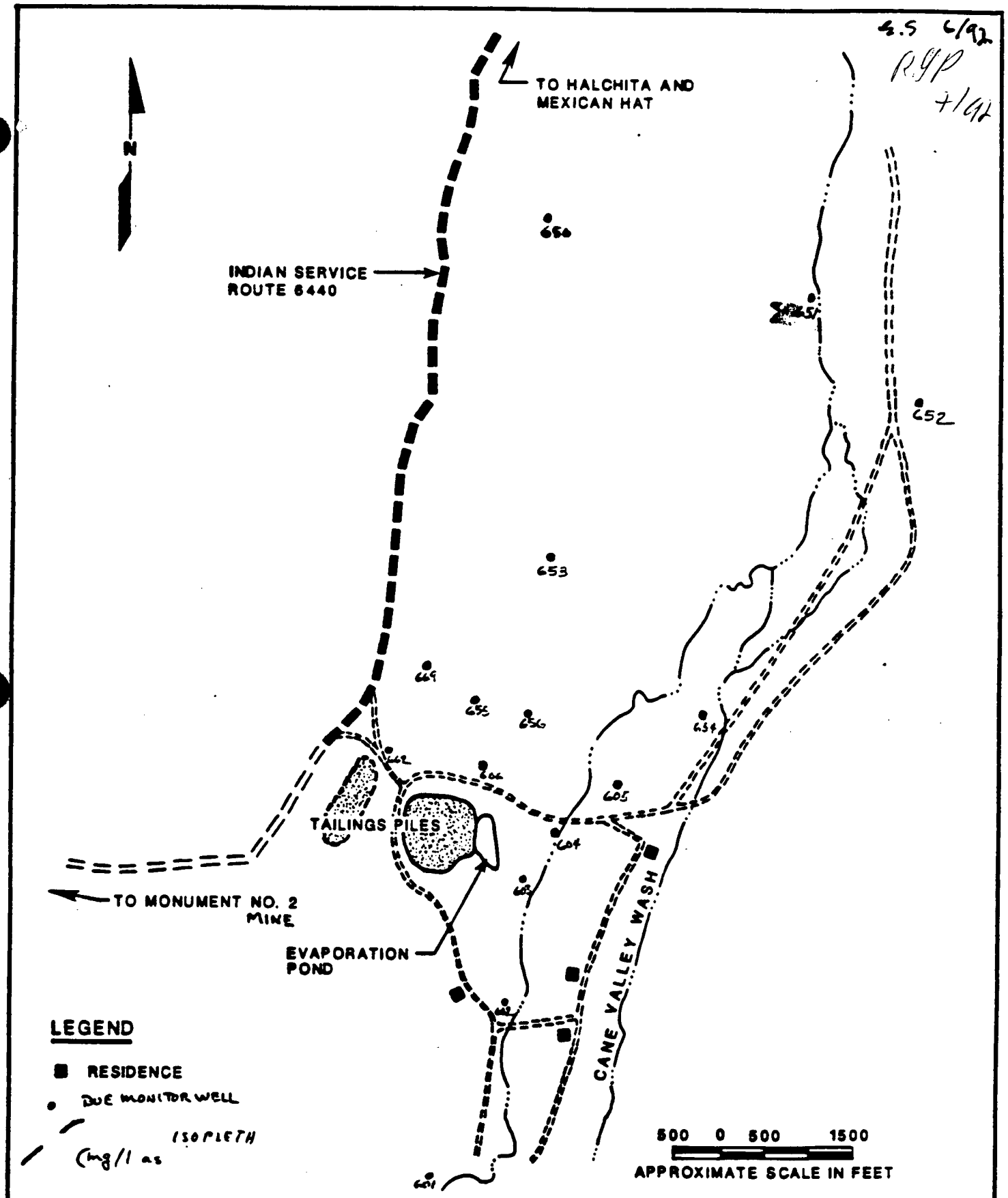

FIGURE 1

Alluvium Monitor Well Locations

DRAWDOWN VS TIME

Monument Valley - Monitor Well 651

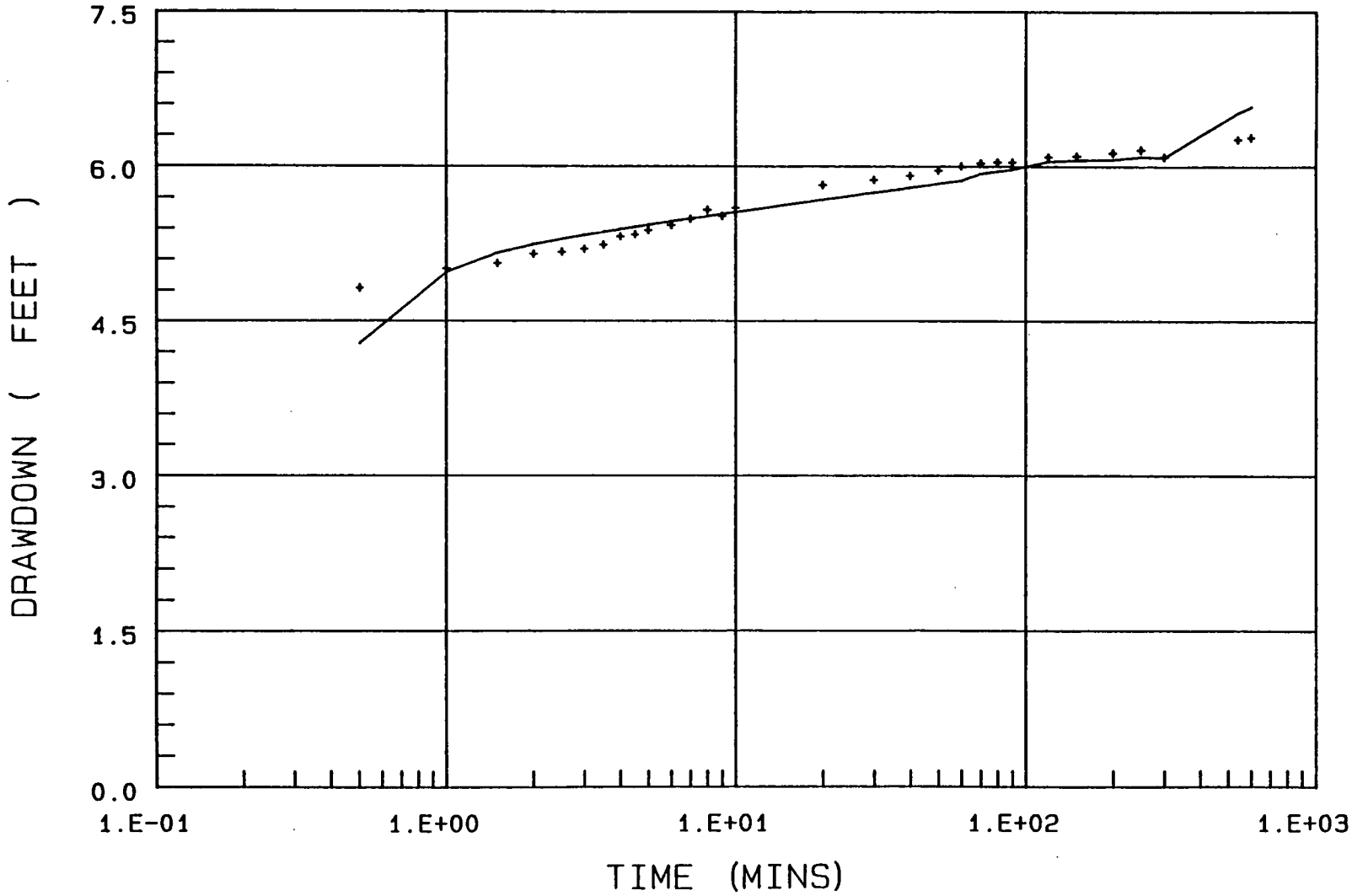

FIGURE 2

Page 1 of 4

E.S 6/92

CALCULATED RECOVERY VS TIME

Monument Valley - Monitor Well 651

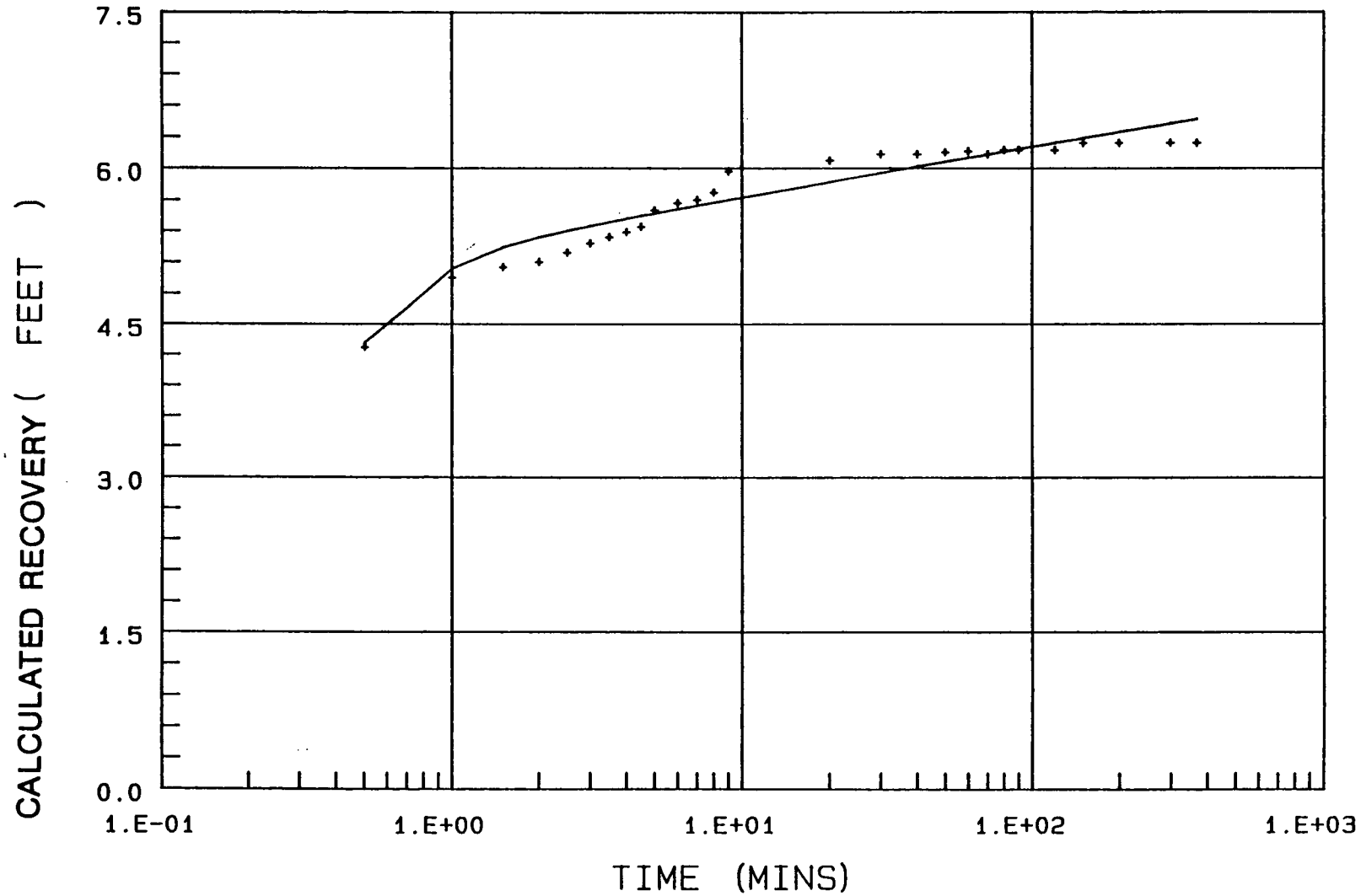

FIGURE 3

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DATE _____ SUBJECT

SHEET NO. 9

BY _____ CHKD. _____

JOB NO. 8.5. 6/92
RAP 7/92

ATTACHMENT 1

10

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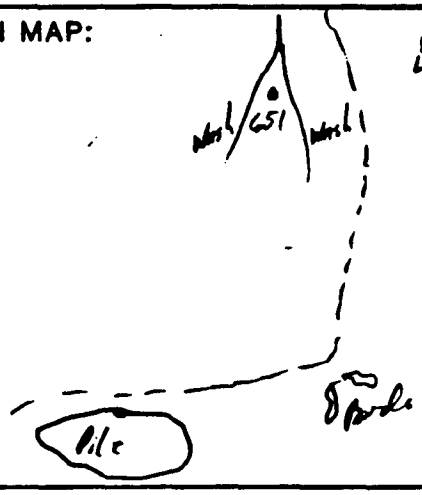
BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: Mon-01 LOCATION ID: 651
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: Rotary
DRILLING CONTR.: Beeman Drilling Co.
DATE STARTED: 9/29/85
DATE COMPLETED: 9/29/85
FIELD REP.: R. Crockett

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION Intersection of 2 washes, sand dune

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
0.0								SP	Sand, Some Silt, Pred Fine - Med, N.P., Red-Brn
									Cont'd
39.0									

COMMENTS: _____

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-2S (4/85)

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JACOBS ENGINEERING GROUP INC.
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BOREHOLE LOG (SOIL)

LOCATION MAP:

See fig. 1

SITE ID: Mon-01 LOCATION ID: 651
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: Rotary
DRILLING CONTR.: Beeman Drilling Co.
DATE STARTED: 9/29/86
DATE COMPLETED: 9/29/86
FIELD REP.: R. Crockett

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
30.0								SP	Sand, Some Silt, Med Fine-Med, N.P., Red Brn.
42.0								CL	Sandy Clay, L.P., Tan
44.0								SP	Sand, Some Silt, Med Fine-Med N.P., Red-Brn
60.0									Cont'd

COMMENTS: _____

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-2S (4/85)

E.S. 6/92

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ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:

See Pg 1

SITE ID: Mw-07 LOCATION ID: 65
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: Rotary
DRILLING CONTR.: Beeson Drilling Co.
DATE STARTED: 6/29/85
DATE COMPLETED: 6/29/85
FIELD REP.: R. Crockett

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
60.0								SP	Sand, Some Silt, Med Fine - Med, N.P., Red-Brn
70.0								CL	Sandy Clay, L.P., Tan - Brn.
88.0									Stopped Drilling @ 88.0'

COMMENTS: _____

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D. 1.38" I.D. drive sample
U - 3" O.D. 2.42" I.D. tube sample
T - 3" O.D. thin-walled Shelby tube

JEG-AL-ENG-2S (4/85)

JACOBS ENGINEERING GROUP INC.
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BOREHOLE/WELL CONSTRUCTION LOG

9.5. 6/92 RGP 7/92

SITE ID: Mw-01 LOCATION ID: 651 FIELD REP: R. Crockett

APPROX. SITE COORDINATES (FT.): N _____ E _____

GROUND ELEVATION (FT. MSL): _____ COMPLETION DATE: 9/29/85

BOREHOLE SUMMARY

DRILLER: Beeman Drilling Co.

RIG TYPE: Gardner - Denver

BIT TYPE	HOLE DIA.● (in.)	END DEPTH● (ft.)	FLUID TYPE
Tricone	7 7/8	82.0	Bent

CASING SUMMARY

CASING TYPE●	DESCRIPTION	DIA. (in.)	END DEPTH● (ft.)
B	Steel Casing	9 5/8	13.0
B	Sch 80 PVC	4	30.0
S	"	4	80.0
B	"	4	82.0

● P-Protective S-Screen B-Blank O-Open N-None

● Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE●	DESCRIPTION	END DEPTH● (ft.)
B	Cement Grout	13.0
S	Bent Pellets	17.0
F	Silica Sand	82.0

● B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	9/29/85	8:00	9:30
CASING	9/29	10:15	12:15
FILTER PACK	9/29	12:15	3:00
SEAL	9/29	3:00	3:30
BACKFILL	9/29	3:30	4:00
DEVELOPMENT			
OTHER			

WELL DEVELOPMENT

COMMENTS: _____

JEG-AL-ENG-1 (8/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. MON-08-92-14-02-00 DISCIPLINE HYDROLOGY NO. OF SHEETS 156

PROJECT: UMTRA

SITE: MONUMENT VALLEY

FEATURE: SLUG TEST ANALYSIS TO DETERMINE HYDRAULIC CONDUCTIVITY

SOURCES OF DATA: DATA COLLECTED BY TAC FIELD STAFF

SOURCES OF FORMULAE & REFERENCES: SEE TEXT

PRELIMINARY CALC. ☐ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
		[illegible]	7/92	[illegible]	7-92		

B/86

R.S. 7/91
RHP 7/92

MONUMENT VALLEY CALCULATION MON-06-92-14-02-00

SLUG TEST ANALYSES FOR MONITOR WELLS: MONUMENT VALLEY SITE

PURPOSE:

The purpose of this calculation is to estimate the hydraulic conductivity of the hydrostratigraphic units at the Monument Valley site. The results of these calculations will be used in groundwater velocity calculations for the Monument Valley site.

METHOD AND PROCEDURES:

Slug test data were collected from monitor wells 601, 602, 604, 605, 610, 612, 653, 655 - 664, 668, and 669 in 1985. The locations of monitor wells are shown in Figures 1 - 3. Slug test data were evaluated using the following methods:

Unconfined System

Bouwer-Rice and Hvorslev

Confined System

Cooper-Bredehoeft-Papadopulos, and Ferris-Knowles

For further information refer to Technical Memo No. 1 (May 15, 1985; Attachment 1) and Technical Memo No. 5 (June 10, 1985; Attachment 2) on slug test analysis.

ASSUMPTIONS:

Refer to Technical Memo No. 1 and No. 5 for specifics to each slug test method.

DATA SOURCES:

All slug test data was collected by UMTRA Technical Assistance Contractor (TAC) staff in April, August, and October 1985. Slug test field data forms, graphical plots, and computed solutions are included in Attachment 3.

CALCULATIONS AND ANALYSES:

BOUWER-RICE METHOD

A detailed description of the Bouwer-Rice method of slug test analysis is presented in Bouwer and Rice, 1976. The equation used to calculate the hydraulic conductivity is:

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$$K = \frac{r_c^2 \ln(\frac{R_e}{r_w})}{2L(t)} \ln(\frac{y_o}{y_t})$$

where y_0 is y-intercept at time zero, y_t is y-intercept at time t, and all other parameters are indicated in Tech Memo No. 5 or Bouwer, 1976.

The dimensionless ratio $\ln(R_e/r_w)$ is fitted using two equations, one for the case where $L_w<H$, and one for the case where $L_w=H$. These equations are, respectively,

$$\ln\frac{R_e}{r_w} = [\frac{1.1}{\ln(L_w/r_w)} + \frac{A+B\ln((H-L_w)/r_w)}{(L_e/r_w)}]^{-1}$$

$$\ln\frac{R_e}{R_w} = [\frac{1.1}{\ln(L_w/r_w)} + \frac{C}{(L_e/r_w)}]^{-1}$$

where A, B, and C are dimensionless numbers, plotted as a function of L_e/r_w (see Tech Memo No. 5).

The parameter $[\ln(y_0/y_t)]/t$ is determined by plotting the residual drawdown versus time on semilog paper, fitting a straight line to the curve, then estimating y_0 (y at time zero), and then selecting a point on the line and determining y_t at time t.

Occasionally, the water table is located below the top of the gravel pack. In this case, the thickness and porosity of the gravel pack should be taken into account when calculating the equivalent value of r_c, the casing radius. The equation used to calculate the equivalent value of r_c for this situation is:

$$r_c = [(1-n)r_c^2 + nr_w^2]^{.5}$$

Note also that slug injection tests should be considered invalid for this particular case, as these tests will overestimate the hydraulic conductivity due to the influence of the gravel pack.

HVORSLEV METHOD

A detailed description of the Hvorslev method of slug test analysis is presented in Hvorslev, 1951. The equation used to calculate the hydraulic conductivity is:

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RJP 7/92

$$K=\frac{r^2 \ln(L/R)}{2LT_o}$$

where T_0 is the time it takes for the water level to rise or fall to 37 percent of the initial change. All other parameters are indicated in Tech Memo No. 5.

Cooper-Bredehoeft-Papadopulos Method

A detailed description of the Cooper-Bredehoeft-Papadopulos method of slug test analysis is presented in Lohman, 1972. The equation used to calculate the hydraulic conductivity is:

$$K=\frac{r_c^2}{tL}$$

where t is obtained from matching the data points of residual drawdown/ initial residual drawdown versus log of time to a type curve found in Lohman, 1972.

Ferris-Knowles Method

A detailed description of the Ferris-Knowles method of slug test analysis is presented in the USGS Water-Supply paper 1536-I, 1963. The equation used to calculate the hydraulic conductivity is:

$$K=\frac{q(1/t)}{4\Pi SL}$$

The values of 1/t and s are obtained from a straight line fit through the data points. The method is valid for large values of t and the straight line fit passing through the origin.

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RESULTS:

Table 1 shows the input data for the slug test calculations for each monitor well tested and for each applicable analysis technique. Table 2 shows the hydraulic conductivities for each slug test method for the respective monitor wells tested.

CONCLUSIONS:

report range

geometric mean

Based on analyses of slug test conducted in monitor 5 wells at the Monument Valley site, the ~~average~~ hydraulic conductivity in the alluvium hydrostratigraphic unit is approximately 1.~~8~~E-5 ft/sec (1.3 ~~1.5~~ ft/day). The ~~average~~ hydraulic conductivity in the Shinarump member is approximately ~~3.2~~E-5 ft/sec (~~2.8~~ ft/day). The ~~average~~ hydraulic conductivity in the DeChelley member is approximately ~~4.2~~E-6 ft/sec (0~~.36~~ ft/day). 1.7 1.5 2.1 0.18

Slug tests yield only a rough approximation of the hydraulic conductivity of an aquifer, and these values should be considered to be an order-of-magnitude estimate of the hydraulic conductivity. Furthermore, the area of influence of a slug test extends only a short distance from the borehole. Therefore, results from slug tests should not be inferred to be valid at a significant distance away from the area of influence.

Because pumping tests are usually more accurate than slug tests for estimating hydraulic conductivity , any critical engineering design should be based primarily on the results of pumping tests, rather than slug tests.

REFERENCES:

Computer Program in Basic - Slug/BAS, on file w/ UMTRA TAC

Bouwer, H., 1978, Groundwater Hydrology, McGraw-Hill Company, N.Y., N.Y., pp. 114-118.

Bouwer, H. and R. C. Rice, 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, 12:423-428.

Hvorslev, M. J., 1951, Time Lag and Soil Permability in Ground Water Observations, Bullentin 36, 50pp., U.S. Army Corps of Engineers Waterways Experimentation Station, Vicksburg, Miss.

Lohman, S.W., 1972, Groundwater Hydraulics, USGS Professional Paper 708, pp. 27-30.

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ATTACHMENTS

Attachment 1 - Technical Memo No. 1: Borehole Hydraulic Testing for Aquifer Characterization.

Attachment 2 - Slug Test Calculations

Attachment 3 - Monitor Well Information, Slug Test Field Data Forms, Data Plots, and Computed Solutions.

TABLE 1
MONUMENT VALLEY
SLUG TEST ANALYSIS - INPUT DATA

WELL COMPLETION DATA						SKIBITSKE		BOUWER - RICE					HVORSLEV	FERRIS-KNOWLES		CBP
WELL ID	TEST DATE	L ft	q ft^3	r ft	R ft	t min	S ft	Y_o	t sec	Y_t	Lw ft	H ft	To min	1/t min^{-1}	S ft	t sec
601	4/27/85	10	0.054	0.083	0.276			2.5	300	0.27	12.5	12.5				
601	8/18/85	10	0.054	0.083	0.276			2.5	480	0.42	12.5	12.5				
602	4/21/85	10	0.054	0.083	0.276			2.5	330	0.69	25.5	26.0	6.3			
602	8/18/85	10	0.054	0.083	0.276			2.5	420	0.43	25.5	26.0				
604	4/21/85	15	0.054	0.083	0.276			2.5	120	0.18	24.0	24.0				
605	4/22/85	15	0.054	0.083	0.276			2.5	90	0.03	24.5	25.0	0.33			
610	8/20/85	20	0.054	0.083	0.276			2.5	540	0.41	54.7	54.7	4.5	0.33	1.25	110
612	4/27/85	20	0.054	0.083	0.276									0.22	0.37	
612	8/25/85	20	0.054	0.083	0.276									0.22	0.52	120
653	10/27/85	20	0.217	0.167	0.33			2.5	150	2.5	44.9	57.7	1.05			
655	10/24/85	20	0.217	0.167	0.33			2.5	480	1.08	23.7	23.7	10.0			
656	10/24/85	20	0.217	0.167	0.33			2.5	150	0.40	29.0	29.0	1.5			
657	10/21/85	15	0.217	0.167	0.33									0.10	1.75	450
658	10/22/85	20	0.217	0.167	0.33			2.5	420	0.29	67.0	67.0		0.21	0.48	60
659	10/26/85	20	0.217	0.167	0.33			2.5	420	0.38	70.0	70.0		0.286	0.91	65

JE JACOBS ENGINEERING

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JOB NO. 2.5. 6/91

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TABLE 1
MONUMENT VALLEY
SLUG TEST ANALYSIS - INPUT DATA

WELL COMPLETION DATA						SKIBITSKE		BOUWER - RICE					HVOR-SLEV	FERRIS-KNOWLES		CBP
WELL ID	TEST DATE	L ft	q ft^3	r ft	R ft	t min	S ft	Y_o	t sec	Y_t	Lw ft	H ft	To min	1/t min^{-1}	S ft	t sec
660	10/27/85	20	0.217	0.167	0.33			2.5	90	0.12	90	90		0.5	0.10	
661	10/28/85	20	0.217	0.167	0.33											650
662	10/22/85	30	0.217	0.167	0.33			2.5	120	0.40	22.12	61.86	1.2			
663	10/24/85	40	0.217	0.167	0.33									0.067	2.3	2200
664	10/27/85	20	0.217	0.167	0.33									0.286	0.64	43
668	10/26/85	20	0.217	0.167	0.33									0.042	1.36	820
669	10/26/85	20	0.217	0.167	0.33			2.5	720	0.30	9.49	9.49	5			

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TABLE 2
SUMMARY OF HYDRAULIC CONDUCTIVITIES CALCULATED FROM SLUG TESTS AND ONE AQUIFER TEST (Monitor well 651)

		HYDRAULIC CONDUCTIVITY (K) – FEET/SEC					
Formation	Well I.D.	Bouwer–Rice	Hvorslev	Ferris–Knowles	CBP	Arithmetic Mean K	Geometric Mean K
AL	602	4.3E–06	3.3E–06	N/A	N/A	3.8E–06	N/A
AL	604	1.7E–05	N/A	N/A	N/A	1.7E–05	N/A
AL	605	3.6E–05	4.6E–05	N/A	N/A	4.1E–05	N/A
AL	651	N/A	N/A	N/A	N/A	2.2E–04	N/A
AL	653	3.3E–05	4.5E–05	N/A	N/A	3.9E–05	N/A
AL	655	3.9E–05	4.6E–06	N/A	N/A	4.3E–06	N/A
AL	656	2.8E–05	3.2E–05	N/A	N/A	3.0E–05	N/A
AL	662	2.0E–05	2.9E–05	N/A	N/A	2.5E–05	N/A
AL	669	5.4E–06	9.5E–06	N/A	N/A	7.5E–06	N/A
DC	610	2.2E–06	2.7E–06	9.5E–07	3.1E–06	2.2E–06	2.0E–06
DC	612	N/A	N/A	1.8E–06	2.9E–06	2.4E–06	N/A
DC	657	N/A	N/A	1.1E–06	4.1E–06	2.6E–06	N/A
DC	661	N/A	N/A	N/A	2.1E–06	2.1E–06	N/A
DC	663	N/A	N/A	2.1E–07	3.2E–07	2.7E–07	N/A
DC	664	N/A	N/A	3.2E–05	6.0E–06	1.9E–05	1.4E–05
DC	668	N/A	N/A	4.4E–07	1.7E–06	1.1E–06	8.6E–07
SR	601	5.5E–06	N/A	N/A	N/A	5.5E–06	N/A
SR	658	1.4E–05	N/A	4.9E–06	2.3E–05	1.4E–05	1.2E–05
SR	659	1.2E–05	N/A	4.5E–06	2.1E–05	1.3E–05	1.0E–05
SR	660	9.4E–05	N/A	7.2E–05	N/A	8.3E–05	N/A

AL – ALLUVIUM
DC – DECHELLEY MEMBER OF THE CUTLER FORMATION
SR – SHINARUMP MEMBER OF THE CHINLE FORMATION
CPB – COOPER–BREDEHOEFT–PAPADOPULOS METHOD
NOTE: Single Aquifer Test Conducted in Alluvial MW 651

ALLUVIUM K RANGE: 3.3E–06 to 2.2E–04 ft/s = 0.28 to 19 ft/day
DECHELLY K RANGE: 2.1E–05 to 3.2E–05 ft/s = 0.018 to 2.8 ft/day
SHINARUMP K RANGE: 4.5E–06 to 9.4E–05 ft/s = 0.39 to 8.1 ft/day

4.5 6/91

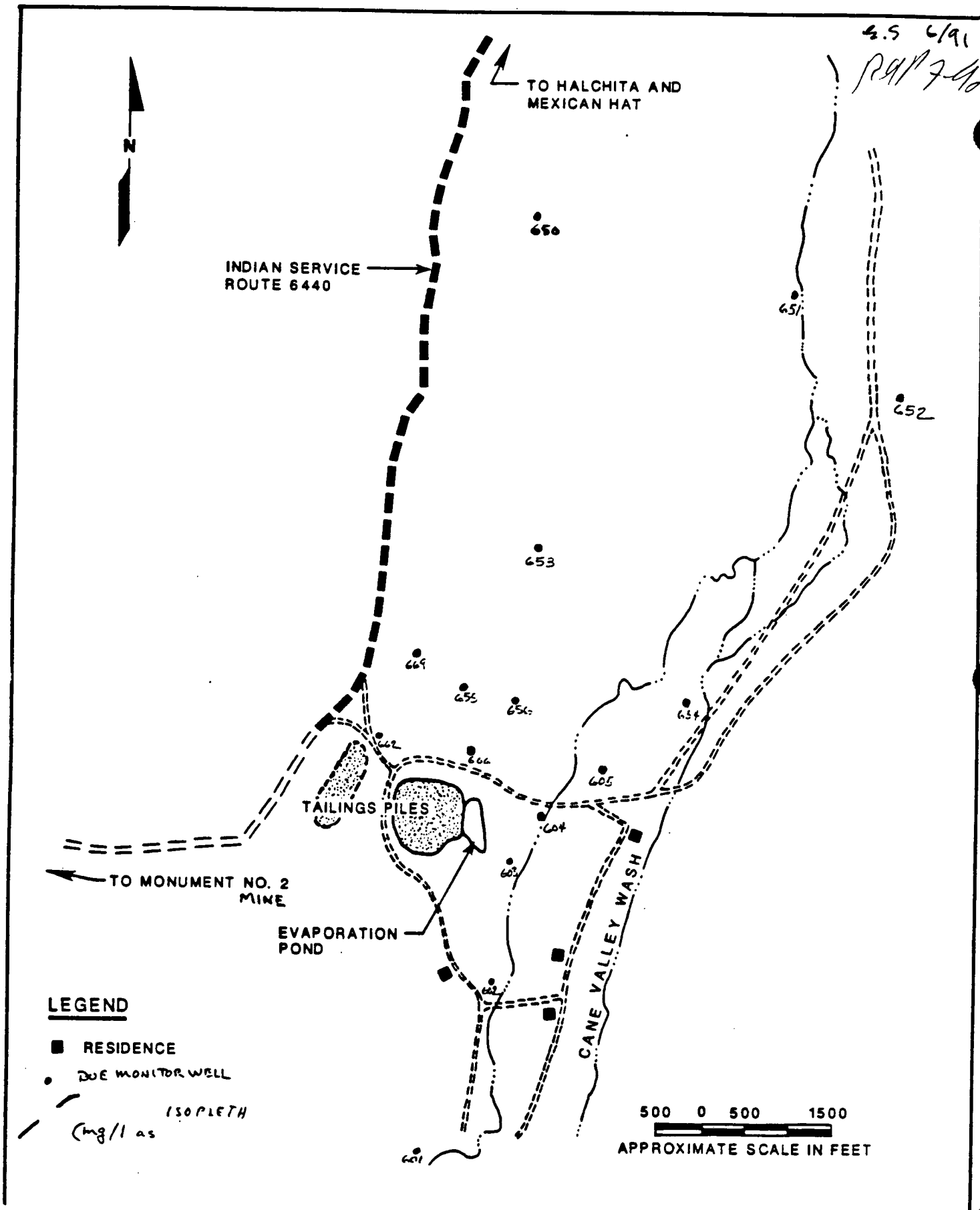

FIGURE 1

Alluvium Monitor Well Locations

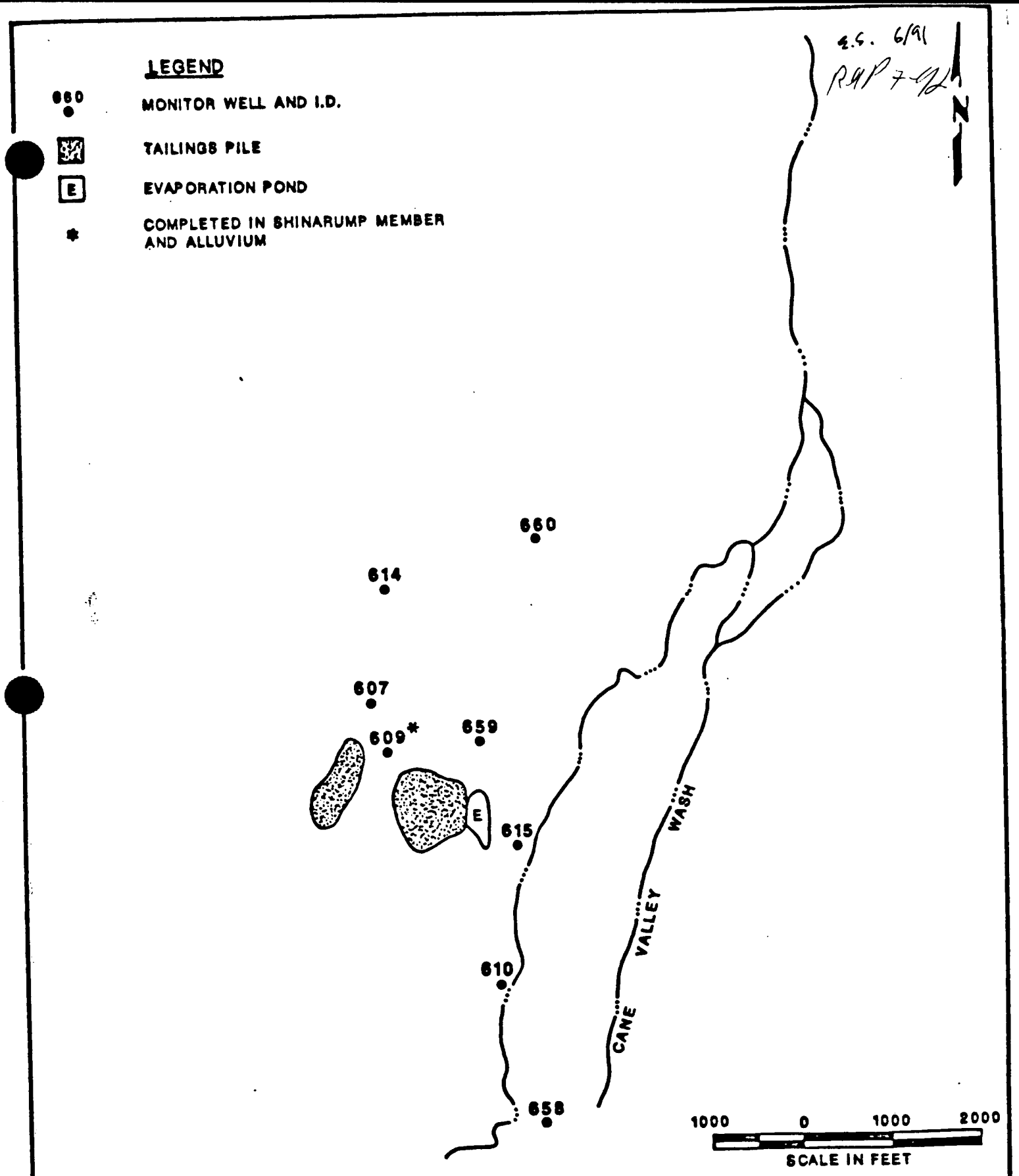

FIGURE 2
LOCATIONS OF MONITOR WELLS COMPLETED IN THE SHINARUMP MEMBER AQUIFER AT THE MONUMENT VALLEY SITE

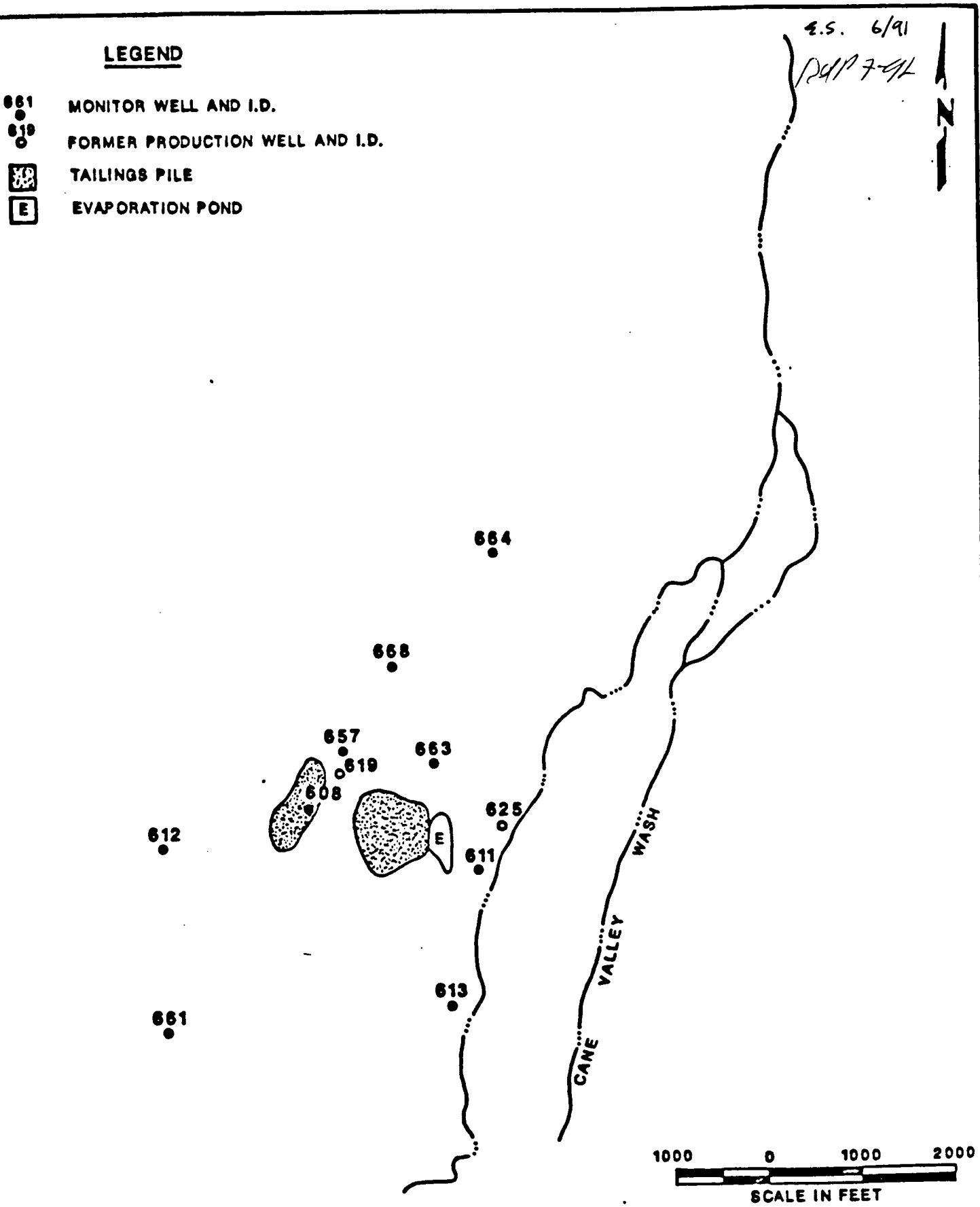

FIGURE 3
LOCATIONS OF MONITOR WELLS COMPLETED IN THE
DE CHELLY SANDSTONE AQUIFER AT THE MONUMENT VALLEY SITE

DATE _____ SUBJECT SH RCP 7-92

BY _____ CHKD. _____ JC

ATTACHMENT 1

BOREHOLE HYDRAULIC TESTING FOR AQUIFER CHARACTERIZATION

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ADVANCED SYSTEMS DIVISION, ALBUQUERQUE O

Slug & Pump Tes

To: Hydrological Services Group

From: John Thackston

Date: May 15, 1985

Subject: Bore Hole Hydraulic Testing for Aquifer Characterization
Technical Memorandum No. 1

The purpose of the attached technical memo is to provide guidelines for conducting hydraulic tests in boreholes or wells in order to characterize the hydraulic properties of aquifers for the UMTRA Project.

Guidelines provided herein are intended to be supplementary to the standard operating procedures (SOP) for these activities currently in effect for the UMTRA Project. In the event there is overlap or conflicts in direction regarding procedures or methodology between this technical memo and the project SOP documents, please advise me. In all such cases, assume that the SOP directives take precedence.

JT:mas
Attachment

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BORE HOLE HYDRAULIC TESTING FOR AQUIFER CHARACTERIZATION

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TECHNICAL MEMORANDUM NO. 1
BORE HOLE HYDRAULIC TESTING FOR AQUIFER CHARACTERIZATION

1.0 INTRODUCTION

This technical memorandum provides guidelines and procedures for determining the hydraulic parameters of aquifers using slug tests and pumping tests. The hydraulic conductivity (K) of an aquifer is a measure of the aquifer's ability to conduct water. The greater the value of hydraulic conductivity, the more readily the aquifer conducts water. Figure 1 illustrates the typical range of hydraulic conductivity values associated with a variety of earth materials. The transmissivity (T) of an aquifer is defined as the ability of the aquifer to transmit water through its entire thickness and is equal to the hydraulic conductivity (K) times the saturated thickness of the aquifer (b); this can be stated as $T = Kb$, for cases in which K is constant with depth. Otherwise, transmissivity is equal to the integration of hydraulic conductivity over depth, $T = \quad K(Z)dz$.

Specific yield of an aquifer is the ratio of the volume of water drained by gravity from a unit volume of aquifer material. The storage coefficient of an aquifer is the volume of water in storage released from a column of aquifer with unit cross section under a unit decline of head.

1.1 SLUG TEST

1.1.1 PURPOSE

The purpose of this section is to outline procedures for the conduction and evaluation of slug tests which are a quick and inexpensive method of estimating the hydraulic conductivity or transmissivity of many aquifer systems.

A slug test will generally work in aquifers where K is less than or equal to 10^{-2} cm/sec. In aquifers of greater hydraulic conductivity the water level may return to static level before a sufficient number of water level readings can be made. In aquifers of low K (10^{-4} to 10^{-7} cm/sec), slug tests are generally a reliable field method of determining hydraulic conductivity or transmissivity near the screened zone of the well.

The advantages of using slug tests to estimate hydraulic conductivities are:

1. Estimates can be made in situ and errors incurred in laboratory testing of disturbed samples are avoided.

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2. Tests can be performed quickly at relatively low cost because a pumping well and observation wells are not required.

3. The hydraulic conductivity of small discrete portions of an aquifer can be made, for example, such as sand layers in a clay.

There are disadvantages in using slug tests which must be evaluated before the test is conducted. These include:

1. Only the hydraulic conductivity of the area immediately surrounding the well is estimated. These results may not be representative of the average hydraulic conductivity of the area.

2. Often only a range of hydraulic conductivity values rather than an average value can be deduced from test results.

3. Certain assumptions are made in the analysis process. If the assumptions made are inappropriate for the geologic conditions at the site, the results may be erroneous.

4. The storage coefficient, S, usually cannot be determined.

5. Data sufficient for analysis may not be collected if the hydraulic conductivity is relatively high.

This technical memorandum explains procedures and equipment commonly used in conducting most slug tests and a list of analysis techniques used under different geologic conditions and for different bore hole or well systems. Also included are example calculations of typical slug tests (Appendices 1-1 and 1-2).

1.1.2 DESIGN, DRILLING AND CONSTRUCTION OF SLUG TEST WELL

Several factors enter into the design of a well for the performance of slug testing. These include depth and diameter of the test well, length of screened interval and size of screen openings. Some of these factors can be chosen as drilling proceeds or be predetermined from previous borings. Well design is generally determined from a combination of drill cuttings, corings, and geophysical logging.

The depth and screened interval of the hole are determined by the location of the zone of interest. The diameter of the hole and casing to be inserted in the hole should be large enough in order that the volume of the slug does not overflow the top of casing. This may be a problem when the water level in the bore hole is relatively close to the ground surface. The screened interval should consist of screen with a percentage of open intervals large enough so as not to excessively restrict water flowing from the bore hole to the subsurface materials tested. Wells with screened intervals which require a gravel pack should be packed with material of a grain size distribution that would result in approximately an order of magnitude of higher hydraulic conductivity than the subsurface materials being tested.

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A variety of drilling techniques can be used in completing the test well. These may include mud-rotary, air-rotary, coring and auger techniques. The type of drilling method used depends on the behavior of the material being drilled and the specific objectives of the project. Drilling without drilling fluids is preferred because this prevents further contamination of the subsurface. Mud-rotary techniques are sometimes required in order to lubricate the bit and hold up the bore hole walls when relatively thick, coarse, unconsolidated materials are encountered. Augering is normally performed without the use of drilling fluids and used in the drilling of relatively shallow holes with relatively cohesive materials.

The construction of the test well is relatively simple and involves the assembly of the appropriate diameter casing (usually PVC because of lower cost) for insertion into the bore hole. A pre-slotted screened section is prepared and attached to the casing string, normally with a cap on the bottom (to prevent material from entering the bottom of the screen), and the whole assembly is lowered into the hole. If a gravel pack is necessary as a filter due to the aquifer containing very fine unconsolidated sand, then it should be placed opposite the screened interval using a tremie pipe. The annulus is then grouted from the top of the gravel pack up to the ground surface in order to allow hydraulic connection only between the test well and the zone to be tested. The hole should be flushed or bailed before grouting if drilling fluid remains in the hole. If the ground water in the hole is highly contaminated, special safety precautions should be taken to control the discharge water before test well development.

1.1.3 EQUIPMENT

Equipment necessary to conduct a slug test include:

- Well or bore hole
- Water level measuring device
- Known solid volume of particular shape (slug) that will easily fit into the well or bore hole or container to add or remove a known volume of water
- Watch with second hand
- Semi-log graph paper
- Indelible pen or pencil and paper

A number of water level measuring devices can be used for measuring the depth to water in a well. An excellent device for measuring the depth to water during a slug test is the pressure transducer. An example strip chart data record is shown in Appendix 1-2. Accurate readings may also be obtained with electric water level indicators or weighted tapes with ploppers. Water level measurement by the wetted-tape method should be avoided as it may be difficult to obtain a sufficient number of readings for analysis of the test if the water level recovers quickly in a short amount of time.

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1.1.4 PROCEDURE

Before beginning the slug test, the following information should be recorded:

- Site ID and well or bore hole location
- Location and elevation of reference point from which water depth measurements are made
- Elevation of ground water with respect to the reference point
- Date and time of test
- Well depth, screen length, riser pipe radius, well screen radius, and radius of the gravel pack plus the well screen or bore hole depth and radius
- Aquifer or ground water zone being tested
- Volume of water added or withdrawn or volume of solid cylinder (slug)
- Type of measuring device used
- Names of personnel conducting test

The following procedures will apply to most slug tests. The field procedures required for a particular slug test may be slightly different, however, and the procedures should be modified to that test as necessary.

- Determine the static water level in the well by measuring the depth to water periodically for several minutes and taking the average of the readings.
- "Instantaneously" introduce or remove a known volume of water to the well. Another method is to introduce a solid cylinder of known volume to displace and raise the water level, allow the water level to restabilize and remove the cylinder. It is important to remove or add the volumes as quickly as possible because the analysis assumes an "instantaneous" change in volume is created in the well.
- With the moment of volume addition or removal assigned time zero, measure and record the depth to water and the time at each reading. Depths should be measured to the nearest 0.01 foot. The number of depth-time measurements necessary to complete the test are variable. It is critical to make as many measurements as possible in the early part of the test.
- Continue measuring and recording depth-time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a semi-log plot of time versus depth.

The time required for a slug test to be completed is a function of the volume of the "slug", the hydraulic conductivity of the formation and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.

If the well is to be used as a monitoring well, precautions should be taken that the wells are not contaminated by material introduced into the well. If water is added to the monitoring well, it should be from an uncontaminated source and transported in a clean container. Bailers or measuring devices should be cleaned prior to the test. If tests are performed on more than one monitoring well, care must be taken to avoid cross contamination of the wells.

1.1.5 DATA ANALYSIS

The analysis of slug test data is based on the modification of well-known ground water flow equations (either the Thaim equation, the Theis equation, or subsequent modification). Several authors have presented analytical solutions for the analysis of slug test data. Most solutions require a semi-logarithmic plot of the data collected: dimensionless head (logarithmic scale) or residual head (logarithmic scale) versus time (arithmetic scale).

Hvorslev (1951) was one of the first researchers to publish techniques of analysis of either constant or slug (falling head) tests in near-surface saturated soils. His analysis for slug tests involves a semi-logarithmic plot of the falling head (or water level) divided by the initial head against time. Basic algebraic equations are presented for different configurations of the soil relative to the test hole. In general, the permeability is proportional to a "shape factor" and inversely proportional to a a "time lag". The "shape factor" is determined from the test well characteristics or dimensions. "Time lag" is determined from the semi-logarithmic plot.

Cooper et al (1967) and Papadopulos et al (1973) developed a set of type curves for analyzing slug test data, particularly for tests run in materials which are confined (under artesian pressure). The field data are plotted as dimensionless head (arithmetic scale) versus time (logarithmic scale) and matched to a set of type curves. The match point values are substituted into simple algebraic formulated to obtain a value for K (Appendix 1-1).

Bower and Rice (1976) and Bower (1978) developed a technique for analyzing slug test data collected from completely or partially penetrating wells in unconfined aquifers. Their analysis involves a plot of residual head (logarithmic scale) versus time (arithmetic scale). A straight line is applied to the early-time data and used to calculate a value for K. An example of the use of this technique is presented in Appendix 1-2. A plot of the data and calculations are included.

Pressurized slug test methods have been developed for testing extremely low conductivity (10^{-8} cm/sec or lower) materials (Bredehoeft and Papadopulos, 1980). Basically, the pressurized slug technique is a modification of the conventional slug test discussed previously. The advantage of the pressurized slug technique is the reduction of time required to perform a test in tight formations. This method involves creating an instantaneous pressure surcharge on drawdown in the test zone, then closing a valve to shut in the well. Based on the rate of decay of the pressure slug and the geometry of the test zone, the transmissivity, hydraulic conductivity, and storativity may be calculated.

1.2 ~~AQUIFER PUMPING TEST~~

1.2.1 PURPOSE

The purpose of this section is to briefly describe the use of aquifer pumping tests to evaluate aquifer characteristics. Aquifer pumping tests, commonly referred to as pump tests, are used to determine hydraulic characteristics and properties of water-bearing zones. Pumping tests provide results that are often more representative of the aquifer's characteristics than do slug tests.

Aquifer characteristics which may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), and specific yield (S_y) for unconfined aquifers and storage coefficient (S) for confined aquifers.

Equipment, personnel and time commitments needed to conduct pumping tests are greater than those required for slug tests. Briefly, a pumping test consists of pumping one well and recording the drawdown in the pumping well and in other nearby observation wells.

There are advantages and disadvantages of pumping tests. Some of these are listed below.

Advantages of pumping test:

- A greater portion of the aquifer is tested and the results obtained may be more reliable and representative of the aquifer characteristics.
- Coefficient of storage and specific yield values can be determined.

Disadvantages of pumping test:

- In low permeability aquifers long-term pumping may be required to complete the test and obtain reliable aquifer characteristics.
- Disposal of discharged water may require special provisions if the ground water is contaminated.

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DATE _____ SUBJECT

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BY _____ CHKD. _____

JOB NO. _____

ATTACHMENT 2

SLUG TEST CALCULATION METHODS

22

ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

RDP
7-92

TO: Hydrology Staff

FROM: JBrinkman J.B.

DATE: June 10, 1985

SUBJECT: Technical Memo #5
Slug Test Calculations

This memo is a rerelease of a memo entitled "Slug Tests" released on May 20, 1985. It has been reformatted and some information has been added to make it consistent with "Final Technical Position on Documentation of Computer codes for High-Level Waste Management", NUREG 0856

JB/11

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A. FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

01. Summary date: Yr. 815, Mo. 06, Day 013

02. Summary prepared by (Name and Phone): Jim Brinkman (505) 846-1250

03. Summary action: New [X] Replacement [ ] Deletion [ ]
Previous Internal Software ID

04. Software date: Yr. 815, Mo. 06, Day 03

05. Software title: SLUG/BAS

06. Short title

07. Internal Software ID

08. Software type
- [ ] Automated Data System
- [X] Computer Program
- [ ] Subroutine/Module

09. Processing mode
- [X] Interactive
- [ ] Batch
- [ ] Combination

10. Application area

General
- [ ] Computer systems Support/Utility
- [X] Scientific/Engineering
- [ ] Bibliographic/Textual
- [ ] Management/Business
- [ ] Process Control
- [ ] Other

Specific: Program to solve 5 Slug test calculations.

11. Submitting organization and address
Technical Assistance Contractor
UMTRA Project
5301 Central Avenue NE, Suite 1400
Albuquerque, New Mexico 87108

12. Technical contact(s) and phone
Jim Brinkman or John Thackston
(505) 846-1250

13. Narrative
This program solves 4 very simple slug test methods and one rather involved method. For four methods, a value or values obtained from a graphical representation of the test data is required input. The program is user-friendly and interactive. All input and the calculated value of hydraulic conductivity are printed.

14. Keywords
Slug Test

15. Computer manufr and model	16. Computer operating system	17. Programming language(s)	18. Number of source program statements
TRS-80	TRSDOS	BASIC	97

19. Computer memory requirements	20. Tape drives	21. Disk/Drum units	22. Terminals
	None	None	One

23. Other operational requirements
Printer

24. Software availability
- Available [X]
- Limited [ ]
- In-house only [ ]

25. Documentation availability
- Available [X]
- Inadequate [ ]
- In-house only [ ]

26. FOR SUBMITTING ORGANIZATION USE

STANDARD FORM 185
JULY 1976
U.S. DEPT. COMMERCE NBS
(FIPS PUB 30)

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B. Mathematical Models and Numerical Methods

SLUG/BAS is a user-friendly BASIC program to analysis slug test data. This program can be used directly on the TRS microprocessors linked with a printer. Five slug test methods can be solved.

✓o Skibitske

Reference: Methods of Determining Permeability, Transmissibility and Drawdown 1963, USGS Water-Supply paper 1536-I, pp-293-298.

✓o Bouwer-Rice
Reference: Groundwater Hydrology, 1978, Herman Bouwer, p-114-118.

o Hvorslev
Reference: Time Lag and Soil Permeability in Ground-Water Observations, 1951, M. Joul Hvorslev, Bulletin No-36, Waterways Experiment Station, Corps of Engineers, U.S. Army, Vicksburg, Mississippi.

o Ferris-Knowles
Reference: Methods of Determining Permeability, Transmissibility and Drawdown, 1963, USGS Water-Supply paper 1536-I, pp-299-304.

✓ o Cooper-Bredehoeft-Papadopulos
Reference: Ground-water Hydraulics, 1972, S.W. Lohman, USGS Professional Paper 708, p-27-30 and Plate 2.

For all the methods except Bouwer-Rice, very simple equations are solved. The Bouwer-Rice method is much more complicated and empirical than the other methods and the solution by hand is rather time consuming. The primary benefit to using this program is that all input data are printed in a uniform format and documentation and certification, i.e., calculation checking, is very easy and quick. For all methods consistent units must be used.

The following Section satisfies all applicable requirements of parts, 2, 3, 4, and 5 of Section B and also serves as a User's Manual.

To run:

1. Insert diskette into TRS microprocessor.
   Be sure printer is attached and on-line.

2. After initializing microprocessor, i.e., entering date and time, enter BASIC by typing BASIC return.

3. Wait until micro response, then load program by typing LOAD "SLUG/BAS" return.

For all five methods, first input:

4. After program is loaded, then run program by typing RUN return.

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1. Well Identification - it is recommended that a nine space identifier be used.

   Example:

   LKV02-508
   a b c

   a Is three letter site designation

   b Is two number designation for processing site or a specific alternate disposal or borrow site.

   c Is three number well designation.

2. The day the field test was initiated.

3. Length of contributing, i.e., screened, packed, etc., interval (L).

4. Which one of the five methods will be applied.

A description of the use of the five methods follow:

o Skibitzke Method

- Used for well completed in confined units with low permeability; residual drawdown should be at last measurement before complete recovery.

- Input data are:

  1. Volume discharged or added (q).

  2. Time from test initiation until residual drawdown measurement (t).

  3. Residual drawdown measurement at time, t (s).

- The equation solved is:

$$K = \frac{qt}{4\pi sL}$$

o Bouwer-Rice Method

- Used for wells completed in unconfined units.

- Input data are:

  1. Well radius (r_c)
  2. Borehole radius (r_w)
  3. Residual drawdown at the initiation of test (Y_o)
  4. Time to residual drawdown measurement (t)
  5. From straight line fit of log (residual drawdown) vs. time, residual drawdown at time, t (Y_t).
  6. Distance from the watertable to the bottom of the contributing interval (L_w).
  7. Distance from the watertable to an impermeable boundary (H).

- The equation solved is:

$$K = \frac{r_c^2 \ln (R_e/r_w)}{2L\ (t)} \ln \frac{y_o}{y_t}, \text{ where}$$

R_e is effective radius.

The term, $\ln (R_e/r_w)$ is determined with one of two empirical relationships.

For partially penetrating wells, $$\ln \frac{R_e}{r_w} = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \dfrac{A + B \ln[(H-L_w)/r_w]}{(L_e/r_w)}}$$

for fully penetrating wells, $$\ln \frac{R_e}{r_w} = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \dfrac{C}{(L_e/r_w)}}$$

A, B and C are empirical coefficients derived from curves based on the value of L_e/r_w (Figures 1, 2 and 3)

Each of the three curves was matched numerically with two parabolas fit to the curve. The points used for the parabolic numerical fits and the resulting parabolas follow:

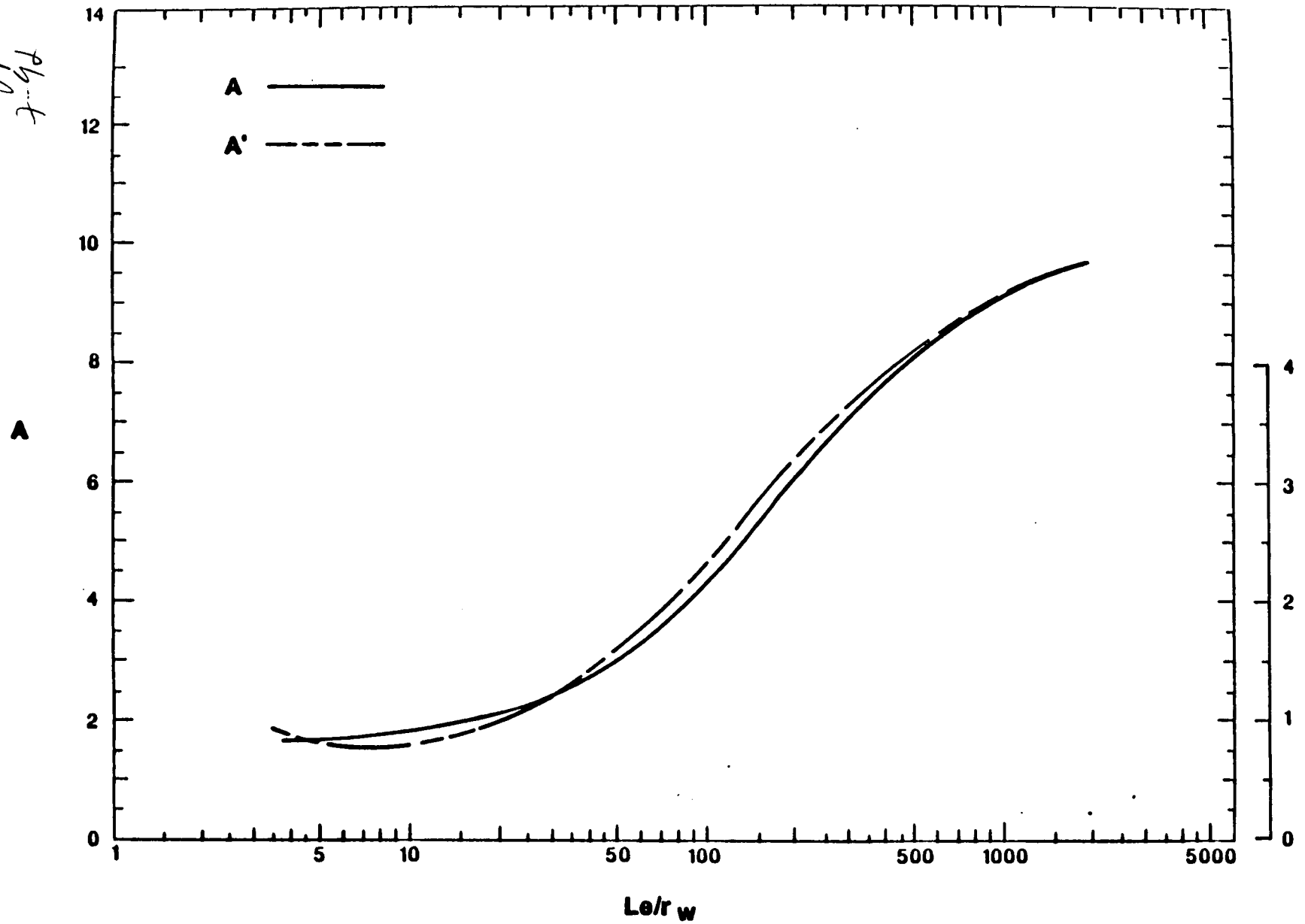

FIGURE 1

COMPARISON OF PUBLISHED AND NUMERICALLY PRODUCED COEFFICIENT RELATIONSHIPS (A,A')

Curve A

L_e/r_w	$X = Ln(L_e/r_w)$	A	
4	1.386	1.8	
32	3.466	2.5	Parabola 1
120	4.787	5.15	
120	4.787	5.15	
450	6.109	8.0	Parabola 2
1600	7.378	9.6	

Parabola 1: $A=0.491x^2-2.045x+3.691$

Parabola 2: $A=0.3455x^2+5.9206x-15.2747$

Curve B

L_e/r_w	$X = Ln(L_e/r_w)$	B	
4	1.386	0.25	
27	3.296	0.43	Parabola 1
190	5.247	1.1	
190	5.247	1.1	
525	6.263	2.3	Parabola 2
1650	7.409	3.3	

Parabola 1: $B= 0.0659x^2 - 0.217x+0.4241$

Parabola 2: $B= 0.12x^2+2.5128x-8.7825$

Curve C

L_e/r_w	$X = Ln(L_e/r_w)$	C	
3.8	1.335	0.8	
32	3.466	2.0	Parabola 1
150	5.011	6.0	
150	5.011	6.0	Parabola 2
370	5.914	9.7	
1650	7.409	13.0	

Parabola 1: $C = 0.5511x^2 - 2.0829x+2.5992$

Parabola 2: $C = -0.7882x^2+12.7088x-37.8922$

Figures 1, 2 and 3 show a comparison of the published curves and the curves developed with the numerical approximations.

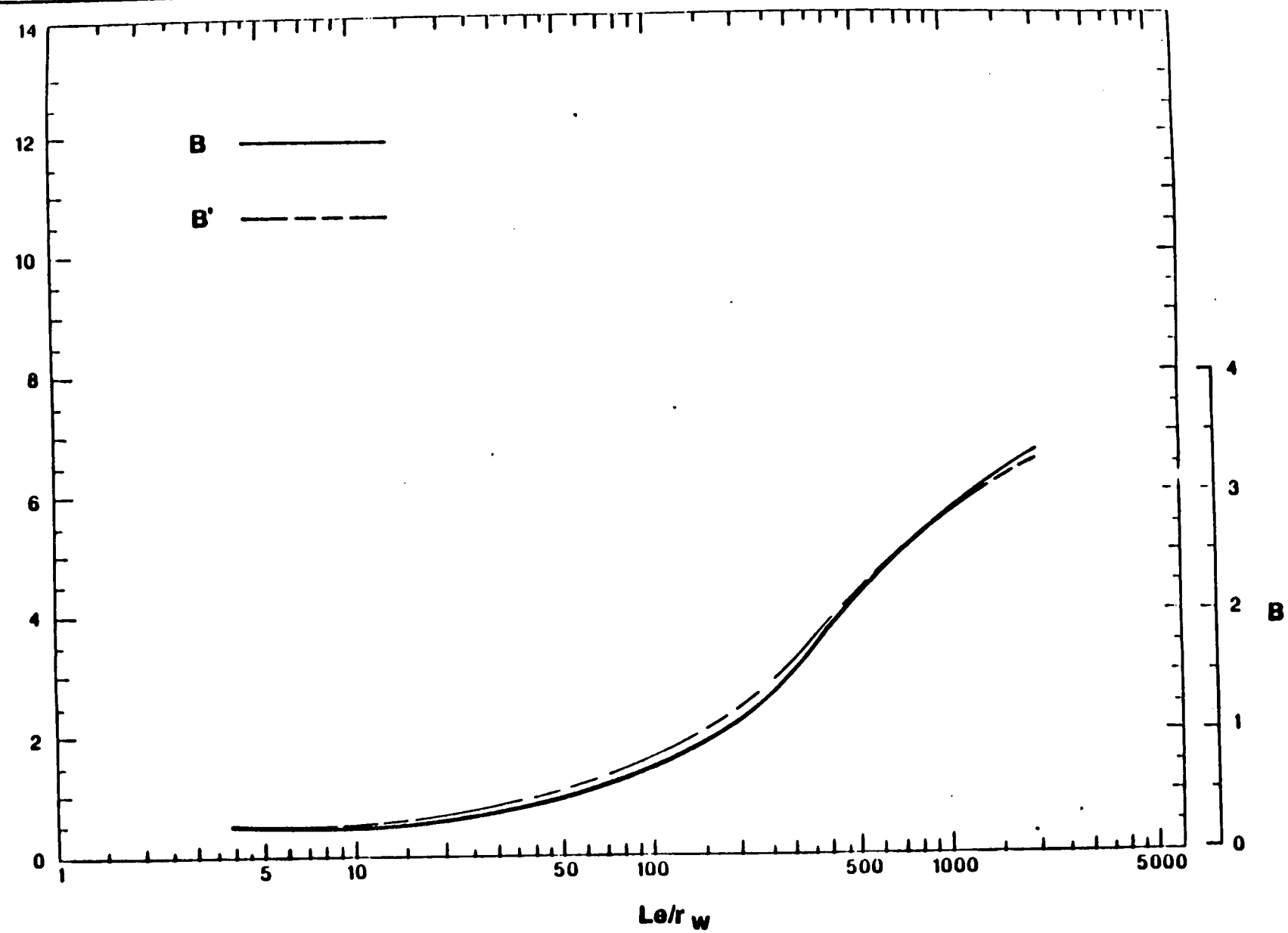

FIGURE 2

COMPARISON OF PUBLISHED AND NUMERICALLY PRODUCED COEFFICIENT RELATIONSHIPS (B,B')

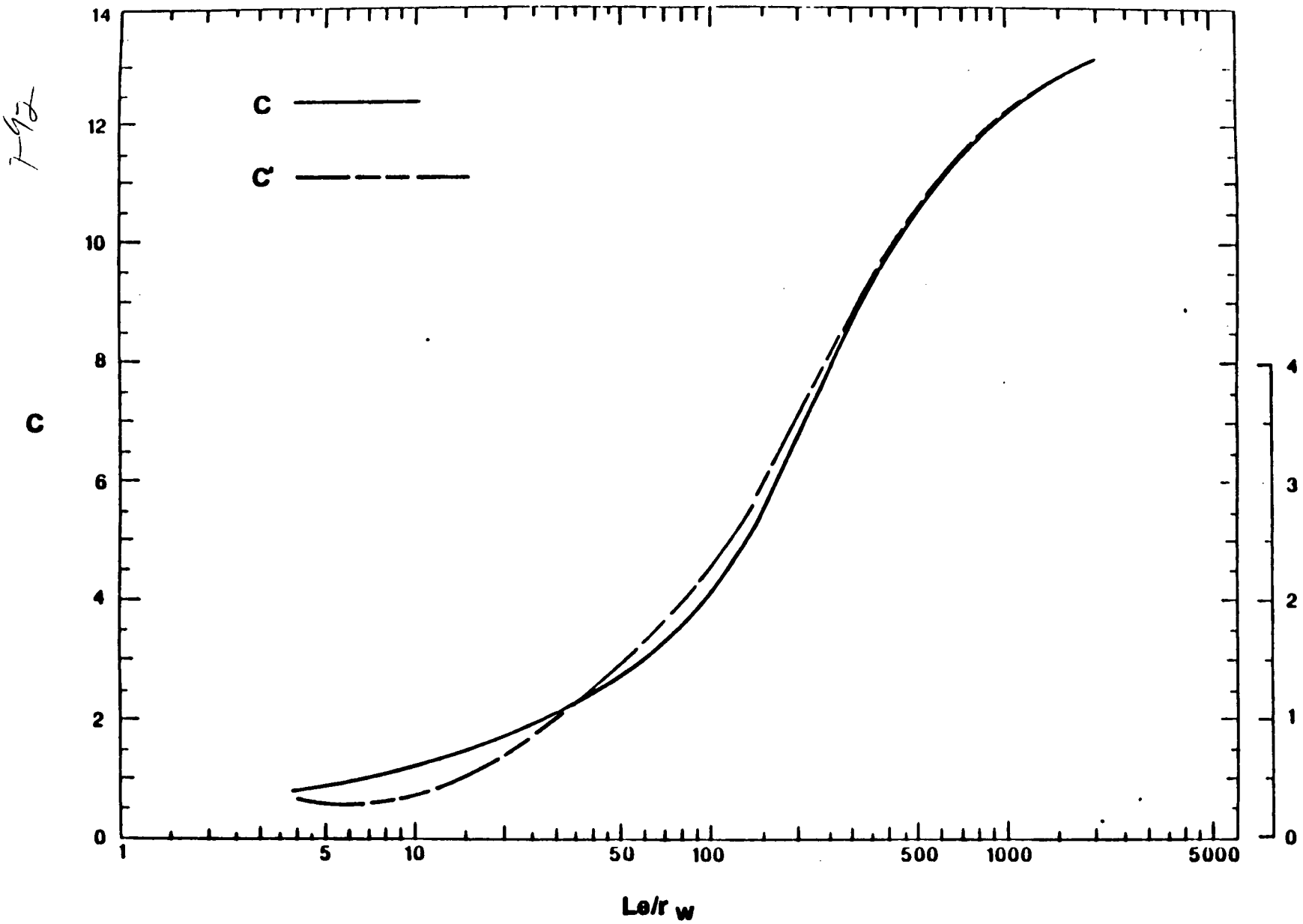

FIGURE 3

COMPARISON OF PUBLISHED AND NUMERICALLY PRODUCED COEFFICIENT RELATIONSHIPS (C,C')

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The greatest relative error due to matching of the curves occurs when the published value of C=1.05 and the numerical value = 0.72. For test cases with L_w ranging from 10 to 200, L_e ranging from 2 to 10 and R_w ranging from 0.083 to 0.25, the maximum relative error was approximately 16 percent with L_w=200, L_e=2 and R_w = 0.25. For most cases, the relative should be much less than 5 percent.

o Hvorslev Method

- Used for unconfined units. This method is valid only if a reasonably fit straight line through the data curve of log (residual drawdown/initial residual drawdown) vs. time passes through the point (1,0).

- Input data are:

  1. Well radius (r)
  2. Borehole radius (R)
  3. Time lag (T_o), T_o is the time when (residual drawdown/initial residual drawdown) = $10^{-10.4343}$

  The equation solved is:

$$K = \frac{r^2 \ln (L/R)}{2 L T_o}$$

o Ferris - Knowles Method

- Used for confined units with K<0.5 cm/sec

- Input data are:

  1. Volume discharge (q)
  2. Reciprical of time (1/t)
  3. Residual drawdown at time, t (s)

  The values of 1/t and s are taken from a straight line fit through the data points. To be valid, this straight line fit must pass through the origin..

- The equation solved is:

$$K = \frac{q\ (1/t)}{4\pi s L}$$

o Cooper-Bredhehoeft-Papadopulos Method

- Used for confined unit with K<0.5 cm/sec.

- Input data are:

  1. Radius of well (r)
  2. Time representing point on matched type curve (t).

  t is obtained from matching the data points of residual drawdown/initial residual drawdown vs. log of time to a type curve found in the referenced report.

- The equation solved is:

$$K = \frac{r_c^2}{tL}$$

C. User's Manual

SLUG/BAS is very easy to use. All input is prompted by explicit commands. The information supplied in Part B is a User's Manual.

D. Code Assessment and Support

To assess and verify the computer code, examples of each method with hand calculation checks are supplied (Attachment 1). Given the simplicity of the calculations, these checks are sufficient verification. The present version of SLUG/BAS is the only presently available version.

E. Continuing Documentation and Code Listings

The code listing is supplied as Attachment 2.

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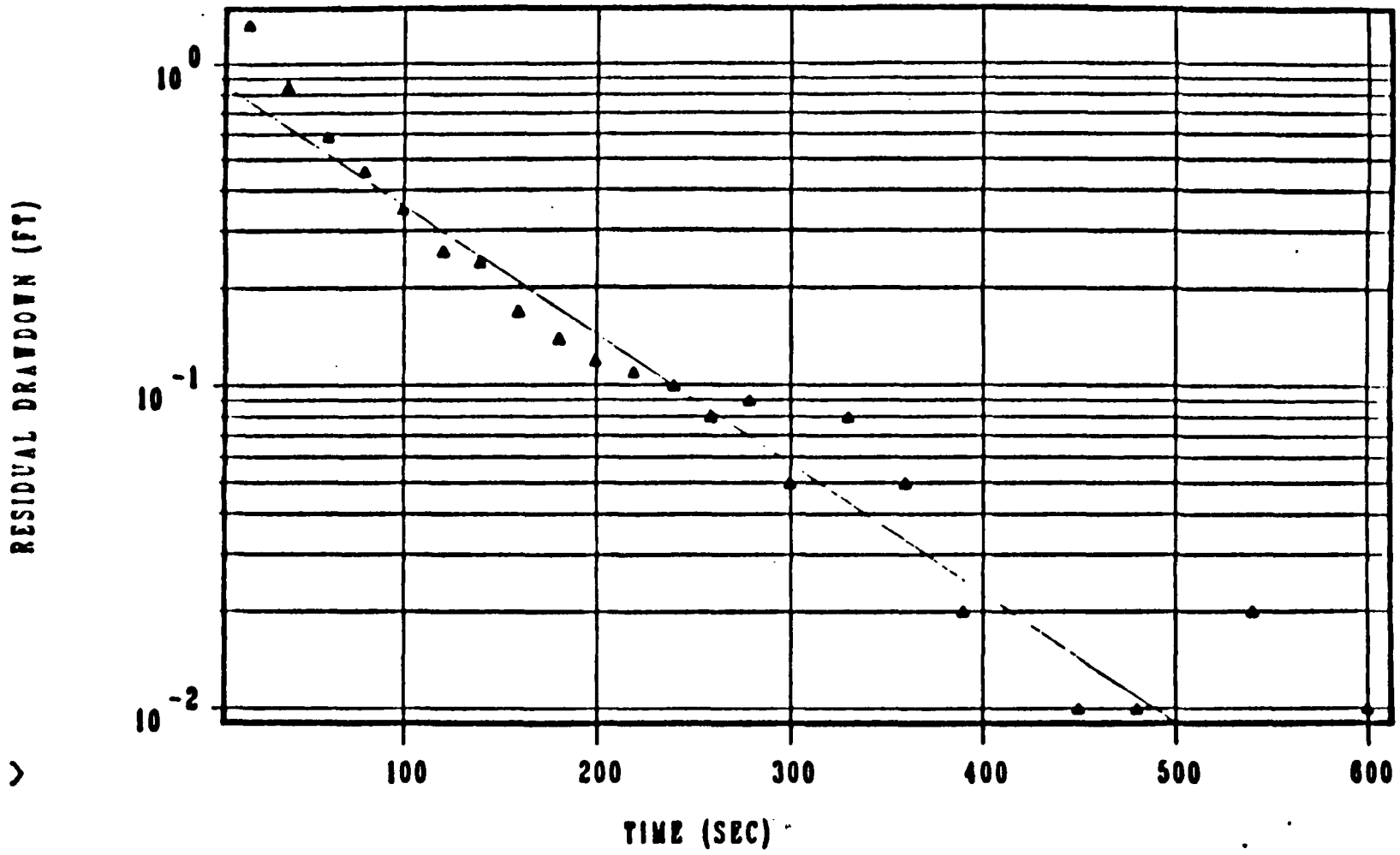
ATTACHMENT 1

BOUWER-RICE SLUG TEST ANALYSIS

SITE:LKV01 LOCATION:501 DATE:08/26/84

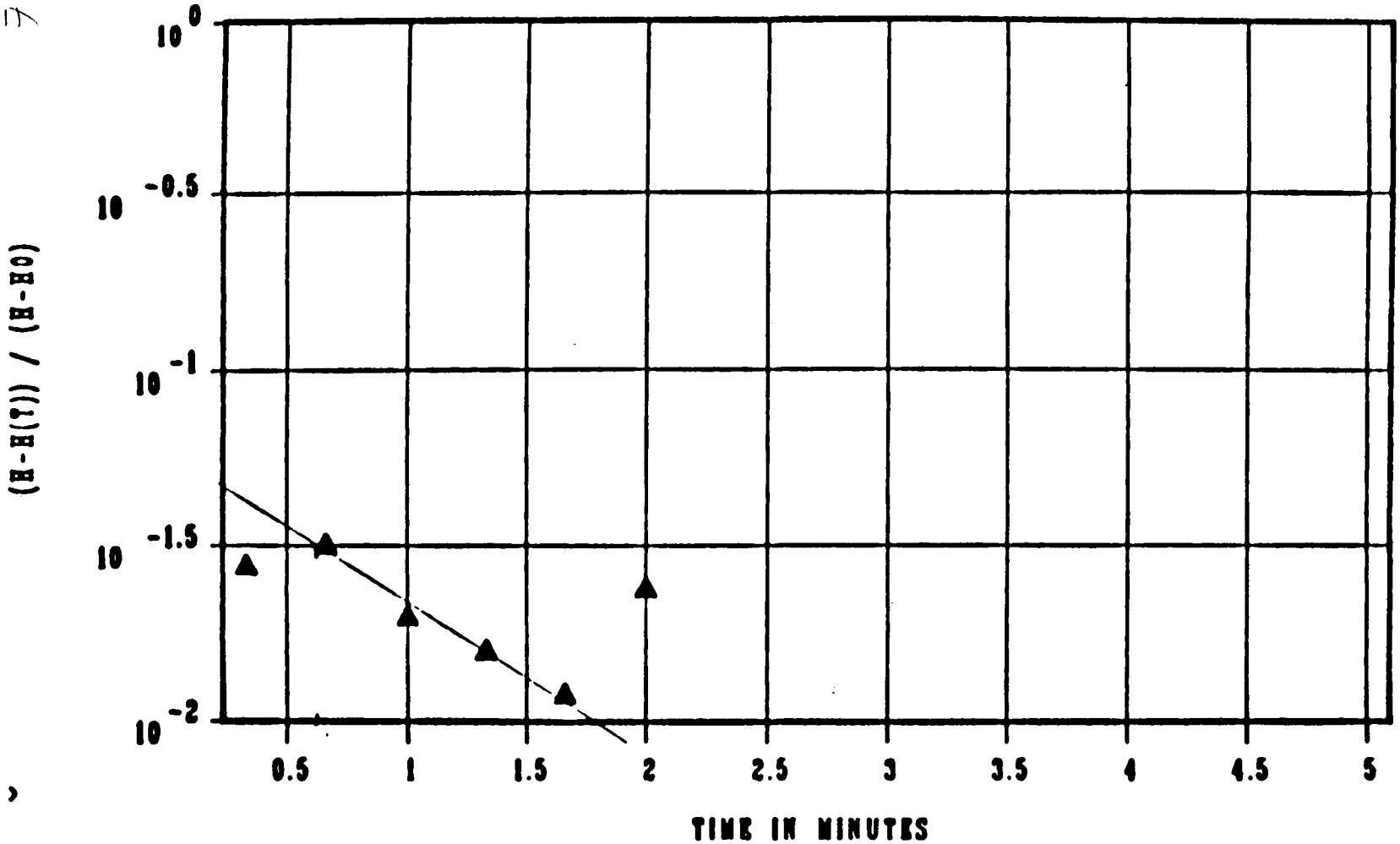


$Y_o = 2.5$ ft.

$t = 300$ sec $= 3.472 \times 10^{-3}$ days

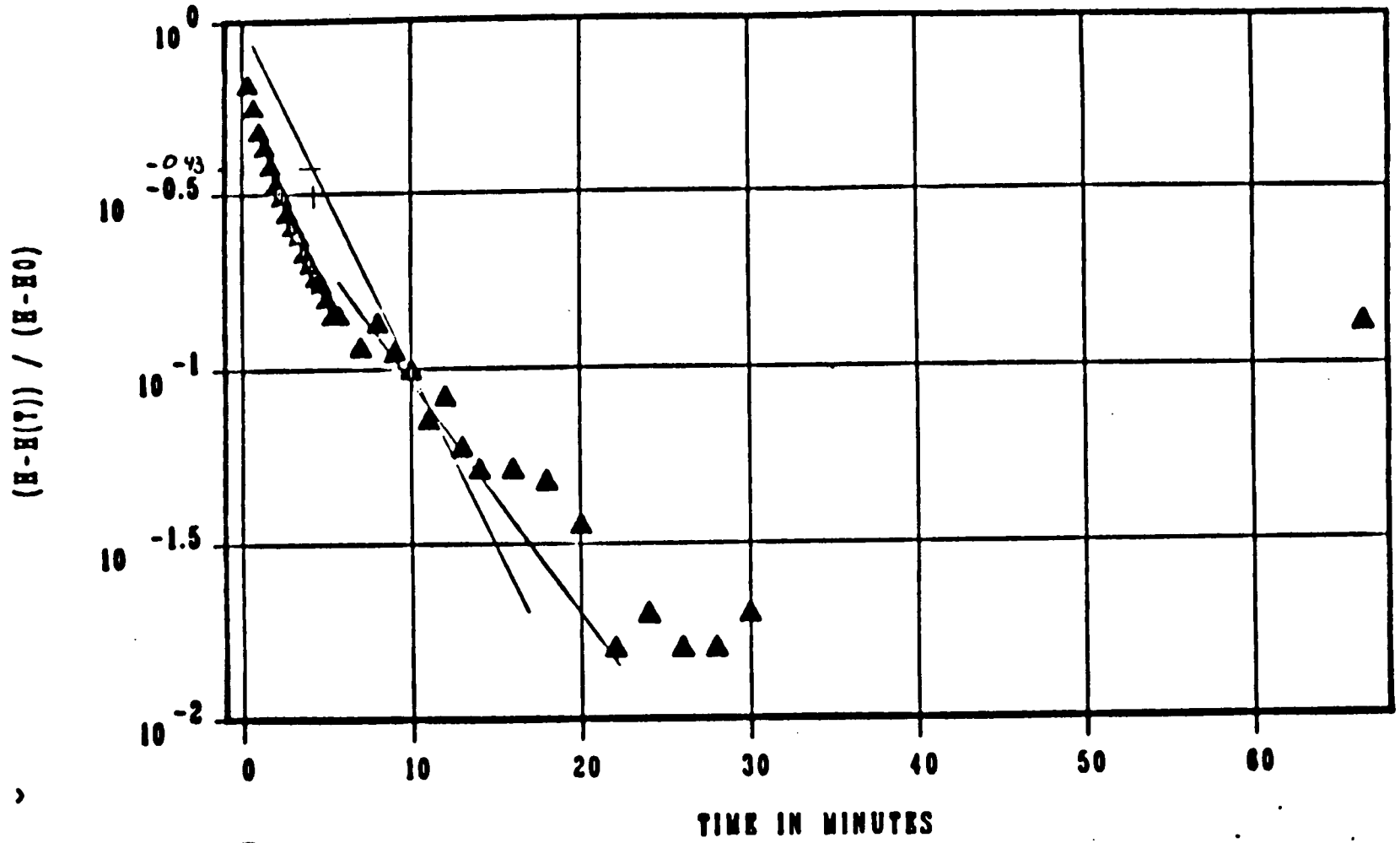
$Y_t = 5.729 \times 10^{-2}$ ft.

LKV01 SLUG TEST- WELL 505



HVORSLEV METHOD
INVALID

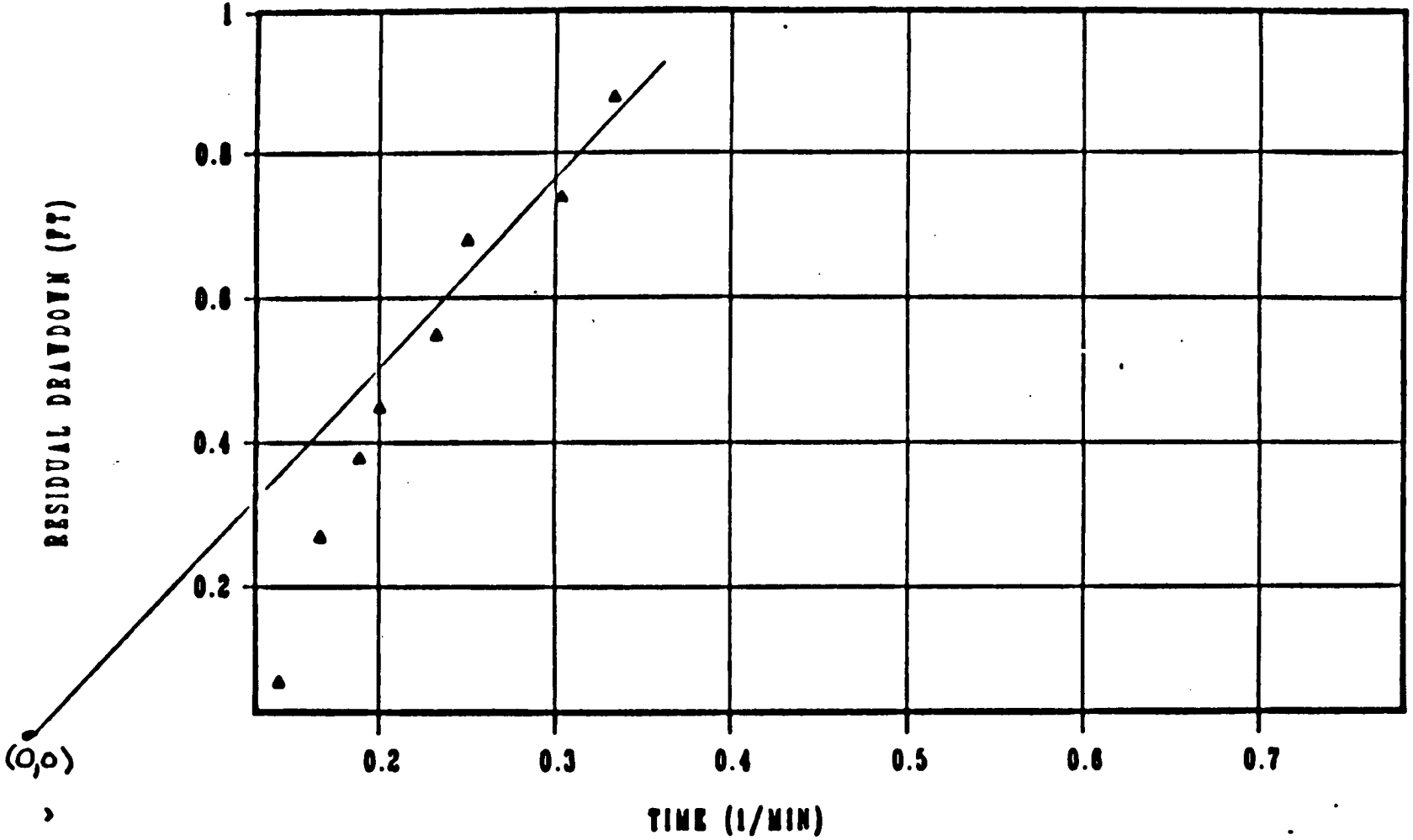
LKV01 SLUG TEST- WELL 503



T_0 = 5 mins = 3.47×10^{-3} days

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:RVT01 LOCATION:704 DATE:01/16/85

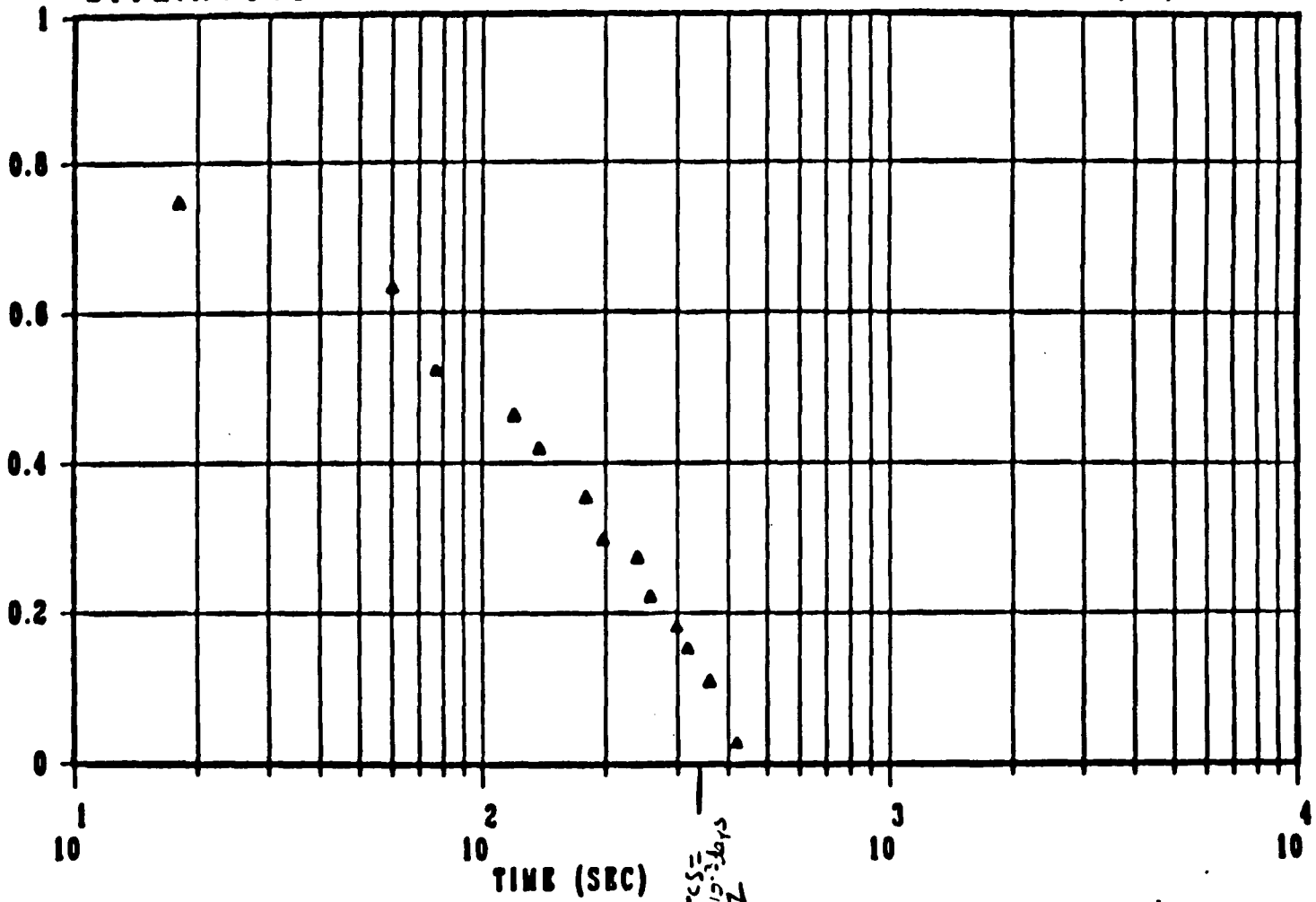


For $\frac{1}{t}$ = 0.2 min^{-1} : 5.7 hr day^{-1}

S = 0.5 ft.

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:RVT01 LOCATION:704 DATE:01/16/85



$t_c = 350$ secs $= 4.1 \times 10^{-3}$ days

$Tt/r_c^2 = 1$

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SLUG TEST SOLUTIONS

```
*****************************************************************
WELL IDENTIFICATION- LKVD1-5D1
DATE OF FIELD TEST- 8/26/1984
LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
SKIBITSKE METHOD
FOR DISCHARGE(Q)=  .054
RESIDUAL DRAWDOWN(s')=  .02
TIME TO RESIDUAL DRAWDOWN(t)=  4.5E-03
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  9.5493
*****************************************************************
```

2a.

```
*****************************************************************
WELL IDENTIFICATION- LKVD1-5D1
DATE OF FIELD TEST- 8/26/1984
LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .083
BOREHOLE RADIUS(Rw)=  .25
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  3.47E-03
HEAD AT TIME t(Yt)=  .0573
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  16.75
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  2000
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.59556
*****************************************************************
```

2b.

```
*****************************************************************
WELL IDENTIFICATION- LKVD1-5D1
DATE OF FIELD TEST- 8/26/1984
LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .083
BOREHOLE RADIUS(Rw)=  .25
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  3.47E-03
HEAD AT TIME t(Yt)=  .0573
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  16.75
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  16.75
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.29325
*****************************************************************
```

3.

```
*****************************************************************
WELL IDENTIFICATION- LKVD1-5D3
DATE OF FIELD TEST- 9/5/1984
LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
HVORSLEV METHOD

FOR WELL RADIUS(r)=  .083
BOREHOLE RADIUS(R)=  .25
AND TIME LAG(To)=  3.47E-03
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  .594744
*****************************************************************
```

4.

```
*****************************************************************
WELL IDENTIFICATION- RVTD1-7D4
DATE OF FIELD TEST- 1/16/1985
LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .054
RECIPROCAL TIME(1/t)=  57.6
DRAWDOWN (s)=  .5
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  .0990371
*****************************************************************
```

5.

```
*****************************************************************
WELL IDENTIFICATION- RVTD1-7D4
DATE OF FIELD TEST- 1/16/1985
LENGTH OF CONTRIBUTING INTERVAL,(L)=    5
COOPER-BREDE-DEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .083
TIME(t)=  4.1E-03
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  .336049
*****************************************************************
```

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JACOBS ENGINEERING

DATE _____ SUBJECT Verification of Slug Test Results SHEET NO 1

BY _____ CHKD. _____ JOB NO. _____

Test cases are on previous page

1. Skibitske:

$$K = \frac{q}{4\pi s t L} = \frac{0.054}{4\pi(0.02)(4.5\times10^{-3})5} = 9.5493$$

2a. Bouwer-Rice with impermeable boundary deeper than bottom of well screen:

$$\ln[(H-L_w)/r_w] = \ln[(2000-16.75)/0.25] = 8.98$$

Substitute 6.0 for 8.98, see Bouwer, 1978, p.115 last sentence

For $L_e/r_w = 5/0.25 = 20$,
$A = 2.2$, $B = 0.3$ see Bouwer, 1978, p.116 fig 5.11

Equa 5.32, p.115: $\ln \frac{R_e}{r_w} = \left\{ \frac{1.1}{\ln(L_w/r_w)} + \frac{A + B\ln[(H-L_w)/r_w]}{(L_e/r_w)} \right\}^{-1}$

$$\left[\frac{1.1}{\ln(16.75/0.25)} + \frac{2.2+0.3(6)}{(5/0.25)}\right]^{-1} = 2.165$$

Equa 5.41, p.115: $K = \frac{r_c^2 \ln(R_e/r_w)}{2L_e} \frac{1}{t} \ln\left(\frac{y_0}{y_t}\right) =$

$$\frac{(0.083)^2(2.165)}{2(5)} \frac{1}{347\times10^{-3}} \ln\left(\frac{2.5}{0.0522}\right) = 1.623$$

ratio of $\frac{\text{computer value}}{\text{longhand value}} = \frac{1.59556}{1.623} = 0.983$

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RJP 7-92

DATE _____ SUBJECT Verification of Slug Test Results SHEET NO 2

BY _____ CHKD. _____ JOB NO _____

2b: Bouwer-Rice with impermeable boundary at bottom of well screen:

For $L_e/r_w = 5/0.25 = 20$, $C = 1.6$, see Bouwer, p. 95 or Fig. 5.

Equa. 5.43, p. 116: $\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{C}{L_e/r_w}\right]^{-1} =$

$$\left[\frac{1.1}{\ln\left(\frac{16.75}{0.25}\right)} + \frac{1.6}{20}\right]^{-1} = 2.93$$

Equa. 5.41, p. 115: $K = \frac{r_c^2 \ln(R_e/r_w)}{2 L_e} \frac{1}{t} \ln\left(\frac{y_0}{y_t}\right) =$

$$\frac{(0.083)^2(2.93)}{2(5)} \frac{1}{3.47\times10^{-3}} \ln\left(\frac{2.5}{0.0575}\right) = 2.20$$

ratio of $\frac{\text{computer value}}{\text{longhand value}} = \frac{2.2035}{2.20} = 1.0016$

3. Hvorslev:

$$K = \frac{r_c^2 \ln(L/R)}{2 L T_0} = \frac{(0.083)^2 \ln(5/0.25)}{2(5)(3.47\times10^{-3})} =$$

5.94744

4. Ferris-Knowles:

$$K = \frac{q\left(\frac{1}{t}\right)}{4\pi s L} = \frac{(0.054)(576)}{4\pi(0.5)(5)} = 0.0[illegible]$$

5. Cooper-Bredehoeft-Papadopulos:

$$K = \frac{r_c^2}{t L} = \frac{(0.083)^2}{(4.1\times10^{-3})(5)} = 0.336049$$

```
10 '*****************************************************************
20 '*****************SLUG/BAS*****************************************
30 '*****************************************************************
40 '
50 ' THIS PROGRAM SOLVES FIVE SLUG TEST METHODS: SKIBITSKE,BOUWER-RICE,
60 ' HVORSLEV,FERRIS-KNOWLES AND COPPER-BREDEHOEFT-PAPADOPULOS.
70 ' IT WAS WRITTEN BY JIM BRINKMAN OF SH&B
90 LPRINT "SLUG TEST SOLUTIONS"
100 LPRINT " "
105 LPRINT "*****************************************************************"
110 INPUT "WELL IDENTIFICATION- ";N$
120 LPRINT "WELL IDENTIFICATION- ";N$
130 INPUT " DATE OF TEST RUN-";D$
140 LPRINT "DATE OF FIELD TEST- "; D$
144 INPUT "LENGTH OF CONTRIBUTING INTERVAL,(L)";L
146 LPRINT "LENGTH OF CONTRIBUTING INTERVAL,(L)=    ";L
150 INPUT "CHOSE METHOD OF ANALYSIS,SKIBITSKE(1),BOUWER(2),HVORSLEV(3),FERRIS-KNOWLES(4) OR COPPER-BREDEHOEFT-PAPADOPULOS(5)";MA
160 IF MA<1 OR MA>5 THEN 150
170 ON MA GOTO 190,290,640,820,940
190 PRINT "SKIBITSKE METHOD"
205 LPRINT "SKIBITSKE METHOD"
210 INPUT "INPUT VOLUME DISCHARGE(Q)";Q
220 INPUT "INPUT RESIDUAL DRAWDOWN(s')";S
230 INPUT "INPUT TIME OF RESIDUAL DRAWDOWN MEASUREMENT(t)";T
250 K=Q/T/S/12.566371/L
255 LPRINT "FOR DISCHARGE(Q)= ";Q
258 LPRINT "RESIDUAL DRAWDOWN(s')= ";S
260 LPRINT "TIME TO RESIDUAL DRAWDOWN(t)= ";T
280 GOTO 755
290 PRINT "BOUWER-RICE METHOD"
300 LPRINT "BOUWER-RICE METHOD"
310 INPUT "WELL RADIUS(Rc)";RC
320 INPUT "BOREHOLE RADIUS (Rw)";RW
340 INPUT "HEAD AT To(Yo)";YO
350 INPUT "TIME TO HEAD MEASUREMENT(t)";T
360 INPUT "HEAD AT TIME t(Yt)";YT
370 INPUT "DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)";LW
380 INPUT "DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)";H
390 IF H=LW THEN 480
400 D=LOG((H-LW)/RW)
410 IF D>6. THEN D=6.
420 X=LOG(L/RW)
430 IF X>4.7875 THEN A=-.3455*X*X+5.9206*X-15.2747 ELSE A=.491*X*X-2.045*X+3.691
440 IF X>5.247 THEN B=-.12*X*X+2.5128*X-8.7825 ELSE B=.0659*X*X-.217*X+.4241
450 LRR=1./(1.1/LOG(LW/RW)+(A+B*D)*RW/L)
470 GOTO 520
480 X=LOG(L/RW)
490 IF X>5.0106 THEN C=-.7882*X*X+12.7088*X-37.8922 ELSE C=.5511*X*X-2.0829*X+2.5992
500 LRR=1./(1.1/LOG(LW/RW)+C*RW/L)
520 K=RC*RC*LRR/2./L/T*LOG(YO/YT)
540 LPRINT "FOR WELL RADIUS(Rc)= "; RC
560 LPRINT"BOREHOLE RADIUS(Rw)= ";RW
580 LPRINT "HEAD AT To(Yo)= "; YO
590 LPRINT "TIME TO HEAD MEASUREMENT(t)= ";T
600 LPRINT "HEAD AT TIME t(Yt)= ";YT
610 LPRINT "DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)= ";LW
620 LPRINT "DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)= ";H
635 GOTO 755
640 PRINT "HVORSLEV METHOD"
660 LPRINT "HVORSLEV METHOD"
```

```
660 INPUT "WELL RADIUS(r)";RW
680 INPUT "BOREHOLE RADIUS(R)";RB
690 INPUT "TIME LAG- TIME AT WHICH (H-h)/(H-Ho)=10E-.4343(To)";TO
700 K=RW*RW*LOG(L/RB)/2./L/TO
710 LPRINT "FOR WELL RADIUS(r)= ";RW
740 LPRINT "BOREHOLE RADIUS(R)= ";RB
750 LPRINT "AND TIME LAG(To)= ";TO
755 LPRINT "*****************************************************************"
760 LPRINT "THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= ";K
765 PRINT "THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= ";K
770 INPUT "DO YOU WANT ANOTHER RUN(YES OR NO)";A$
772 LPRINT "*****************************************************************"
773 LPRINT ""
775 LPRINT ""
777 LPRINT ""
780 IF A$="YES" THEN 100
790 IF A$<>"NO" THEN 770
810 END
870 PRINT "FERRIS-KNOWLES METHOD"
830 LPRINT "FERRIS-KNOWLES METHOD"
840 INPUT "VOLUME DISCHARGED(Q)=";Q
850 INPUT "RECIPROCAL OF TIME(1/t)=";RT
860 INPUT "DRAWDOWN AT 1/t (t)=";S
880 K=Q*RT/S/L/12.566371
890 LPRINT "FOR: DISCHARGE(Q)= ";Q
900 LPRINT "RECIPROCAL TIME(1/t)= ";RT
910 LPRINT "DRAWDOWN (s)= ";S
930 GOTO 755
940 PRINT "COOPER-BREDEHOEFT-PAPADOPULOS METHOD"
950 LPRINT "COOPER-BREDEHOEFT-PAPADOPULOS METHOD"
960 INPUT "RADIUS OF WELL CASING(Rc)=";RC
970 INPUT "TIME FOR POINT ON MATCHED TYPE CURVE(t)=";T
990 K=RC*RC/T/L
1000 LPRINT "FOR:WELL RADIUS (Rc)= ";RC
1010 LPRINT "TIME(t)= ";T
1030 GOTO 755
```

JACOBS ENGINEERING

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DATE _____ SUBJECT _____ SHEET NO. -3

BY _____ CHKD. _____ JOB NO. _____

ATTACHMENT 3

MONITOR WELL INFORMATION

SLUG TEST FIELD FORMS

DATA PLOTS

COMPUTED SOLUTIONS

MONITORING WELL INFORMATION
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 06/04/92

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	GROUND ELEVATION (FT MSL)	BOREHOLE DEPTH (FT)	BOREHOLE DIAMETER (INCHES)	CASING ELEVATION (FT MSL)	CASING DEPTH (FT)	CASING DIAMETER (INCHES)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	FLOW CODE	FORMATION OF COMPLETION
0601	54980.4	88017.7	4881.51	24.00	6.625	4884.43	27.00	2.000	15.00	10.0	U	SR
0602	56377.4	88661.2	4861.53	35.00	6.625	4864.02	34.00	2.000	22.00	10.0	N	AL
0603	57812.7	89036.9	4846.64	55.00	6.625	4848.56	57.00	2.000	45.00	10.0	C	AL
0604	58397.0	89424.6	4837.30	30.00	6.625	4839.09	32.00	2.000	15.00	15.0	C	AL
0605	58707.6	90066.7	4831.42	32.00	6.625	4833.96	34.00	2.000	17.00	15.0	D	AL
0606	59034.2	88634.0	4860.44	47.00	6.625	4863.31	50.00	2.000	35.00	10.0	D	AL
0607	59657.2	87519.2	4869.41	30.00	6.625	4871.26	30.00	2.000	12.50	10.0	D	SR
0608	58685.7	87189.4	4901.08	120.00	6.625	4903.11	122.00	2.000	100.00	20.0	O	DC
0609	59052.1	87652.9	4878.30	15.00	6.625	4880.17	16.00	2.000	9.00	5.0	O	SR
0610	56338.8	88611.6	4860.83	87.00	6.625	4861.81	87.00	2.000	65.00	20.0	N	SR
0611	57811.0	89017.5	4846.35	185.00	6.625	4848.35	185.00	2.000	155.00	20.0	N	DC
0612	58437.2	85614.8	5000.09	215.00	6.625	5001.74	217.50	2.000	170.00	20.0	N	DC
0613	56377.8	88643.7	4860.81	160.00	6.625	4862.82	162.00	2.000	140.00	20.0	N	DC
0614	60940.5	87832.6	4854.28	84.50	6.625	4855.66	72.00	2.000	50.00	20.0	D	SR
0615	57794.4	88980.7	4847.50	89.00	6.625	4849.29	100.00	2.000	68.00	20.0	C	SR
0616	56747.3	87987.6	4869.00	-	-	4869.92	8.00	-	-	-	N	AL
0617	52090.6	87094.4	4907.96	-	-	4908.96	-	-	-	-	N	AL
0618	58868.3	87016.1	4920.00	153.00	12.000	4921.02	153.00	12.000	-	-	O	DC
0619	58876.5	87587.9	4886.52	154.00	12.000	4887.42	154.00	12.000	-	-	O	DC
0625	58272.5	89803.1	4838.80	89.00	12.000	4840.09	89.00	12.000	-	-	C	DC
0650	64970.2	89923.8	4790.15	99.50	7.875	4793.29	102.50	4.000	80.50	20.0	D	AL
0651	63788.9	92734.3	4781.46	82.00	7.875	4784.51	85.00	4.000	23.00	60.0	D	AL
0652	62581.5	93759.3	4800.69	56.00	7.875	4803.84	59.00	4.000	37.00	20.0	D	AL
0653	61249.3	89596.3	4832.14	78.00	7.875	4834.94	80.00	4.000	58.00	20.0	D	AL
0654	59351.4	91063.4	4824.41	79.00	7.875	4827.01	82.00	4.000	60.00	20.0	C	AL
0655	59754.6	88624.1	4857.73	60.00	7.875	4860.39	63.00	4.000	41.00	20.0	D	AL
0656	59545.2	89175.1	4852.07	62.00	7.875	4854.61	65.00	4.000	43.00	20.0	D	AL
0657	59266.0	87596.5	4881.18	138.00	7.875	4883.21	141.00	4.000	124.00	15.0	O	DC
0658	54763.4	88857.0	4876.19	165.00	7.875	4878.82	160.00	4.000	138.00	20.0	N	SR
0659	59069.8	88670.3	4860.84	109.00	7.875	4863.63	112.00	4.000	90.00	20.0	D	SR
0660	61303.4	89584.3	4831.38	155.00	7.875	4834.16	158.00	4.000	136.00	20.0	D	SR
0661	56366.1	85447.7	5057.34	218.00	7.875	5059.99	215.00	4.000	193.00	20.0	N	DC
0662	59236.5	87577.5	4877.07	70.00	7.875	4879.81	73.00	4.000	41.00	30.0	D	AL
0663	59069.6	88593.5	4861.56	217.00	7.875	4864.41	222.00	4.000	180.00	40.0	D	DC
0664	61255.9	89537.0	4832.84	233.00	7.875	4835.76	236.00	4.000	214.00	20.0	D	DC
0668	60171.4	88287.0	4864.27	218.00	7.875	4866.71	217.50	4.000	182.50	20.0	D	DC
0669	60146.3	88247.8	4863.19	56.00	7.875	4865.78	59.00	4.000	37.00	20.0	D	AL

FORMATION OF COMPLETION CODE:
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION
AL - ALLUVIUM
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION

FLOW RELATIONSHIP CODE:
U - UPGRADIENT
N - UNKNOWN
C - CROSS GRADIENT
D - DOWN GRADIENT
O - ON-SITE

DATA FILE: M:\DART\MON01\MWI10000.DAT

FIELDS DISPLAYED WITH A DASH INDICATE THE DATA IS UNAVAILABLE

Page 3-64

RAB 7-92 45

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

JUL 0 2 1985

SLUG TEST DATA

SITE ID: MONØL LOCATION ID: MN-1-1(601) STATIC WATER LEVEL: DATE: 85/4/27 TIME: 4:30 p

SLUG VOLUME (ft.^{3}): 0.[illegible]5-1 DEPTH (ft): 13.45 - not measured

INITIAL WATER LEVEL: OPEN INTERVAL NOT KNOWN to NOT KNOWN

DATE: 85/4/18 TOTAL DEPTH OF WELL (ft): 24.73

TIME: 9:31 A.M WELL DIAM. (ft): .167

DEPTH (ft FROM TOC): 13.58 OBSERVERS: D. Miller

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
1:00	13.45			
1:50	14.31			
1:00	14.12			
1:50	14.09			
2:00	13.99			
2:50	13.95			
3:00	13.90			
3:50	13:86			
4:00	13.81			
4:50	13.78			
5:00	13.72			
6:00	13.64			
7:00	13.60			
8:00	13.56			
9:00	13.56			
10:00	13.56			

COMMENTS: DROPPED SLUG ≈ 3:00 85/4/22
well did not completely recover after 9 days.

SLUG TEST DATA

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SITE: MON01 MONUMENT VALLEY
LOCATION: 601
DATE: 04/27/85

---- ELAPSED TIME ---- [MIN] H	[1/MIN] F	[SEC] C	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.] F	H[T]/H0 [FT./FT.]
.00	.00000	0	13.45	.00	.0000
.50	2.00000	30	14.31	-.86	-.3474
1.00	1.00000	60	14.12	-.67	-.2707
1.50	.66667	90	14.09	-.64	-.2586
2.00	.50000	120	13.99	-.54	-.2182
2.50	.40000	150	13.95	-.50	-.2020
3.00	.33333	180	13.90	-.45	-.1818
3.50	.28571	210	13.86	-.41	-.1656
4.00	.25000	240	13.81	-.36	-.1454
4.50	.22222	270	13.78	-.33	-.1333
5.00	.20000	300	13.72	-.27	-.1091
6.00	.16667	360	13.64	-.19	-.0768
7.00	.14286	420	13.60	-.15	-.0606
8.00	.12500	480	13.56	-.11	-.0444
9.00	.11111	540	13.56	-.11	-.0444
10.00	.10000	600	13.56	-.11	-.0444

FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS

UMTRA*EZPLOT H001
UMTRA*EZPLOT H002
UMTRA*EZPLOT H003
UMTRA*EZPLOT H004

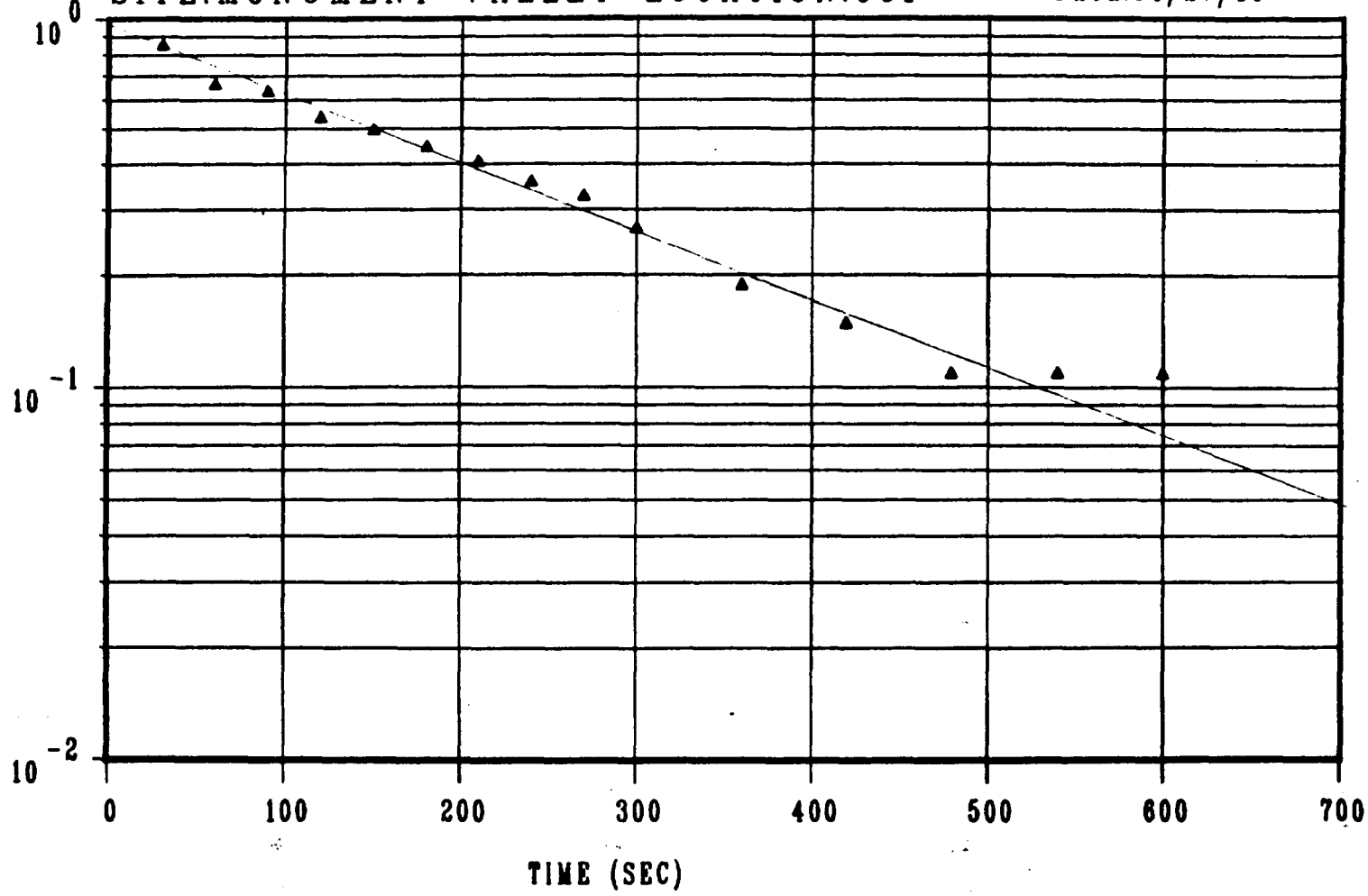
H001
H002
H003
H004

611
615

AM X,Y H003

BOUWER-RICE SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:601 DATE:04/27/85



$y_0 = 2.5$ ft

Rel 7-9h-48

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

AUG 26 1985

SLUG TEST DATA

SITE ID: MCN-01 LOCATION ID: 601

SLUG VOLUME (ft.³): 0.054

INITIAL WATER LEVEL:

DATE: 85/8/15

TIME: 5:08p

DEPTH (ft FROM TOC): 14.50

STATIC WATER LEVEL:

DATE: 85/8/18 TIME: 1:25p

DEPTH (ft): 14.55

OPEN INTERVAL 18 to 25

TOTAL DEPTH OF WELL (ft): 25.2

WELL DIAM. (ft): 0.167

OBSERVERS: Mignardot

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
:0	14.55			
.5	15.24			
1:00	15.16			
.5	15.13			
2:00	15.12			
.5	15.09			
3:00	15.08			
.5	15.07			
4:00	15.06			
.5	15.05			
5:00	15.03			
6:00	15.01			
7:00	15.00			
8:00	14.97			
10:00	14.94			
15:00	14.88			
30:00	14.76			
60:00	14.68			
120:00	14.65			
180.00	14.63			

COMMENTS: Dropped Slug @ 5:08p, 85/8/15
Pulled Slug @ 1:25p, 85/8/18
Checked static @ 3:55p, 85/8/19 → static was 14.63

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BAP
7-92

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 601
DATE: 08/18/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	14.55	.00	.0000
.50	2.00000	30	15.24	-.69	-.2788
1.00	1.00000	60	15.16	-.61	-.2464
1.50	.66667	90	15.13	-.58	-.2343
2.00	.50000	120	15.12	-.57	-.2303
2.50	.40000	150	15.09	-.54	-.2182
3.00	.33333	180	15.08	-.53	-.2141
3.50	.28571	210	15.07	-.52	-.2101
4.00	.25000	240	15.06	-.51	-.2060
4.50	.22222	270	15.05	-.50	-.2020
5.00	.20000	300	15.03	-.48	-.1939
6.00	.16667	360	15.01	-.46	-.1858
7.00	.14286	420	15.00	-.45	-.1818
8.00	.12500	480	14.97	-.42	-.1697
10.00	.10000	600	14.94	-.39	-.1576
15.00	.06667	900	14.88	-.33	-.1333
30.00	.03333	1800	14.76	-.21	-.0848
60.00	.01667	3600	14.68	-.13	-.0525
120.00	.00833	7200	14.65	-.10	-.0404
180.00	.00556	10800	14.63	-.08	-.0323

FERRIS-KNOWLES UMTRA*EZPLOTJH01
HVORSLEV UMTRA*EZPLOTJH02
BOWLER-RICE UMTRA*EZPLOTJH03
COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOTJH04
@@NOPR

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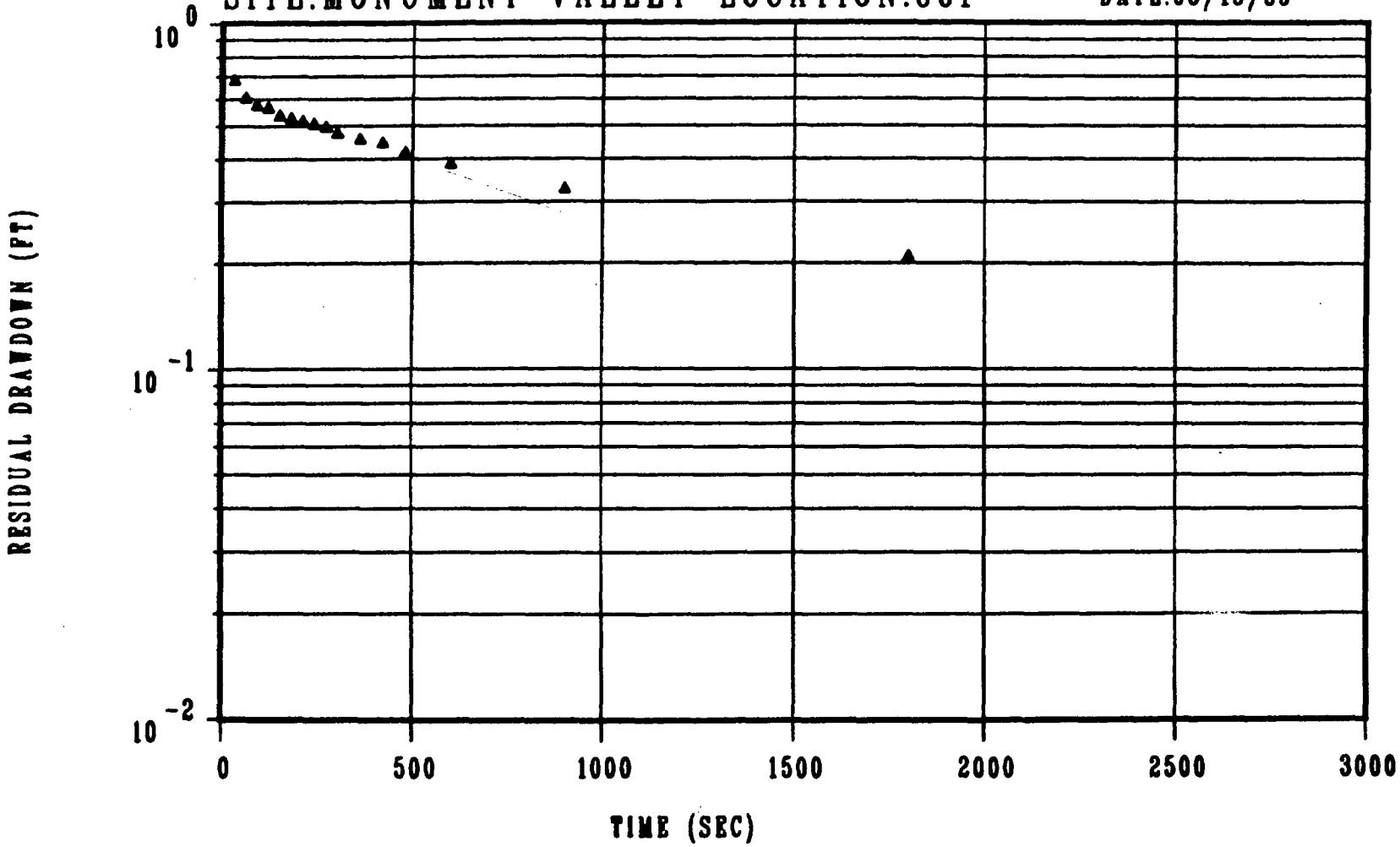
BOUWER-RICE SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:601 DATE:08/18/85



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RAP 7-92

Well 601

SLUG TEST SOLUTIONS

****
WELL IDENTIFICATION- 601
DATE OF FIELD TEST- 4/27/85
LENGTH OF CONTRIBUTING INTERVAL,(L)= 10
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)= .083
BOREHOLE RADIUS(Rw)= .276
HEAD AT To(Yo)= 2.5
TIME TO HEAD MEASUREMENT(t)= 300
HEAD AT TIME t(Yt)= .27
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)= 12.5
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)= 12.5
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 7.303906E-06 ft/sec
****

****

****

****
WELL IDENTIFICATION- 601
DATE OF FIELD TEST- 6/18/85
LENGTH OF CONTRIBUTING INTERVAL,(L)= 10
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)= .083
BOREHOLE RADIUS(Rw)= .276
HEAD AT To(Yo)= 2.5
TIME TO HEAD MEASUREMENT(t)= 480
HEAD AT TIME t(Yt)= .42
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)= 12.5
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)= 12.5
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 3.656705E-06 ft/sec
****

R&P 742

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JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MONOL LOCATION ID: 602

SLUG VOLUME (ft.^{3}): _____

INITIAL WATER LEVEL:

DATE: 85/4/18

TIME: 10:45 A.M

DEPTH (ft FROM TOC): 8.34

STATIC WATER LEVEL:

DATE: 85/4/21 TIME: 4:45

DEPTH (ft): 8.29

OPEN INTERVAL NOT KNOWN to NOT KNOWN

TOTAL DEPTH OF WELL (ft): 31.73

WELL DIAM. (ft): .167

OBSERVERS: Bausberg/Seitz

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
00	8.29			
:30	9.97			
1:00	9.86			
1:30	9.75			
2:00	9.66			
2:30	9.54			
3:00	9.44			
3:30	9.36			
4:00	9.26			
:30	9.19			
5:00	9.09			
:30	8.98			
6:00	8.95			
:30	8.88			
7:00	8.83			
:30	8.80			
8:00	8.76			
9:00	8.70			
10:00	8.65			
11:00	8.61			

COMMENTS: DROPPED SLUG @ 6.00p 85/4/20

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RAP
7-90

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

JUL

SLUG TEST DATA

SITE ID: MONU LOCATION ID: 602 (contd)

SLUG VOLUME (ft.^{3}): _____

INITIAL WATER LEVEL:

DATE: _____

TIME: _____

DEPTH (ft FROM TOC): _____

STATIC WATER LEVEL:

DATE: _____ TIME: _____

DEPTH (ft): _____

OPEN INTERVAL _____ to _____

TOTAL DEPTH OF WELL (ft): _____

WELL DIAM. (ft): _____

OBSERVERS: _____

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
12:00	8.57			
13:00	8.54			
14:00	8.52			
15:00	8.50			
16:00	8.46			
17:00	8.44			
18:00	8.43			
19:00	8.41			
20:00	8.40			
25:00	8.36			
30:00	8.33			
35:00	8.32			

COMMENTS: _____

18

54

SLUG TEST DATA

SITE: MON04 MONUMENT VALLEY
LOCATION: 602
DATE: 04/21/85

Rll/p 20
7-92

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	8.29	.00	.0000
.50	2.00000	30	9.97	-1.68	-.6787
1.00	1.00000	60	9.86	-1.57	-.6343
1.50	.66667	90	9.75	-1.46	-.5899
2.00	.50000	120	9.66	-1.37	-.5535
2.50	.40000	150	9.54	-1.25	-.5050
3.00	.33333	180	9.44	-1.15	-.4646
3.50	.28571	210	9.36	-1.07	-.4323
4.00	.25000	240	9.26	-.97	-.3919
4.50	.22222	270	9.19	-.90	-.3636
5.00	.20000	300	9.09	-.80	-.3232
5.50	.18182	330	8.98	-.69	-.2788
6.00	.16667	360	8.95	-.66	-.2666
6.50	.15385	390	8.88	-.59	-.2384
7.00	.14286	420	8.83	-.54	-.2182
7.50	.13333	450	8.80	-.51	-.2060
8.00	.12500	480	8.76	-.47	-.1899
9.00	.11111	540	8.70	-.41	-.1656
10.00	.10000	600	8.65	-.36	-.1454
11.00	.09091	660	8.61	-.32	-.1293
12.00	.08333	720	8.57	-.28	-.1131
13.00	.07692	780	8.54	-.25	-.1010
14.00	.07143	840	8.52	-.23	-.0929
15.00	.06667	900	8.50	-.21	-.0848
16.00	.06250	960	8.46	-.17	-.0687
17.00	.05882	1020	8.44	-.15	-.0606
18.00	.05556	1080	8.43	-.14	-.0566
19.00	.05263	1140	8.41	-.12	-.0485
20.00	.05000	1200	8.40	-.11	-.0444
25.00	.04000	1500	8.36	-.07	-.0283
30.00	.03333	1800	8.33	-.04	-.0162
35.00	.02857	2100	8.32	-.03	-.0121

FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

UMTRA*EZPLOT0005
UMTRA*EZPLOT0006
UMTRA*EZPLOT0007
UMTRA*EZPLOT0008

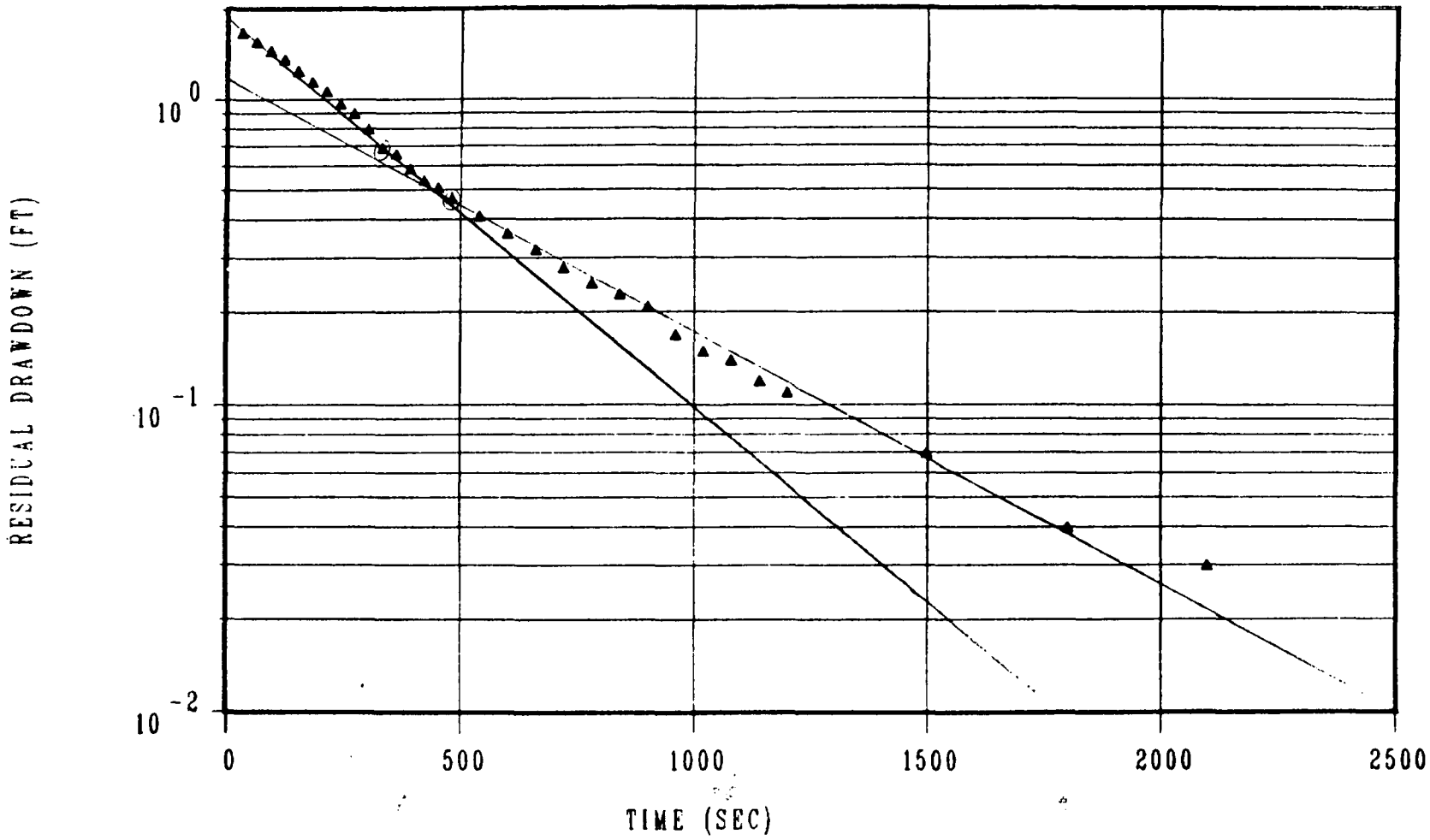
CF FERR
CF COOP
CF BOWR
CF HVOR

55

RMP 7-92

BOUWER-RICE SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:602 DATE:04/21/85



y_0 = 2.5

for early time fit

t = 330 sec = 3.819×10^{-3} day

y_t = 0.69 ft.

for overall fit

t = 480 sec = 5.556×10^{-3} day

y_t = 0.47 ft

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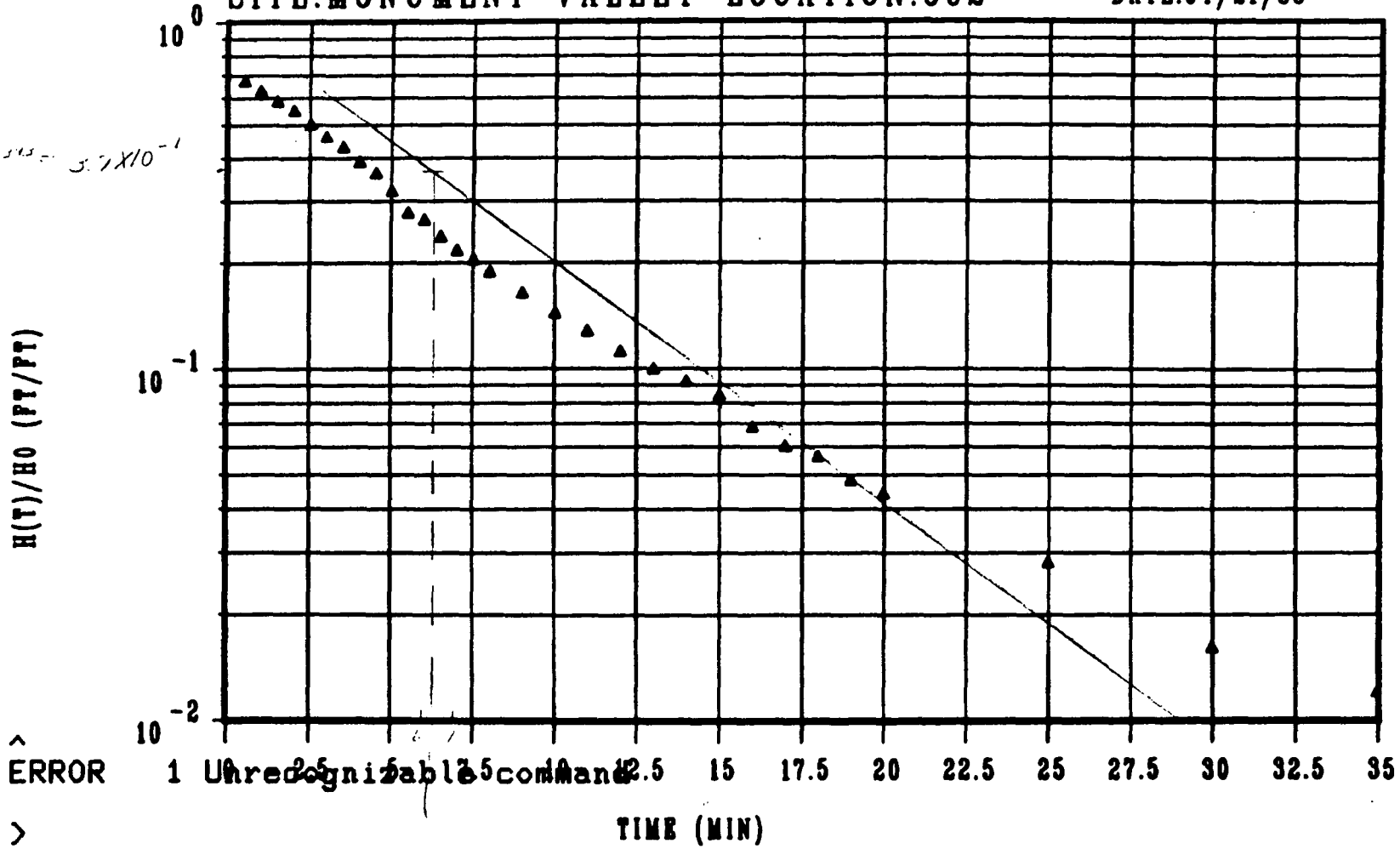
Pull 7-9-2

HVORSLEV SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:602 DATE:04/21/85



$10^{-0.4343} = 3.7 \times 10^{-1}$

^
ERROR 1 Unrecognizable command
>

$T_0 = 6.3$ min

RAI
7-9-n 57

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MOW-01 LOCATION ID: 602

SLUG VOLUME (ft.^{3}): 0.054

INITIAL WATER LEVEL (AT t_0):

DATE: 85/8/18

TIME: 4:40p

DEPTH (ft FROM TOC): 9.43

STATIC WATER LEVEL:

DATE: 85/8/18 TIME: 4:40p

DEPTH (ft): 9.43

OPEN INTERVAL (ft.) _____ to _____

TOTAL DEPTH OF WELL (ft): 32.0

WELL DIAM. (ft): 0.167

FIELD REP: Mignardot

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:0	9.43			
:5	10.59			
1:00	10:45			
.5	10.43			
2:00	10.35			
.5	10.25			
3:00	10.20			
.5	10.13			
4:00	10.03			
.5	10.00			
5:00	9.97			
6:00	9.93			
7:00	9.86			
8:00	9.75			
9.00	9.75			
10:00	9.73			
12:00	9.70			
14:00	9.63			
16:00	9.60			
18.00	9.58			

COMMENTS: Dropped slug @ 4:40p, 85/8/18
Pulled slug @ 6:40p, 85/8/20

JEG-AL-ENG-8 (3/84)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

RJP 7-90

SLUG TEST DATA

SITE ID: MENO1 LOCATION ID: 602

STATIC WATER LEVEL:
DATE: 85/8/20 TIME:

SLUG VOLUME (ft.^{3}):

DEPTH (ft):

INITIAL WATER LEVEL:

OPEN INTERVAL _____ to _____

DATE: 85/8/18

TOTAL DEPTH OF WELL (ft):

TIME:

WELL DIAM. (ft): 0.167

DEPTH (ft FROM TOC): 9.43

OBSERVERS: Roberts

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
23:00	9.55			
28:00	9.51			
33:00	9.51			
38:00	9.51			
43:00	9.51			
48:00	9.51			
53:00	9.51			
58.00	9.51			
1HR 30min	9.42			

COMMENTS:

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RAP
7-91

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 602
DATE: 08/18/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HET]/H0 [FT./FT.]
.00	.00000	0	9.43	.00	.0000
.50	2.00000	30	10.59	-1.16	-.4687
1.00	1.00000	60	10.45	-1.02	-.4121
1.50	.66667	90	10.43	-1.00	-.4040
2.00	.50000	120	10.35	-.92	-.3717
2.50	.40000	150	10.25	-.82	-.3313
3.00	.33333	180	10.20	-.77	-.3111
3.50	.28571	210	10.13	-.70	-.2828
4.00	.25000	240	10.03	-.60	-.2424
4.50	.22222	270	10.00	-.57	-.2303
5.00	.20000	300	9.97	-.54	-.2182
6.00	.16667	360	9.93	-.50	-.2020
7.00	.14286	420	9.86	-.43	-.1737
8.00	.12500	480	9.75	-.32	-.1293
9.00	.11111	540	9.75	-.32	-.1293
10.00	.10000	600	9.73	-.30	-.1212
12.00	.08333	720	9.70	-.27	-.1091
14.00	.07143	840	9.63	-.20	-.0808
16.00	.06250	960	9.60	-.17	-.0687
18.00	.05556	1080	9.58	-.15	-.0606
23.00	.04348	1380	9.55	-.12	-.0485
28.00	.03571	1680	9.51	-.08	-.0323
33.00	.03030	1980	9.51	-.08	-.0323
38.00	.02632	2280	9.51	-.08	-.0323
43.00	.02326	2580	9.51	-.08	-.0323
48.00	.02083	2880	9.51	-.08	-.0323
53.00	.01887	3180	9.51	-.08	-.0323
58.00	.01724	3480	9.51	-.08	-.0323
90.00	.01111	5400	9.42	.01	.0040

FERRIS-KNOWLES UMTRA*EZPLOTJH05
HVORSLEV UMTRA*EZPLOTJH06
BOWLER-RICE UMTRA*EZPLOTJH07
COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOTJH08
@@NOPR

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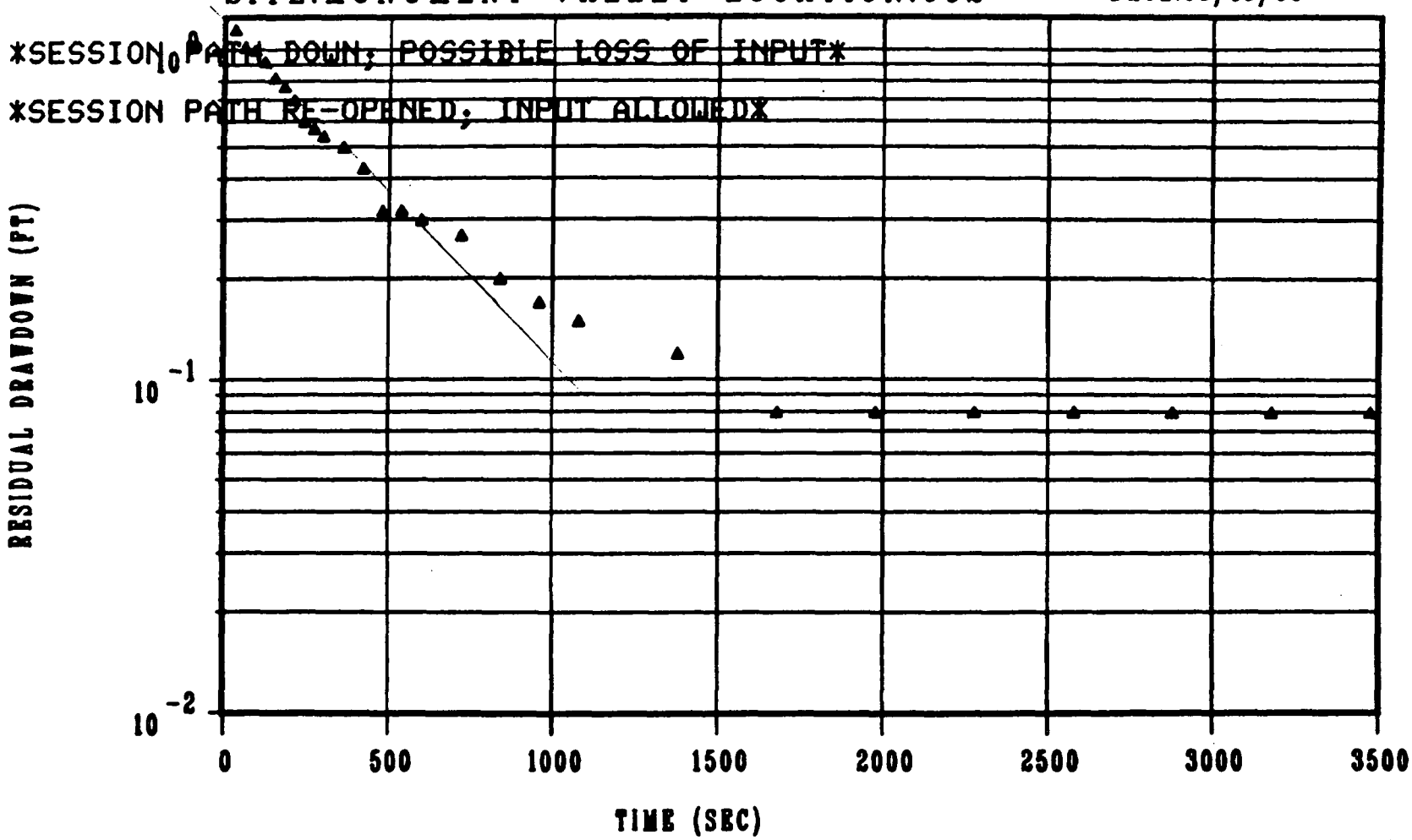
BOUWER-RICE SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:602 DATE:08/18/85



90 sec 14

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Rap
F-92

Well 602

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*************************************************************
WELL IDENTIFICATION- 602
DATE OF FIELD TEST- 4/21/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    10
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .083
BOREHOLE RADIUS(Rw)=  .276
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  330
HEAD AT TIME t(Yt)=  .69
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  25.5
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  26
*************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  4.13399E-06   ft/sec
*************************************************************
```

```
*************************************************************
WELL IDENTIFICATION- 602
DATE OF FIELD TEST- 4/21/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    10
HVORSLEV METHOD
FOR WELL RADIUS(r)=  .083
BOREHOLE RADIUS(R)=  .276
AND TIME LAG(Tc)=  6.3
*************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.962785E-04   ft/min
*************************************************************
```

$= 3.27 \times 10^{-6}$ ft/sec

```
*************************************************************
WELL IDENTIFICATION- 602
DATE OF FIELD TEST- 8/18/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    10
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .083
BOREHOLE RADIUS(Rw)=  .276
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  420
HEAD AT TIME t(Yt)=  .43
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  25.5
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  26
*************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  4.441329E-06   ft/sec
*************************************************************
```

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JE JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MONDI LOCATION ID: 604

SLUG VOLUME (ft.^{3}): _____

INITIAL WATER LEVEL:

DATE: 85/4/18

TIME: 5:03 p

DEPTH (ft FROM TOC): 5.02

STATIC WATER LEVEL:

DATE: 85/4/21 TIME: 4 15

DEPTH (ft): 8 02

OPEN INTERVAL NOT KNOWN to _____

TOTAL DEPTH OF WELL (ft): _____

WELL DIAM. (ft): .167

OBSERVERS: Bansberg/Seitz

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
00	8.02			
:50	8.46			
1:00	8.32			
1:50	8.25			
2:00	8.20			
2:50	8.16			
3:00	8.15			
3:50	8.13			
4:00	8.12			
4:50	8.10			
5:00	8.10			
6:00	8.07			
7:00	8.06			
8:00	8.06			
9:00	8.04			
10 00	8.04			
15:00	8.02			

COMMENTS: _____

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Rdf
7-92

SLUG TEST DATA

SITE: MON04 MONUMENT VALLEY
LOCATION: 604
DATE: 04/21/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	8.02	.00	.0000
.50	2.00000	30	8.46	-.44	-.1778
1.00	1.00000	60	8.32	-.30	-.1212
1.50	.66667	90	8.25	-.23	-.0929
2.00	.50000	120	8.20	-.18	-.0727
2.50	.40000	150	8.16	-.14	-.0566
3.00	.33333	180	8.15	-.13	-.0525
3.50	.28571	210	8.13	-.11	-.0444
4.00	.25000	240	8.12	-.10	-.0404
4.50	.22222	270	8.10	-.08	-.0323
5.00	.20000	300	8.10	-.08	-.0323
6.00	.16667	360	8.07	-.05	-.0202
7.00	.14286	420	8.06	-.04	-.0162
8.00	.12500	480	8.06	-.04	-.0162
9.00	.11111	540	8.04	-.02	-.0081
10.00	.10000	600	8.04	-.02	-.0081
15.00	.06667	900	8.02	.00	.0000

FERRIS-KNOWLES UMTRA*EZPLOT0013
HVORSLEV UMTRA*EZPLOT0014
BOWLER-RICE UMTRA*EZPLOT0015
COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOT0016
@@NOPR

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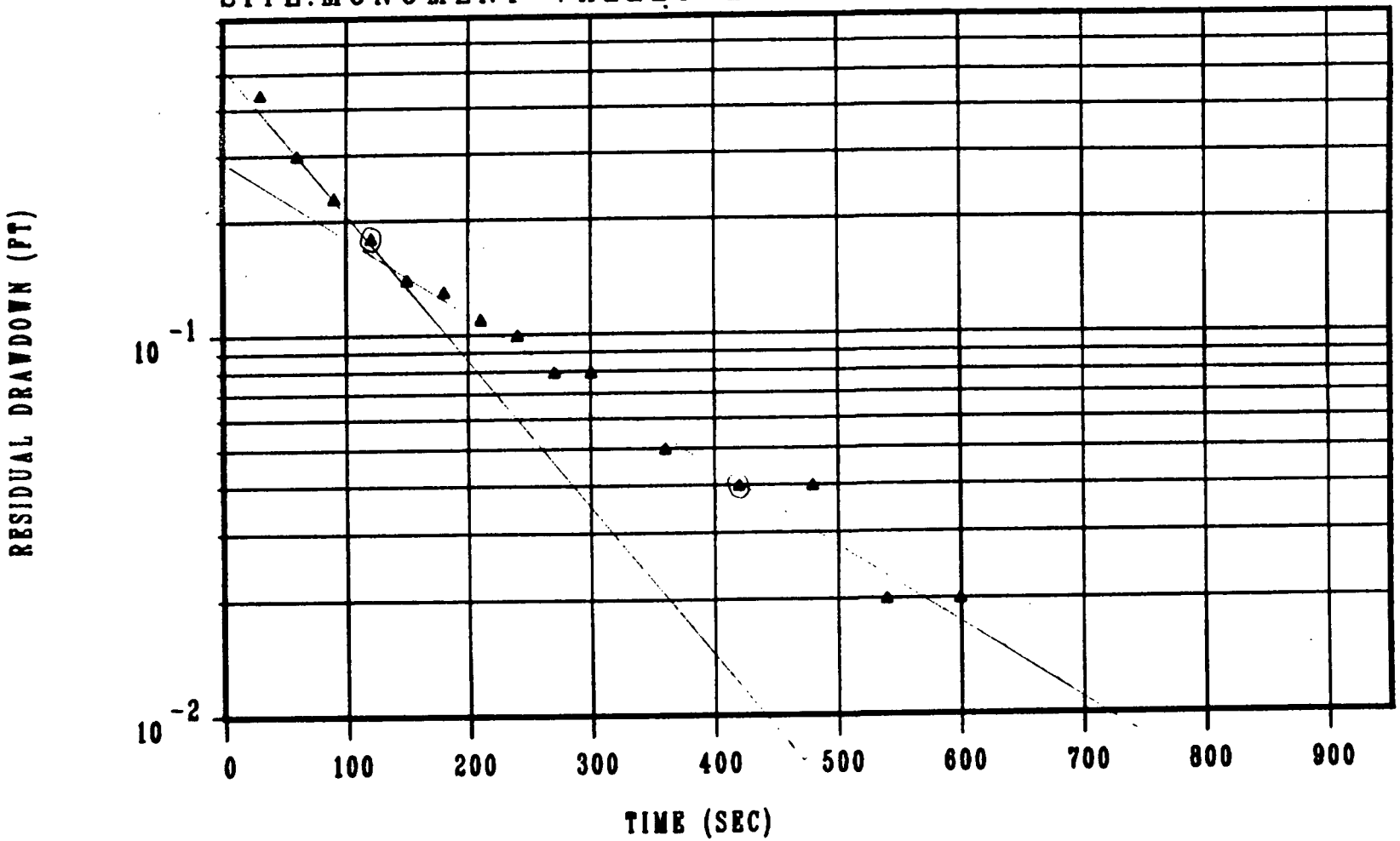
Rept 7-94

BOUWER-RICE SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:604 DATE:04/21/85



$y_0 = 2.3$ ft

for early time fit:

$t = 120$ sec $= 1.389 \times 10^{-3}$ day

$y_t = 0.18$ ft

for overall fit:

$t = 420$ sec $= 4.861 \times 10^{-3}$ day

$y_t = 0.04$ ft

Well 604

RAP
7-92

```
*****************************************************************
WELL IDENTIFICATION- 604
DATE OF FIELD TEST- 4/21/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    15
BOUWER-RICE METHOD
FOR WELL RADIUS(Re)=  .083
BOREHOLE RADIUS(Rw)=  .276
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  120
HEAD AT TIME t(Yt)=  .18
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  24
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  24
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.662175E-05      ft/sec
*****************************************************************
```

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

R97
7 92

SLUG TEST DATA

SITE ID: MON-21 LOCATION ID: 605

STATIC WATER LEVEL:
DATE: 85/4/22 TIME: 2:50 p

SLUG VOLUME (ft.^{3}): _____

DEPTH (ft): 9.50

INITIAL WATER LEVEL:

OPEN INTERVAL NOT KNOWN to NOT KNOWN

DATE: 85/4/18

TOTAL DEPTH OF WELL (ft): 31.14

TIME: 2:16 P.M

WELL DIAM. (ft): .167

DEPTH (ft FROM TOC): 9.50

OBSERVERS: D. Miller / K. Seitz

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
:00	9.50			
:30	9.94			
1:00	9.62			
1:30	9.53			
2:00	9.51			
2:30	9.50			
3:00	9.50			
3:30				
4:00				
4:30				
5:00				

COMMENTS: Drop Slug @ 5:30 85/4/21

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R9P
7-92

SLUG TEST DATA

SITE: MON04 MONUMENT VALLEY
LOCATION: 605
DATE: 04/22/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	9.50	.00	.0000
.50	2.00000	30	9.94	-.44	-.1778
1.00	1.00000	60	9.62	-.12	-.0485
1.50	.66667	90	9.53	-.03	-.0121
2.00	.50000	120	9.51	-.01	-.0040
2.50	.40000	150	9.50	.00	.0000
3.00	.33333	180	9.50	.00	.0000

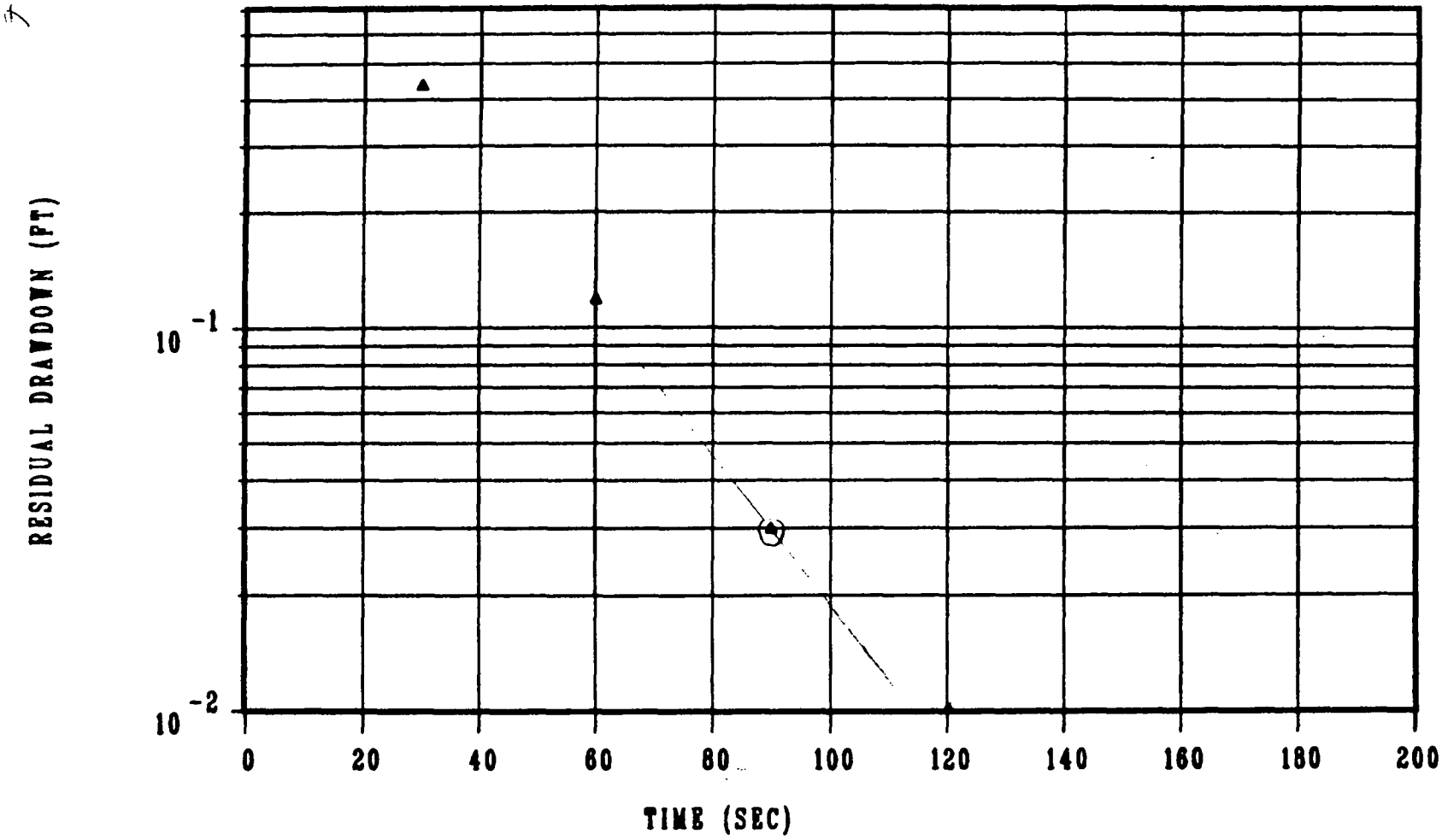
FERRIS-KNOWLES UMTRA*EZPLOT0017
HVORSLEV UMTRA*EZPLOT0018
BOWLER-RICE UMTRA*EZPLOT0019
COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOT0020
@@NOPR

89

Pg 7-9d

BOUWER-RICE SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:605 DATE:04/22/85



$y_o = 2.3$ ft

$t = 90$ sec $= 1.042 \times 10^{-3}$ day

$y_t = 0.03$ ft

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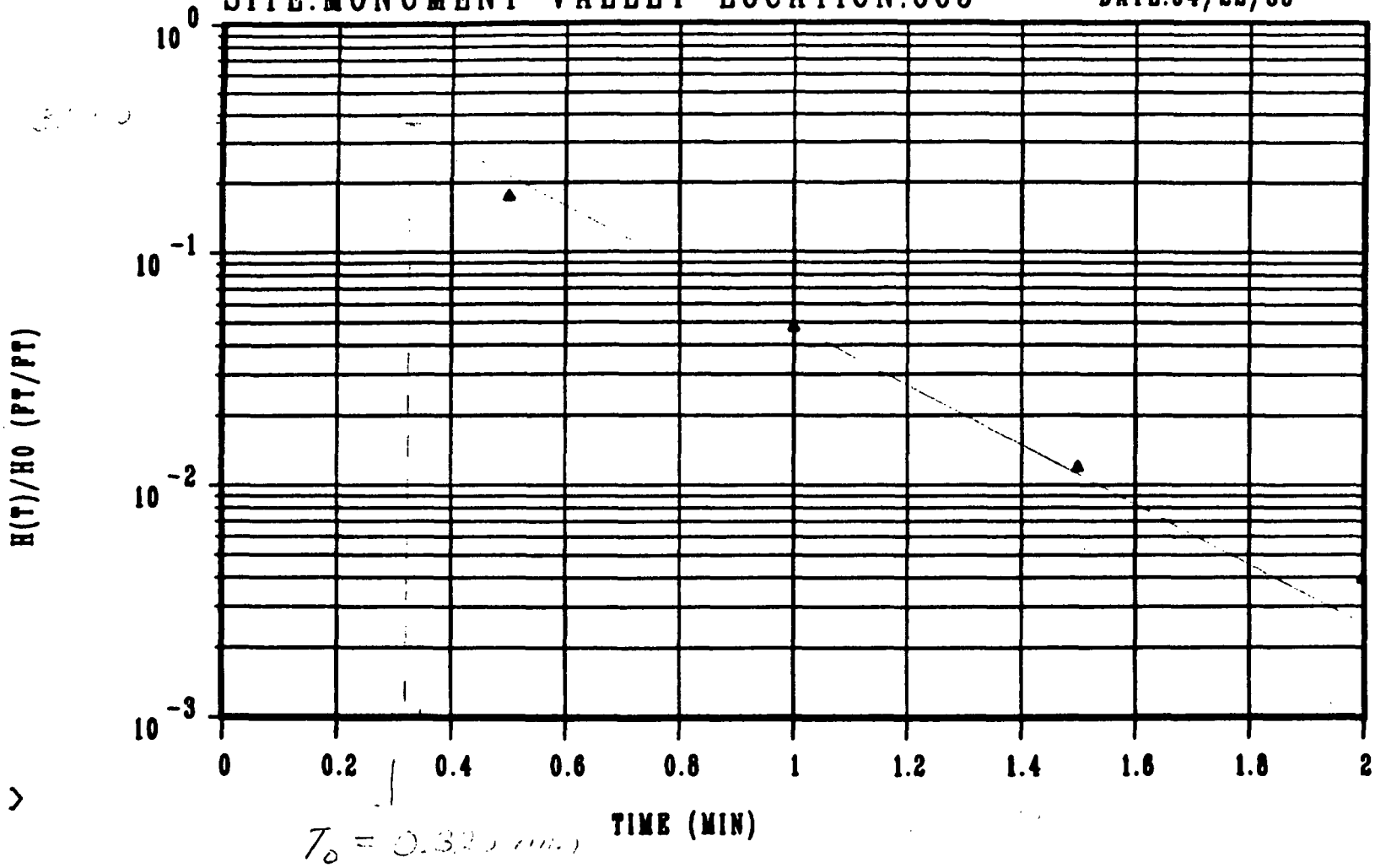
RAB 7-92

HVORSLEV SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:605 DATE:04/22/85



>

^
ERROR 1 Unrecognizable command

Well 605

RAP
7-92

```
*****************************************************************
WELL IDENTIFICATION- 605
DATE OF FIELD TEST- 4/22/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    15
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .083
BOREHOLE RADIUS(Rw)=  .276
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  90
HEAD AT TIME t(Yt)=  .03
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  24.5
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  25
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.597799E-05   ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 605
DATE OF FIELD TEST- 4/22/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    15
HVORSLEV METHOD
FOR WELL RADIUS(r)=  .083
BOREHOLE RADIUS(R)=  .276
AND TIME LAG(To)=  .33
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.780236E-03   ft/min
*****************************************************************
```

$= 4.59 \times 10^{-5}$ ft/sec

```
*****************************************************************
```

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

71.
RAP
7-92

SLUG TEST DATA

SITE ID: Maxell LOCATION ID: 610

STATIC WATER LEVEL:
DATE: 85/8/20 TIME:

SLUG VOLUME (ft.^{3}):

DEPTH (ft):

INITIAL WATER LEVEL:

OPEN INTERVAL _____ to _____

DATE:

TOTAL DEPTH OF WELL (ft):

TIME:

WELL DIAM. (ft):

DEPTH (ft FROM TOC):

OBSERVERS:

ELAPSED TIME (MIN, SEC from t_0)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_0 or $\frac{H-h}{H-H_0}$
18:00	6.41			
20:00	6.40			
22:00	6.37			
24:00	6.37			
26:00	6.37			
30:00	6.35			
35:00	6.35			
40:00	6.34			
45:00	6.33			
50:00	6.33			
55:00	6.32			
60:00	6.32			

COMMENTS:

Page 2 of 2

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Rap
2-92

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 610
DATE: 08/20/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT]/HO [FT./FT.]
.00	.00000	0	6.32	.00	.0000
.50	2.00000	30	8.68	-2.36	-.9535
1.00	1.00000	60	8.46	-2.14	-.8646
1.50	.66667	90	8.06	-1.74	-.7030
2.00	.50000	120	7.90	-1.58	-.6383
2.50	.40000	150	7.74	-1.42	-.5737
3.00	.33333	180	7.57	-1.25	-.5050
3.50	.28571	210	7.46	-1.14	-.4606
4.00	.25000	240	7.31	-.99	-.4000
4.50	.22222	270	7.24	-.92	-.3717
5.00	.20000	300	7.13	-.81	-.3272
6.00	.16667	360	6.95	-.63	-.2545
7.00	.14286	420	6.85	-.53	-.2141
8.00	.12500	480	6.76	-.44	-.1778
9.00	.11111	540	6.73	-.41	-.1656
10.00	.10000	600	6.64	-.32	-.1293
11.00	.09091	660	6.59	-.27	-.1091
12.00	.08333	720	6.52	-.20	-.0808
14.00	.07143	840	6.48	-.16	-.0646
16.00	.06250	960	6.46	-.14	-.0566
18.00	.05556	1080	6.41	-.09	-.0364
20.00	.05000	1200	6.40	-.08	-.0323
22.00	.04545	1320	6.37	-.05	-.0202
24.00	.04167	1440	6.37	-.05	-.0202
26.00	.03846	1560	6.37	-.05	-.0202
30.00	.03333	1800	6.35	-.03	-.0121
35.00	.02857	2100	6.35	-.03	-.0121
40.00	.02500	2400	6.34	-.02	-.0081
45.00	.02222	2700	6.33	-.01	-.0040
50.00	.02000	3000	6.33	-.01	-.0040
55.00	.01818	3300	6.32	.00	.0000
60.00	.01667	3600	6.32	.00	.0000

FERRIS-KNOWLES UMTRA*EZPLOTJH25
HVORSLEV UMTRA*EZPLOTJH26
BOWLER-RICE UMTRA*EZPLOTJH27
COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOTJH28
@@NOPR

JH26
JH27

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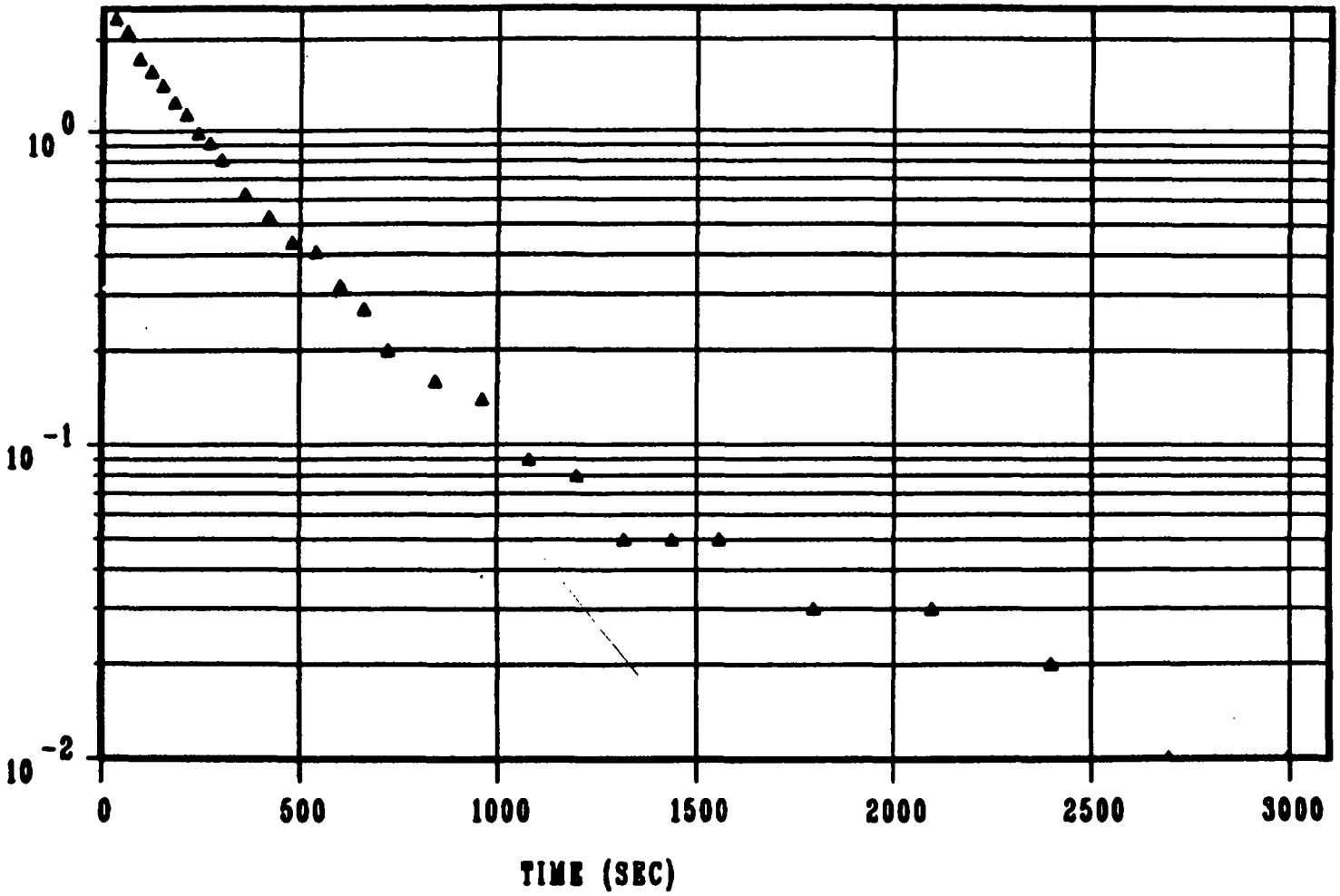
Page 7-96

BOUWER-RICE SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:610 DATE:08/20/85



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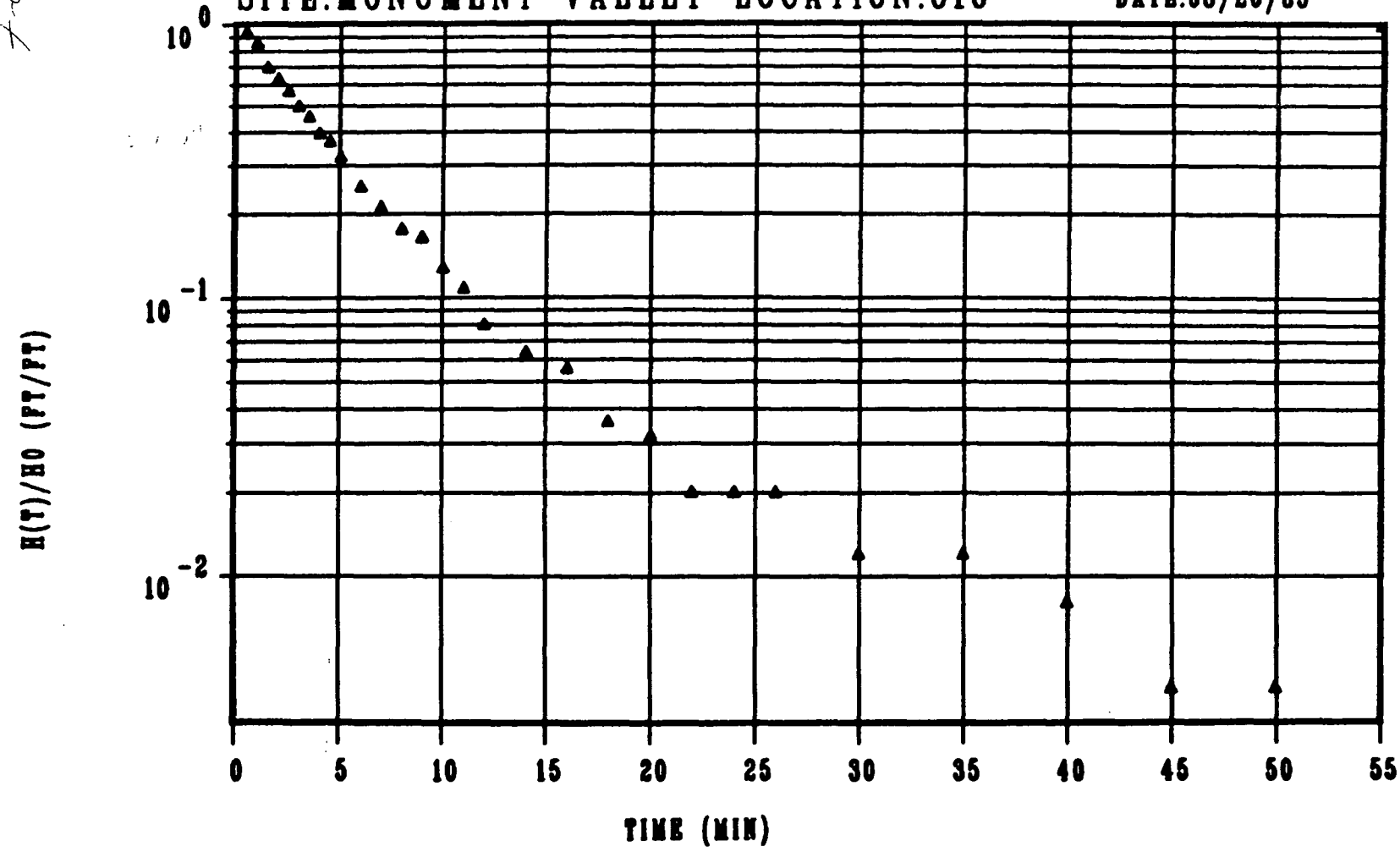
RGP 7-96

HVORSLEV SLUG TEST ANALYSIS
SITE:MONUMENT VALLEY LOCATION:610 DATE:08/20/85

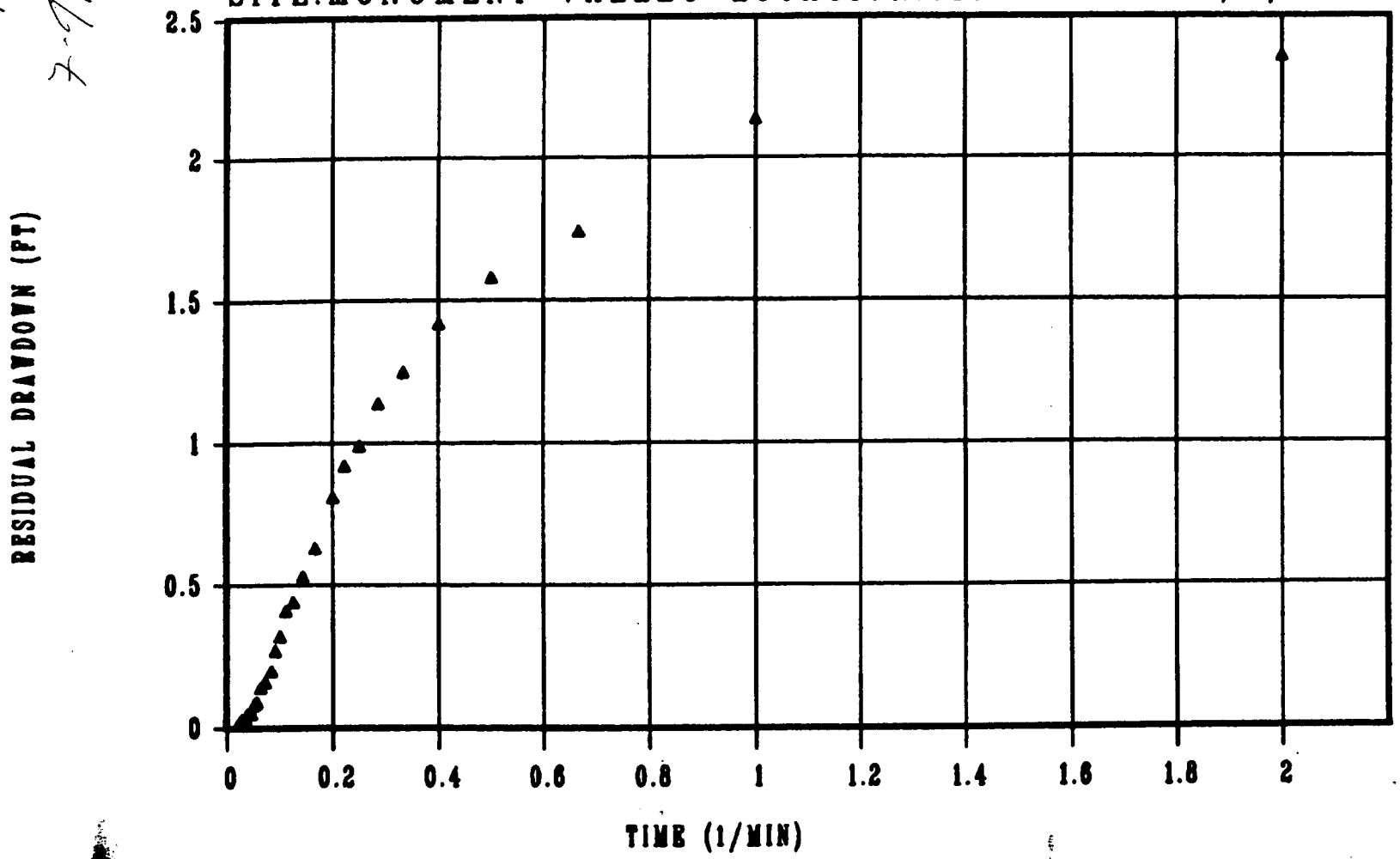


75

Rdp 7-96

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:610 DATE:08/20/85



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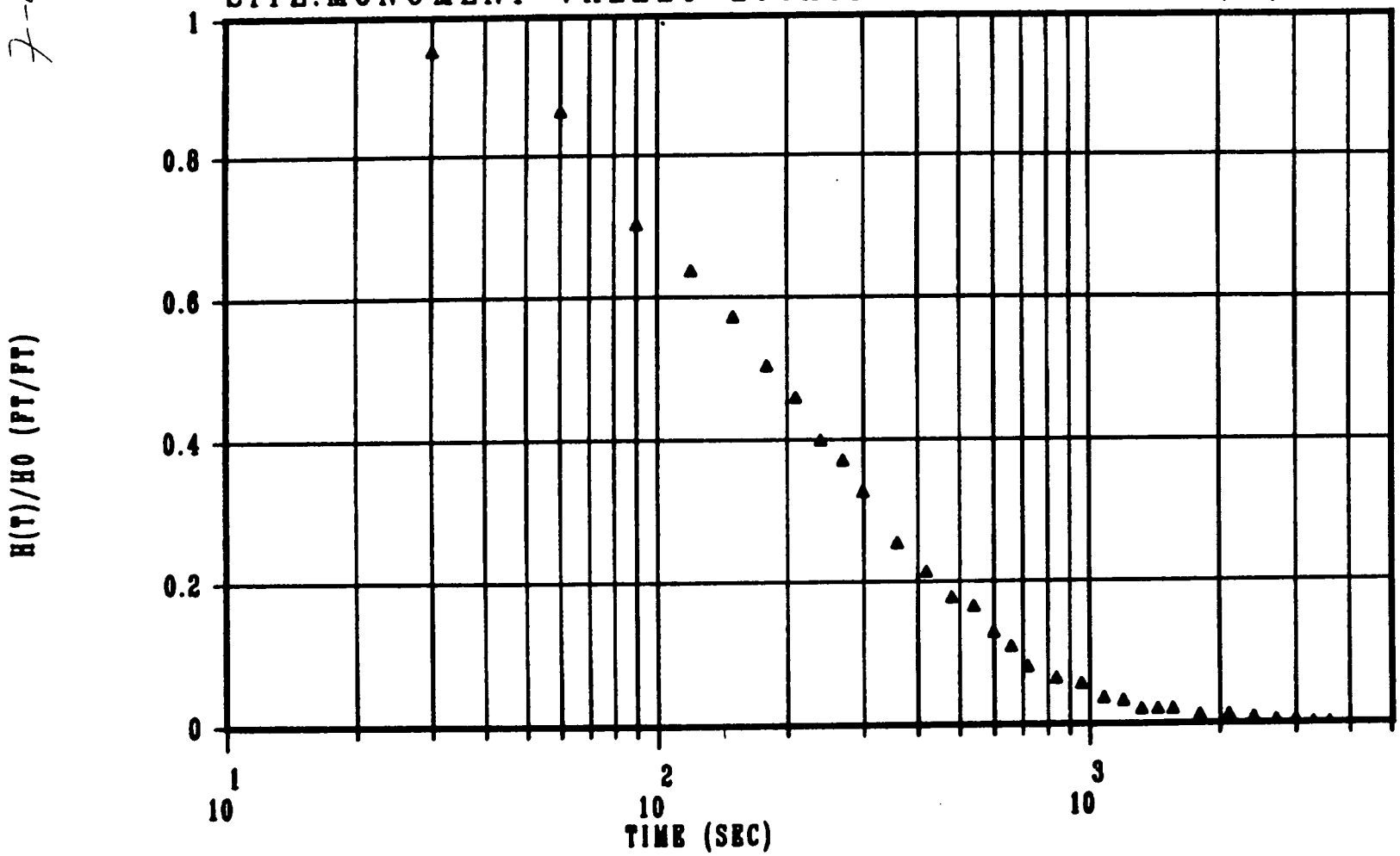
RJP 7-96

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:610 DATE:08/20/85



RAP 7-92

Well 610

```
*****************************************************************
WELL IDENTIFICATION- 610
DATE OF FIELD TEST- 8/20/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .083
BOREHOLE RADIUS(Rw)=  .276
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  540
HEAD AT TIME t(Yt)=  .41
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  54.7
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  54.7
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.215629E-06   ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 610
DATE OF FIELD TEST- 8/20/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .054
RECIPROCAL TIME(1/t)=  .33
DRAWDOWN (s)=  1.25
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  5.672282E-05   ft/min
*****************************************************************
```

$= 9.45 \times 10^{-7}$ ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 610
DATE OF FIELD TEST- 8/20/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .083
TIME(t)=  110
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.131363E-06   ft/sec
*****************************************************************
```

```
WELL IDENTIFICATION- 610
DATE OF FIELD TEST- 8/20/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
HVORSLEV METHOD
FOR WELL RADIUS(r)=  .083
BOREHOLE RADIUS(R)=  .276
AND TIME LAG(To)=  4.5
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.639232E-04   ft/min
*****************************************************************
```

$= 2.7 \times 10^{-6}$ ft/sec

15
Roll
7-90

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MON-01 LOCATION ID: 612

SLUG VOLUME (ft.^{3}): _____

INITIAL WATER LEVEL:

DATE: 85/4/20

TIME: 9:58 AM

DEPTH (ft FROM TOC): 161.46

STATIC WATER LEVEL:

DATE: 85/4/27 TIME: 5:00 p

DEPTH (ft): 160.95

OPEN INTERVAL NOT KNOWN to NOT KNOWN

TOTAL DEPTH OF WELL (ft): 210

WELL DIAM. (ft): .167

OBSERVERS: D. Miller

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	160.95			
:50	161.89			
1:00	161.75			
1:30	161.69			
2:00	161.59			
:30	161.52			
3:00	161.43			
:30	161.41			
4:00	161.38			
:30	161.32			
5:00	161.30			
6:00	161.23			
7:00	161.21			
8:00	161.20			
9:00	161.19			
10:00	161.18			
20:00	161.06			
25:00	161.06			
30:00	161.06			
45:00	161.03			
60:00	161.95			

COMMENTS: DROPPED SLUG = 6:00 85/4/21

After 7 days well had not recovered to original level.

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 612
DATE: 04/27/85

RAP 7-92

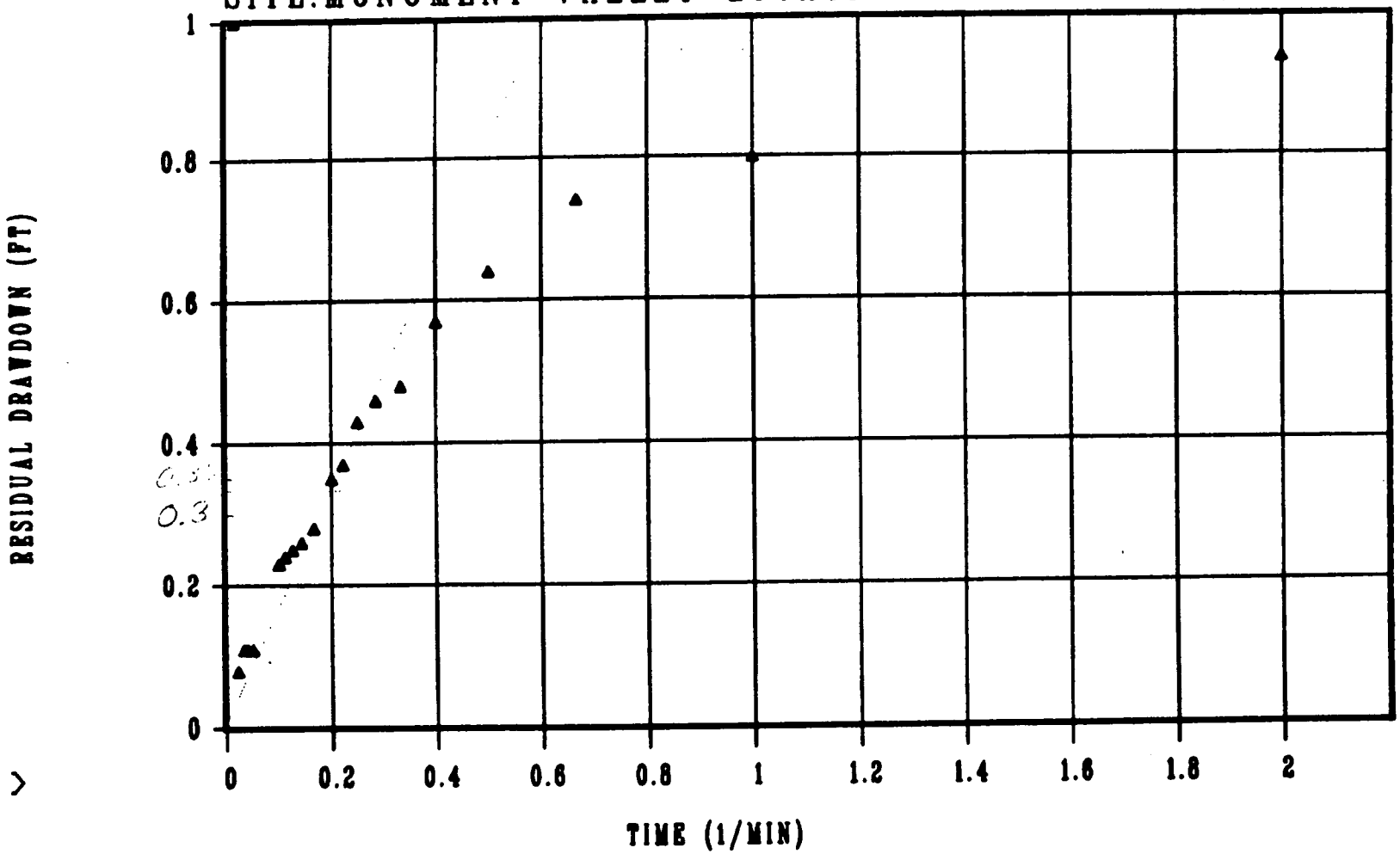
---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	160.95	.00	.0000
.50	2.00000	30	161.89	-.94	-.3798
1.00	1.00000	60	161.75	-.80	-.3232
1.50	.66667	90	161.69	-.74	-.2990
2.00	.50000	120	161.59	-.64	-.2586
2.50	.40000	150	161.52	-.57	-.2303
3.00	.33333	180	161.43	-.48	-.1939
3.50	.28571	210	161.41	-.46	-.1858
4.00	.25000	240	161.38	-.43	-.1737
4.50	.22222	270	161.32	-.37	-.1495
5.00	.20000	300	161.30	-.35	-.1414
6.00	.16667	360	161.23	-.28	-.1131
7.00	.14286	420	161.21	-.26	-.1050
8.00	.12500	480	161.20	-.25	-.1010
9.00	.11111	540	161.19	-.24	-.0970
10.00	.10000	600	161.18	-.23	-.0929
20.00	.05000	1200	161.06	-.11	-.0444
25.00	.04000	1500	161.06	-.11	-.0444
30.00	.03333	1800	161.06	-.11	-.0444
45.00	.02222	2700	161.03	-.08	-.0323
60.00	.01667	3600	161.95	-1.00	-.4040

FERRIS-KNOWLES UMTRA*EZPLOT0037
HVORSLEV UMTRA*EZPLOT0038
BOWLER-RICE UMTRA*EZPLOT0039
COOPER, BREDHOEFT, PAPADOPULOS UMTRA*EZPLOT0040
@@NOPR

80
Rdp
7-92

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:612 DATE:04/27/85



>

^
ERROR 1 Unrecognizable command

$\frac{1}{t} = 0.2 \text{ min}^{-1}$

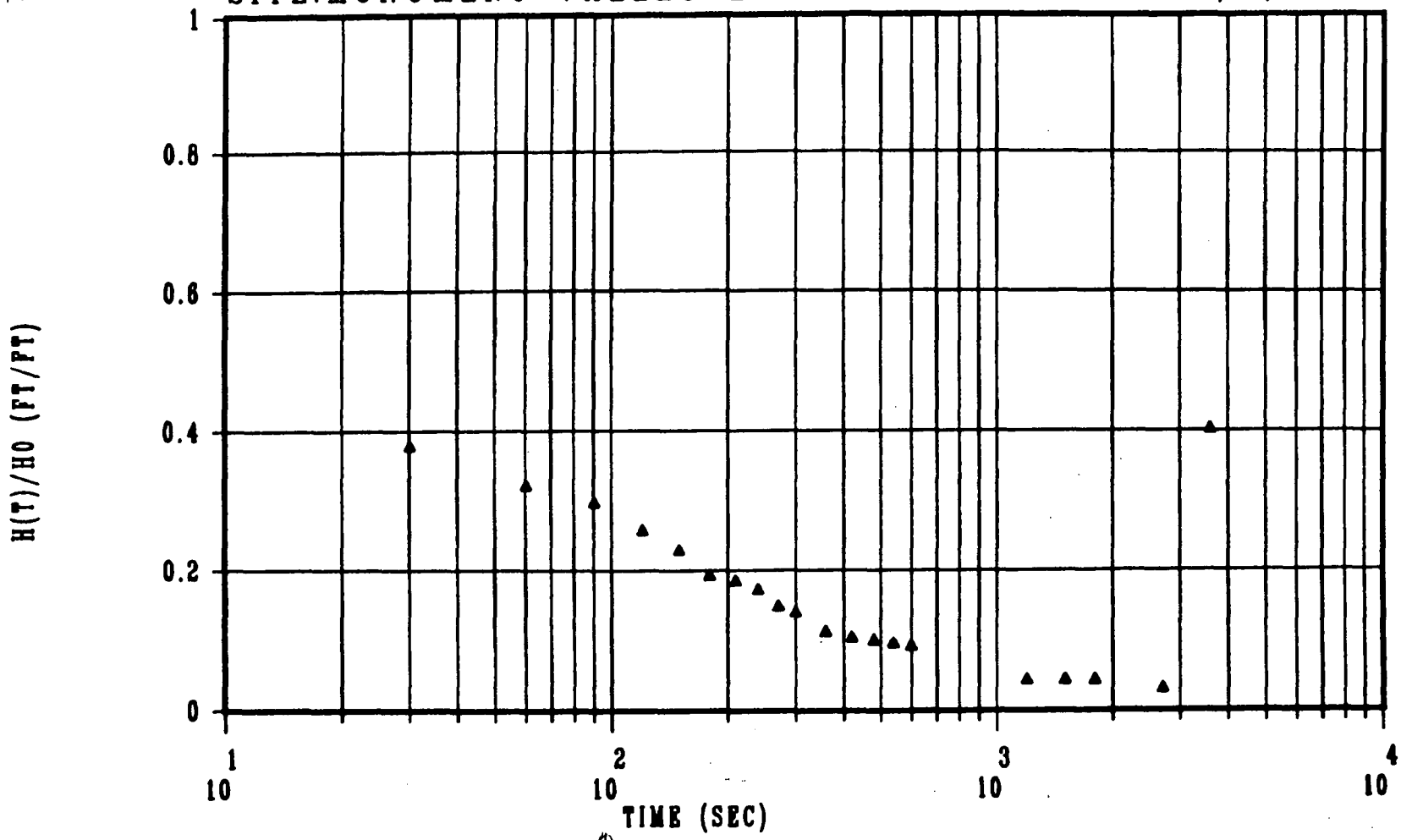
$S = 0.35$ ft

18

Plate 7

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:612 DATE:04/27/85



100 sec

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

RUP 7-10

SEP 09 1985

SLUG TEST DATA

SITE ID: MW-01 LOCATION ID: 612

SLUG VOLUME (ft.³): 0.054

INITIAL WATER LEVEL (AT t_o):

DATE: 85/8/18

TIME: 4:30p

DEPTH (ft FROM TOC): 161.33

STATIC WATER LEVEL:

DATE: 85-8-25 TIME: 1150A

DEPTH (ft): 160.97

OPEN INTERVAL (ft.) _____ to _____

TOTAL DEPTH OF WELL (ft): _____

WELL DIAM. (ft): 0.167

FIELD REP: D Miller

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:0	160.97			
~~.5~~	—			
~~1:00~~	—			
1.5	162.16			
2:00	161.85			
.5	161.72			
3:00	161.68			
.5	161.61			
4:00	161.53			
.5	161.49			
5:00	161.45			
6:00	161.35			
7:00	161.33			
8:00	161.33			

COMMENTS: Dropped slug @ 4:30p, 85/8/18
check slug 85/8/20, 1:00p 160.92' static

JEG-AL-ENG-8 (3/84)

DAP
7-9-85

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 612
DATE: 08/25/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	160.97	.00	.0000
1.50	.66667	90	162.16	-1.19	-.4808
2.00	.50000	120	161.85	-.88	-.3555
2.50	.40000	150	161.72	-.75	-.3030
3.00	.33333	180	161.68	-.71	-.2868
3.50	.28571	210	161.61	-.64	-.2586
4.00	.25000	240	161.53	-.56	-.2262
4.50	.22222	270	161.49	-.52	-.2101
5.00	.20000	300	161.45	-.48	-.1939
6.00	.16667	360	161.35	-.38	-.1535
7.00	.14286	420	161.33	-.36	-.1454
8.00	.12500	480	161.33	-.36	-.1454

FERRIS-KNOWLES	UMTRA*EZPLOTJH33
HVORSLEV	UMTRA*EZPLOTJH34
BOWLER-RICE	UMTRA*EZPLOTJH35
COOPER, BREDHOEFT, PAPADOPULOS	UMTRA*EZPLOTJH36
@@NOPR	

FERRIS-KNOWLES SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:612 DATE:08/25/85

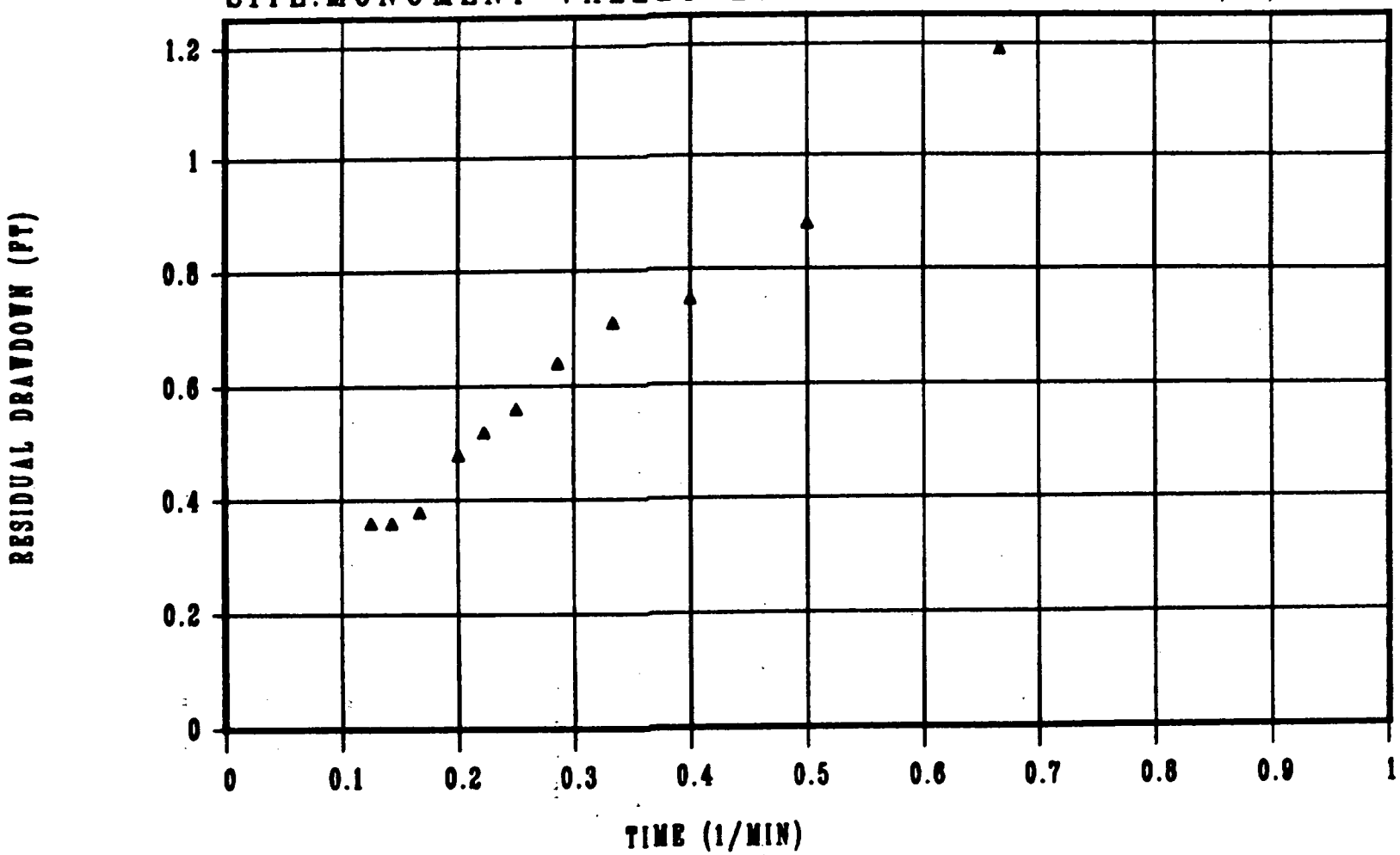


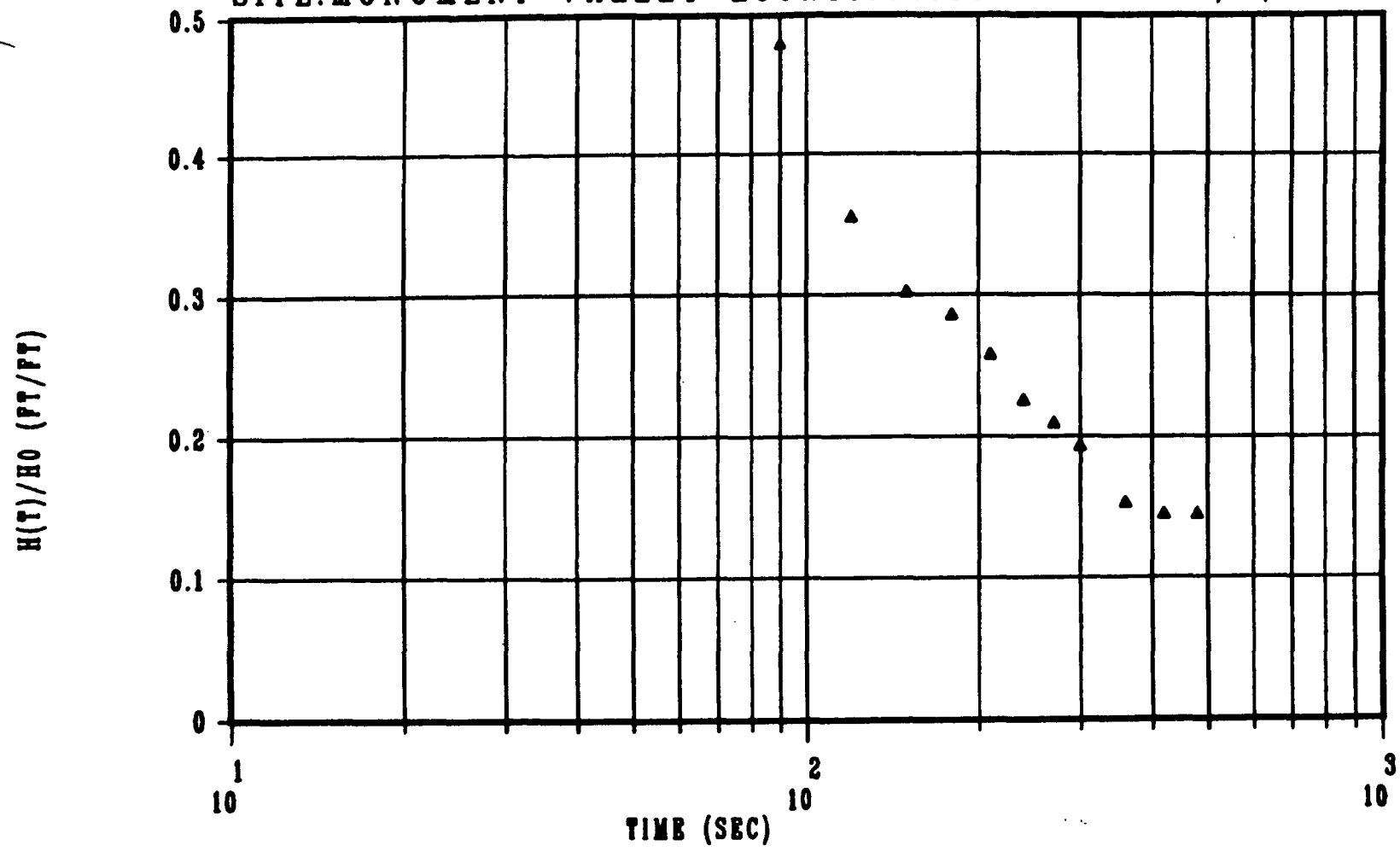
Fig 7

85

RDP 7-91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SITE:MONUMENT VALLEY LOCATION:612 DATE:08/25/85



Well 612

```
*****************************************************************
WELL IDENTIFICATION- 612
DATE OF FIELD TEST- 4/27/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .054
RECIPROCAL TIME(1/t)=  .22
DRAWDOWN (s)=  .37
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.277541E-04   ft/min
*****************************************************************
```

$= 2.13 \times 10^{-6}$ ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 612
DATE OF FIELD TEST- 8/25/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .054
RECIPROCAL TIME(1/t)=  .22
DRAWDOWN (s)=  .52
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  9.090196E-05   ft/min
*****************************************************************
```

1.52×10^{-6} ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 612
DATE OF FIELD TEST- 8/25/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .083
TIME(t)=  120
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.870416E-06   ft/sec
*****************************************************************
```

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

RdP 7-9a

SLUG TEST DATA

SITE ID: Mon01 LOCATION ID: 653

SLUG VOLUME (ft.^{3}): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/27

TIME: 12:00 noon

DEPTH (ft FROM TOC): 35.55

STATIC WATER LEVEL:
DATE: 85/10/27 TIME: 4:30p

DEPTH (ft): 35.14

OPEN INTERVAL (ft.) (From TOC) 58.0 to 78.0

TOTAL DEPTH OF WELL (ft): (From TOC) ~~80.0~~ 80

WELL DIAM. (ft): .333

FIELD REP: Friths

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	35.14			
.5	33.79			
1.0	34.35			
1.5	34.58			
2.0	34.76			
.5	34.89			
3.0	34.97			
.5	35.03			
4.0	35.07			
.5	35.09			
5.0	35.11			
6.0	35.13			
7.0	35.14			
8.0	35.14			

COMMENTS:

JEG-AL-ENG-8 (3/84)

RAP
7-92

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 653
DATE: 10/27/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT]/HO [FT./FT.]
.00	.00000	0	35.14	.00	.0000
.50	2.00000	30	33.79	1.35	.5429
1.00	1.00000	60	34.35	.79	.3177
1.50	.66667	90	34.58	.56	.2252
2.00	.50000	120	34.76	.38	.1528
2.50	.40000	150	34.89	.25	.1005
3.00	.33333	180	34.97	.17	.0684
3.50	.28571	210	35.03	.11	.0442
4.00	.25000	240	35.07	.07	.0282
4.50	.22222	270	35.09	.05	.0201
5.00	.20000	300	35.11	.03	.0121
6.00	.16667	360	35.13	.01	.0040
7.00	.14286	420	35.14	.00	.0000
8.00	.12500	480	35.14	.00	.0000

FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

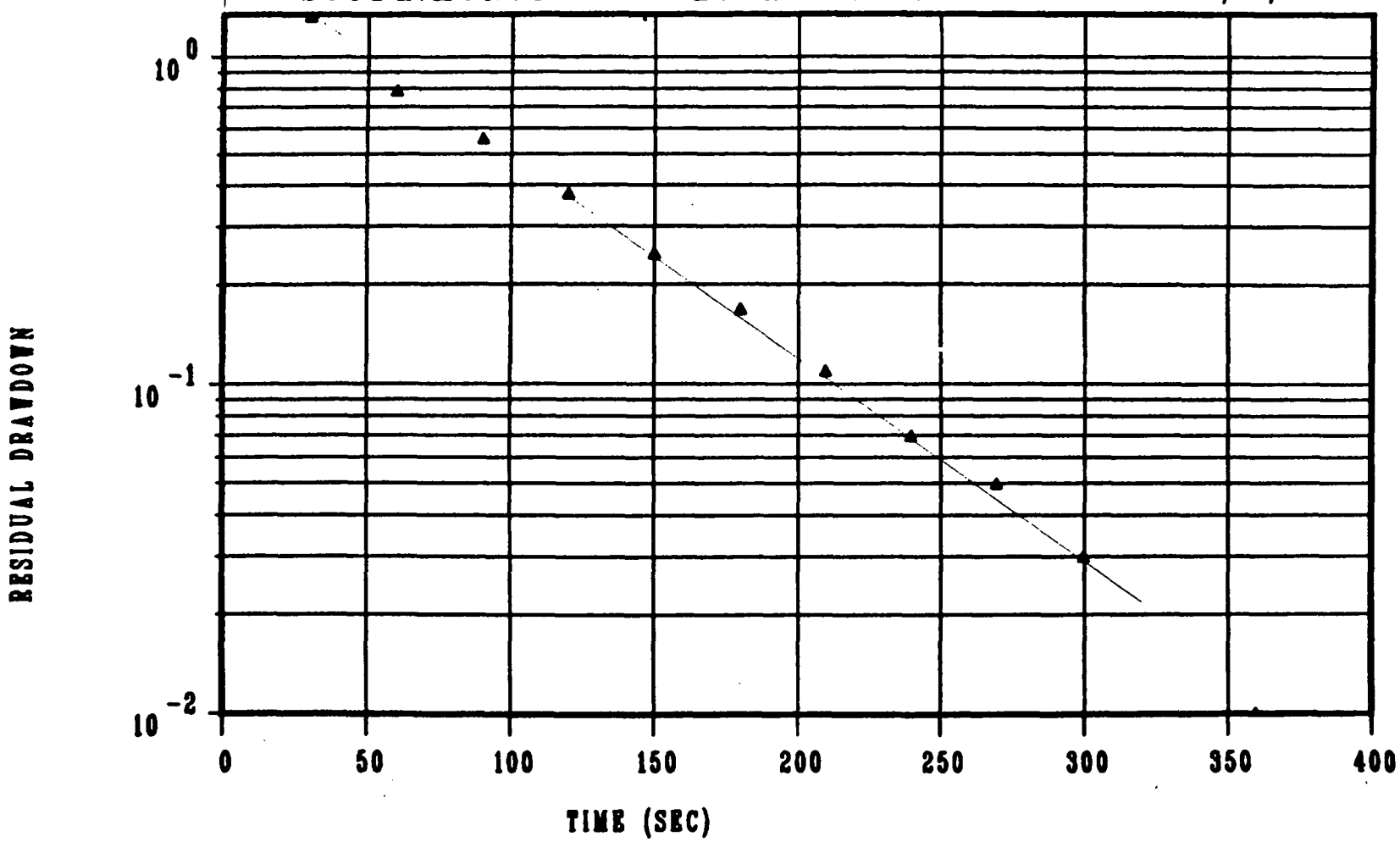
UMTRA*EZPLOTH~~412~~ 5165
UMTRA*EZPLOTH~~413~~ 5166
UMTRA*EZPLOTH414 5167
UMTRA*EZPLOTH415 5168

mapper data Filename = mon01 * UDPSTD100013

89
Rolf
7-Pt

BOUWER-RICE SLUG TEST ANALYSIS

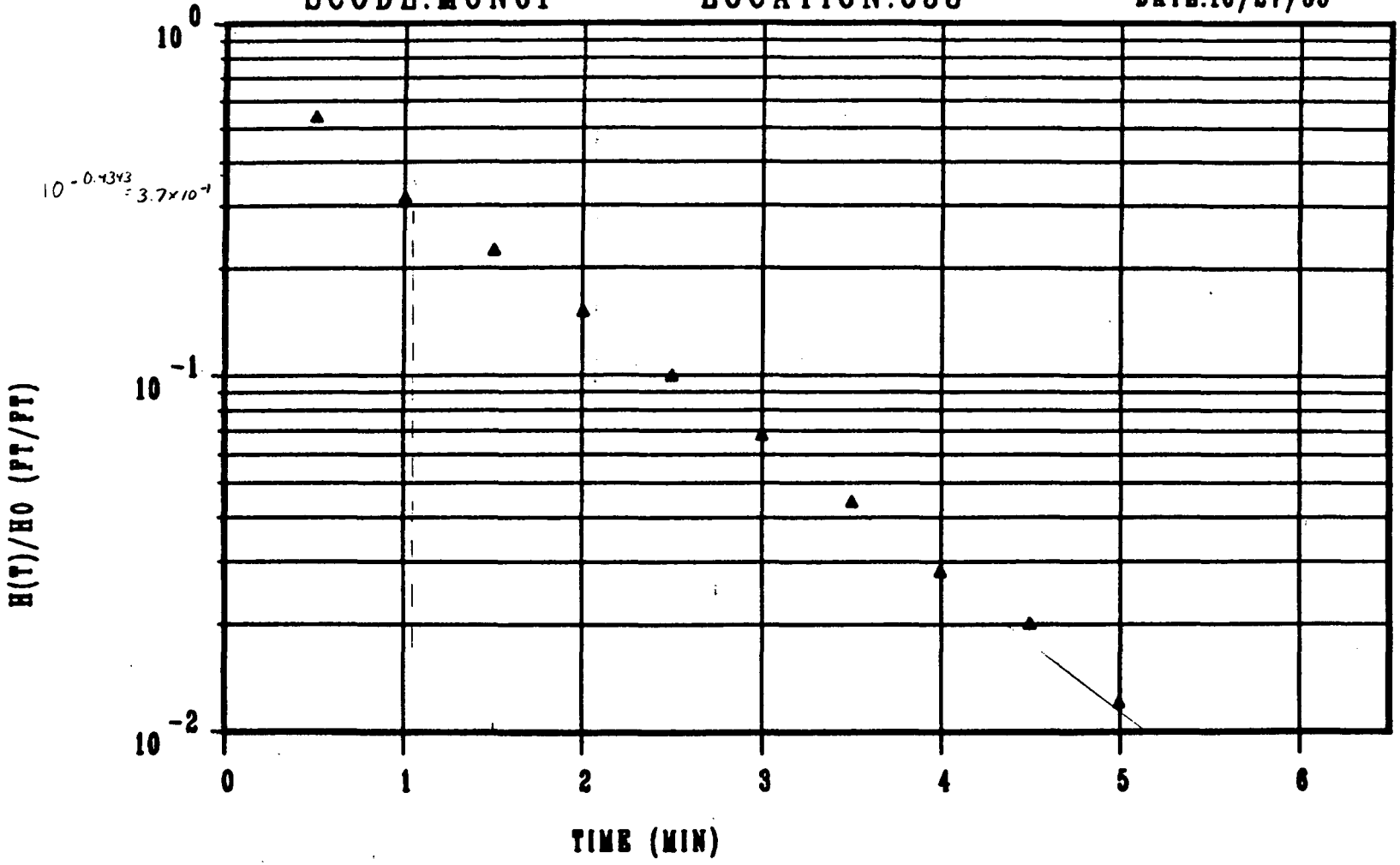
SCODE:MON01 LOCATION:653 DATE:10/27/85



overall Fit at T = 150 (sec), $y_{(1)}$ = 0.25 Ft

HVORSLEV SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:653 DATE:10/27/85



$T_0 = 1.05$ (min)

RdP
7-92

Well 653

```
*****************************************************************
WELL IDENTIFICATION- 653
DATE OF FIELD TEST- 10/27/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
HVORSLEV METHOD
FOR WELL RADIUS(r)=  .167
BOREHOLE RADIUS(R)=  .33
AND TIME LAG(Tc)=  1.05
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.725416E-03    ft/min
*****************************************************************
```

$= 4.53 \times 10^{-5}$ ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 653
DATE OF FIELD TEST- 10/27/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .167
BOREHOLE RADIUS(Rw)=  .33
HEAD AT Tc(Yc)=  2.5
TIME TO HEAD MEASUREMENT(t)=  150
HEAD AT TIME t(Yt)=  .25
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  44.9
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  57.7
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.327721E-05    ft/sec
*****************************************************************
```

R 9/7

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MON01 LOCATION ID: 655

SLUG VOLUME (ft.^{3}): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/23

TIME: 2:45

DEPTH (ft FROM TOC): 39.23

STATIC WATER LEVEL:

DATE: 85/10/24 TIME: 5:30p

DEPTH (ft): 39.27

OPEN INTERVAL (ft.) (From TOC) 41 to 61

TOTAL DEPTH OF WELL (ft): (From TOC) 63

WELL DIAM. (ft): .333

FIELD REP: D. Miller / J Faiths

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	39.27			
.5	37.00			
1.0	37.11			
1.5	37.22			
2.0	37.32			
2.5	37.41			
3.0	37.51			
3.5	37.59			
4.0	37.68			
4.5	37.74			
5.0	37.85			
6.0	37.97			
7.0	38.07			
8.0	38.19			
9.0	38.26			
10.0	38.35			
11.0	38.43			
12.0	38.48			
13.0	38.55			
14.0	38.60			

COMMENTS: Page 1 of 2

JEG-AL-ENG-8 (3/84)

RAP 7-92

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

cont.

SITE ID: MON 01 LOCATION ID: 655

STATIC WATER LEVEL:
DATE: _____ TIME: _____

SLUG VOLUME (ft.^{3}): _____

DEPTH (ft): _____

INITIAL WATER LEVEL (AT t_o):

OPEN INTERVAL (ft.) _____ to _____

DATE: _____

TOTAL DEPTH OF WELL (ft): _____

TIME: _____

WELL DIAM. (ft): _____

DEPTH (ft FROM TOC): _____

FIELD REP: _____

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
16.0	38.71			
18.0	38.76			
20.0	38.82			
22.0	38.90			
24.0	38.95			
28.0	39.03			
33.0	39.09			
38.00	39.11			
43.00	39.17			
48.0	39.17			
53.0	39.20			
60.0	39.20			

COMMENTS: Page 2 of 2

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 655
DATE: 10/24/85

RAP
7-92

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT1/HO [FT./FT.]
.00	.00000	0	39.27	.00	.0000
.50	2.00000	30	37.00	2.27	.9129
1.00	1.00000	60	37.11	2.16	.8686
1.50	.66667	90	37.22	2.05	.8244
2.00	.50000	120	37.32	1.95	.7842
2.50	.40000	150	37.41	1.86	.7480
3.00	.33333	180	37.51	1.76	.7078
3.50	.28571	210	37.59	1.68	.6756
4.00	.25000	240	37.68	1.59	.6394
4.50	.22222	270	37.74	1.53	.6153
5.00	.20000	300	37.85	1.42	.5711
6.00	.16667	360	37.97	1.30	.5228
7.00	.14286	420	38.07	1.20	.4826
8.00	.12500	480	38.19	1.08	.4343
9.00	.11111	540	38.26	1.01	.4062
10.00	.10000	600	38.35	.92	.3700
11.00	.09091	660	38.43	.84	.3378
12.00	.08333	720	38.48	.79	.3177
13.00	.07692	780	38.55	.72	.2895
14.00	.07143	840	38.60	.67	.2694
16.00	.06250	960	38.71	.56	.2252
18.00	.05556	1080	38.76	.51	.2051
20.00	.05000	1200	38.82	.45	.1810
22.00	.04545	1320	38.90	.37	.1488
24.00	.04167	1440	38.95	.32	.1287
28.00	.03571	1680	39.03	.24	.0965
33.00	.03030	1980	39.09	.18	.0724
38.00	.02632	2280	39.11	.16	.0643
43.00	.02326	2580	39.17	.10	.0402
48.00	.02083	2880	39.17	.10	.0402
53.00	.01887	3180	39.20	.07	.0282
60.00	.01667	3600	39.20	.07	.0282

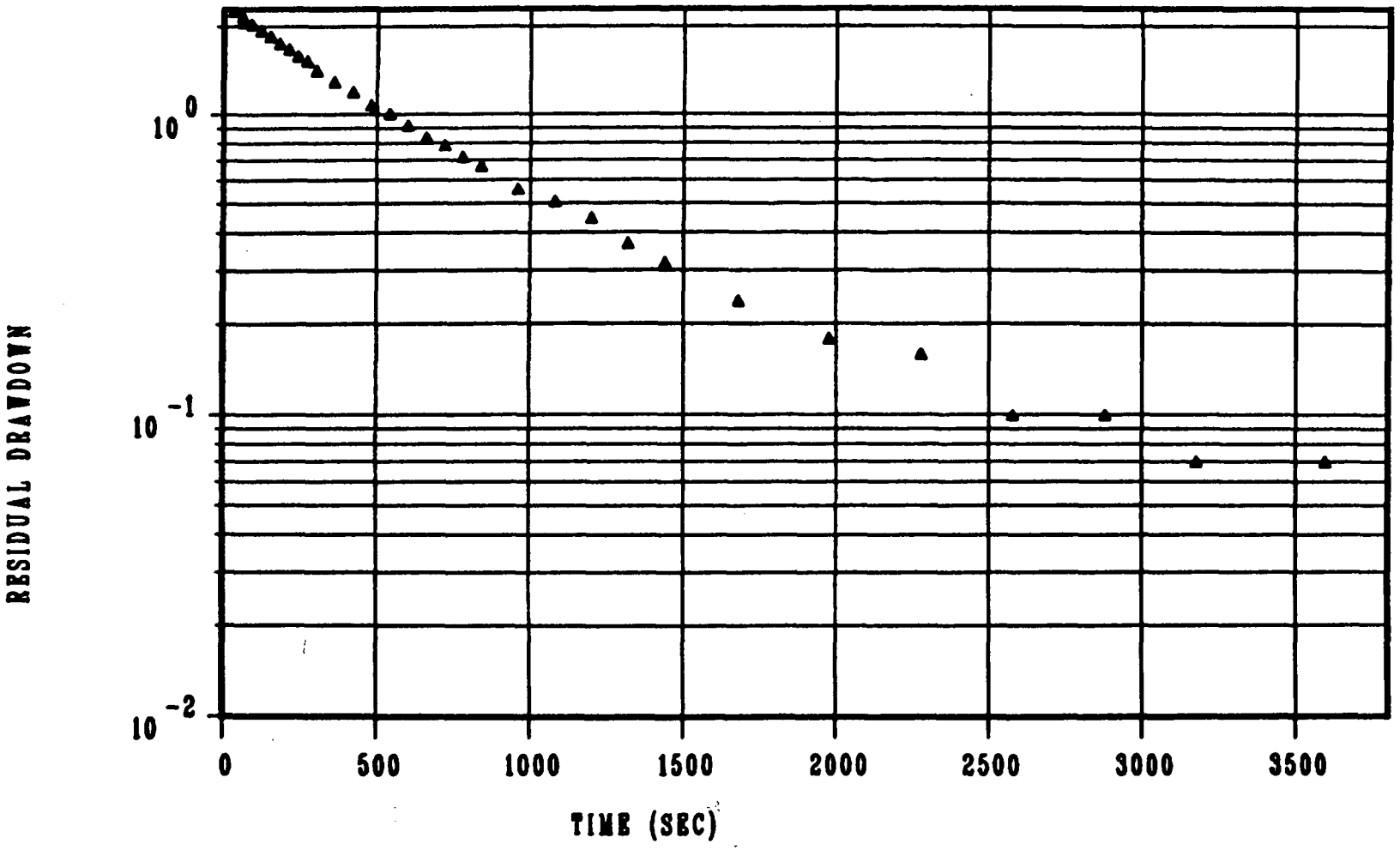
FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

UMTRA*EZPLOTH~~420~~ S173
UMTRA*EZPLOTH~~421~~ S174
UMTRA*EZPLOTH~~422~~ S175
UMTRA*EZPLOTH~~423~~ S176

95
RAP
F-92

BOUWER-RICE SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:655 DATE:10/24/85

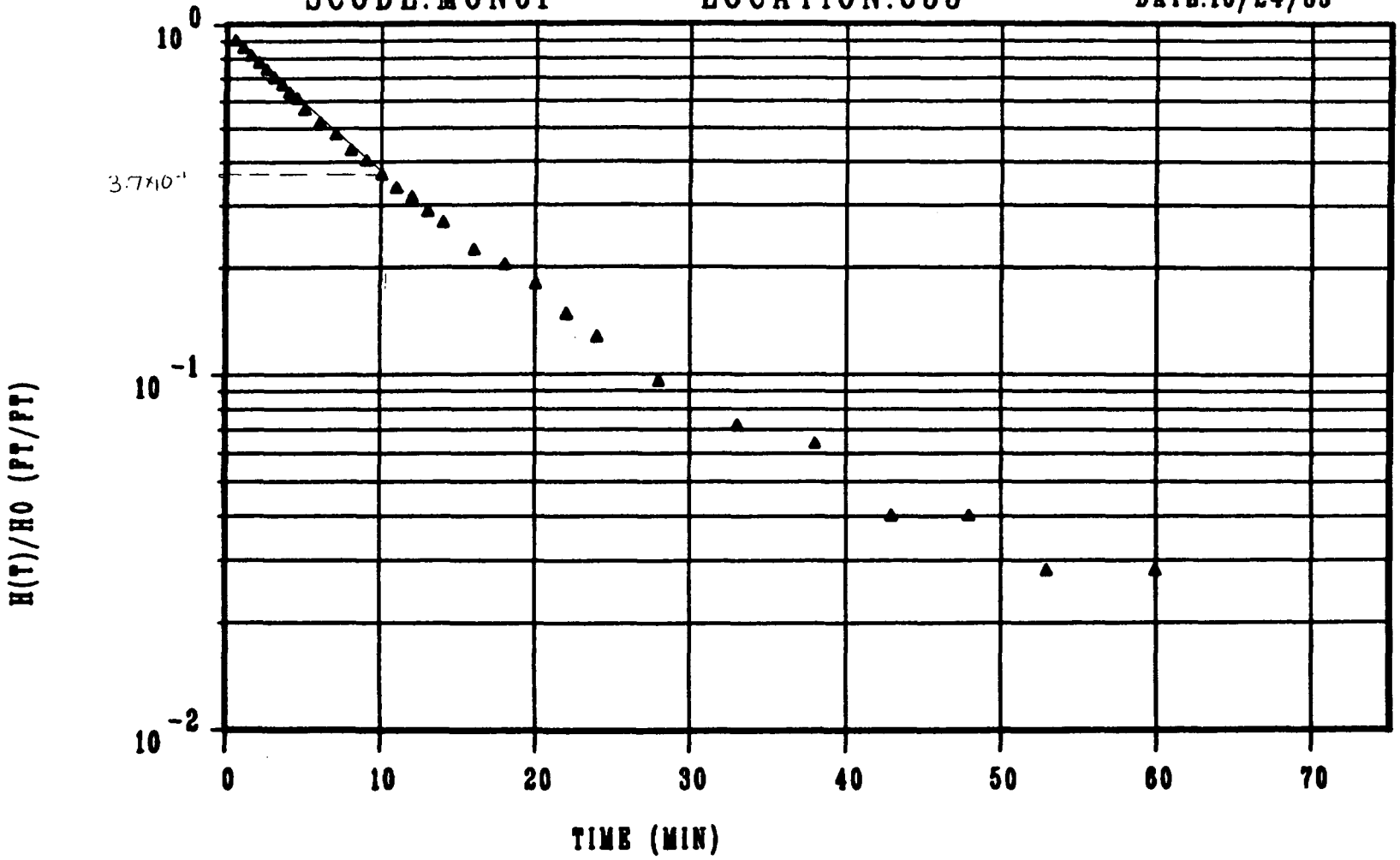


t = 180 sec y(t) = 1.76 ft

96
R 6/7
7-9/2

HVORSLEV SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:655 DATE:10/24/85



$t_0 = 10.0$ min

Well 655

RMP
7-92

```
*****************************************************************
WELL IDENTIFICATION- 655
DATE OF FIELD TEST- 10/24/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .167
BOREHOLE RADIUS(Rw)=  .33
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  480
HEAD AT TIME t(Yt)=  1.08
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  23.7
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  23.7
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.902928E-06    ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 655
DATE OF FIELD TEST- 10/24/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
HVORSLEV METHOD
FOR WELL RADIUS(r)=  .167
BOREHOLE RADIUS(R)=  .33
AND TIME LAG(To)=  10
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.661687E-04   ft/min
*****************************************************************
```

$= 4.55 \times 10^{-6}$ ft/sec

3

RYA

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MON 01 LOCATION ID: 656

SLUG VOLUME (ft.^{3}): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/24

TIME: 10:00 A

DEPTH (ft FROM TOC): 35.98

STATIC WATER LEVEL:

DATE: 85/10/24 TIME: 9:15 pm.

DEPTH (ft): 35.96

OPEN INTERVAL (ft.) ~~41~~ 43 to ~~61~~ 63 (From TOC)

TOTAL DEPTH OF WELL (ft): ~~63~~ 65 (From TOC)

WELL DIAM. (ft): .333

FIELD REP: D. Miller / J. Fritz

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
00	35.96			
:50	—			
1:00	35.00			
:50	35.27			
2:00	35.36			
:50	35.56			
3:00	35.63			
:50	35.66			
4:00	35.75			
:50	35.79			
5:00	35.85			
:50	35.88			
6:00	35.88			
:50	35.88			
7:00	35.91			
8:00	35.91			
9:00	35.92			
10:00	35.93			
11:00	35.94			
12:00	35.96			

COMMENTS:

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 656
DATE: 10/24/85

R917
F-96

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT1/H0 [FT./FT.]
.00	.00000	0	35.96	.00	.0000
1.00	1.00000	60	35.00	.96	.3861
1.50	.66667	90	35.27	.69	.2775
2.00	.50000	120	35.36	.60	.2413
2.50	.40000	150	35.56	.40	.1609
3.00	.33333	180	35.63	.33	.1327
3.50	.28571	210	35.66	.30	.1206
4.00	.25000	240	35.75	.21	.0845
4.50	.22222	270	35.79	.17	.0684
5.00	.20000	300	35.85	.11	.0442
5.50	.18182	330	35.88	.08	.0322
6.00	.16667	360	35.88	.08	.0322
6.50	.15385	390	35.88	.08	.0322
7.00	.14286	420	35.91	.05	.0201
8.00	.12500	480	35.91	.05	.0201
9.00	.11111	540	35.92	.04	.0161
10.00	.10000	600	35.93	.03	.0121
11.00	.09091	660	35.94	.02	.0080
12.00	.08333	720	35.96	.00	.0000

FERRIS-KNOWLES
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

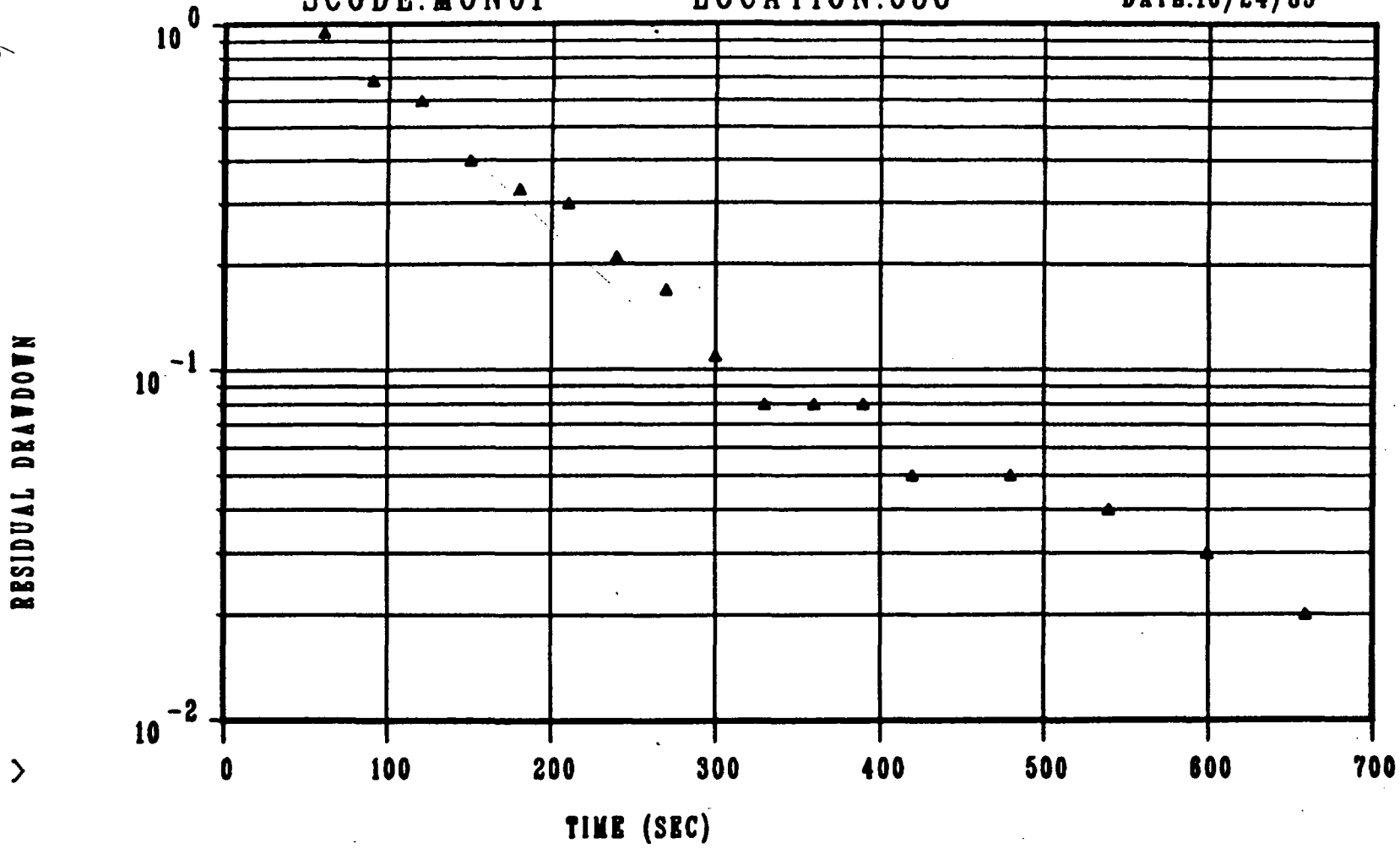
UMTRA*EZPLOTH~~424~~ S177
UMTRA*EZPLOTH~~425~~ S178
UMTRA*EZPLOTH~~426~~ S179
UMTRA*EZPLOTH~~427~~ S180

100

PAP
t-96

BOUWER-RICE SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:656 DATE:10/24/85



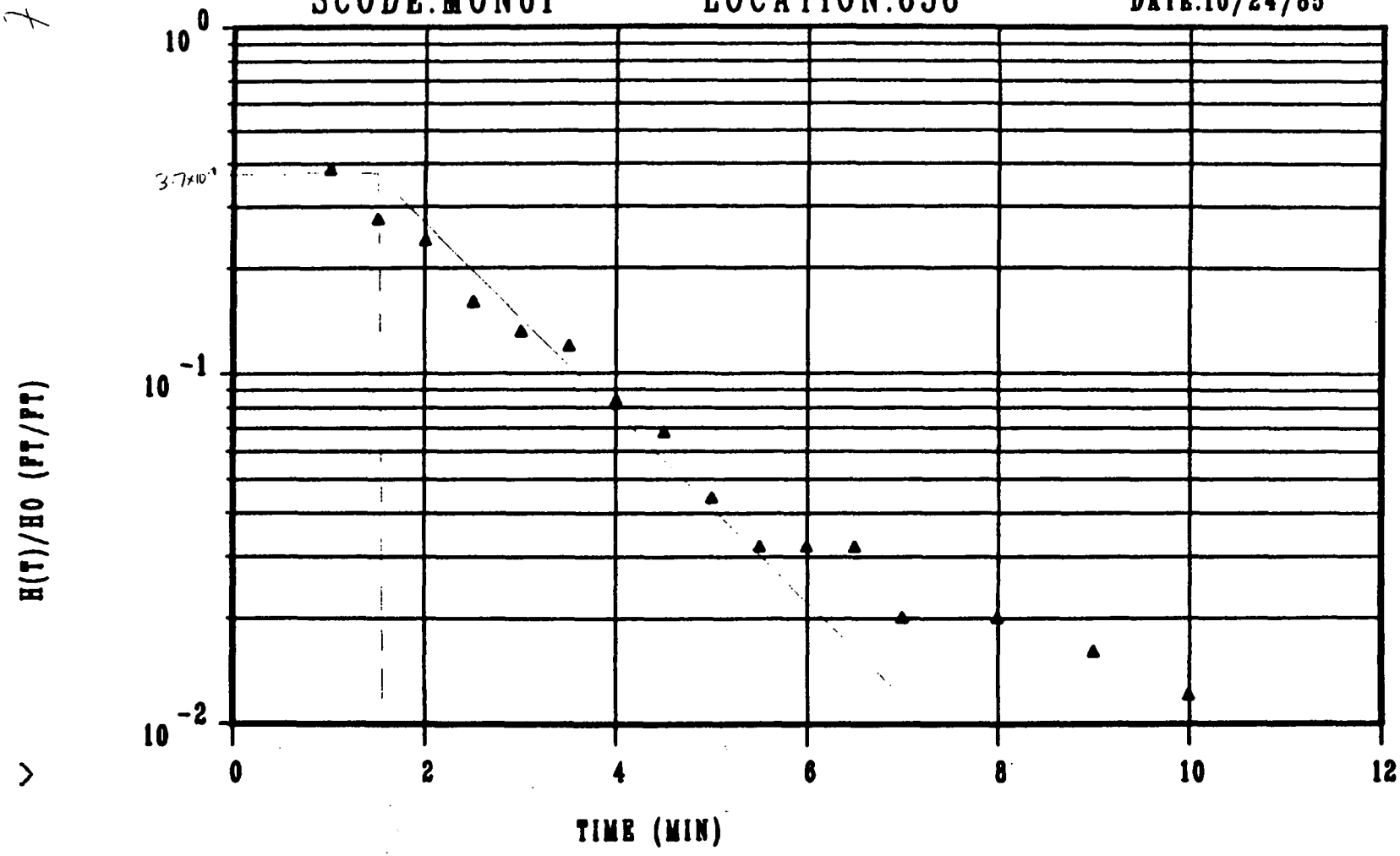
early time t = 150 sec y(t) = 0.40

101

RGP 7-92

HVORSLEV SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:656 DATE:10/24/85



Well 656

102

R9P
7-92

****

SLUG TEST SOLUTIONS

****
WELL IDENTIFICATION- 656
DATE OF FIELD TEST- 10/24/85
LENGTH OF CONTRIBUTING INTERVAL,(L)= 20
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)= .167
BOREHOLE RADIUS(Rw)= .33
HEAD AT To(Yo)= 2.5
TIME TO HEAD MEASUREMENT(t)= 150
HEAD AT TIME t(Yt)= .4
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)= 29
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)= 29
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 2.832124E-05 ft/sec
****

****
WELL IDENTIFICATION- 656
DATE OF FIELD TEST- 10/24/85
LENGTH OF CONTRIBUTING INTERVAL,(L)= 20
HVORSLEV METHOD
FOR WELL RADIUS(r)= .167
BOREHOLE RADIUS(R)= .33
AND TIME LAG(To)= 1.5
****
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)= 1.957791E-03 ft/min
****
$= 3.2 \times 10^{-5}$ ft/sec

123 RAP 7-86

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

NOV 5 1985

SLUG TEST DATA

SITE ID: MON 01 LOCATION ID: 657

SLUG VOLUME (ft.³): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/19

TIME: 3:14 p

DEPTH (ft FROM TOC): 50.20

STATIC WATER LEVEL:
DATE: 85/10/21 TIME: 4:19 p

DEPTH (ft): 49.87

OPEN INTERVAL (ft.) ~~122.0~~ 124 to ~~134.0~~ 13
(From TOC)

TOTAL DEPTH OF WELL (ft): ~~136.25~~ 141
(from TOC)

WELL DIAM. (ft): .333

FIELD REP: D. Miller

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	49.87			
:50	47.24			
1:00	~~47.29~~			
:50	47.34			
2:00	47.40			
:50	47.45			
3:00	47.50			
:50	47.54			
4:00	47.61			
:50	47.66			
5:00	47.75			
10:00	48.12			
15:00	48.45			
20:00	48.69			
25:00	49.07			
30:00	49.30			
35:00	49.37			
45:00	49.59			
60:00	49.70			
75:00	49.87			

COMMENTS:

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 657
DATE: 10/21/85

RAP
7-92

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT]/HO [FT./FT.]
.00	.00000	0	49.87	.00	.0000
.50	2.00000	30	47.24	2.63	1.0577
1.00	1.00000	60	47.29	2.58	1.0375
1.50	.66667	90	47.34	2.53	1.0174
2.00	.50000	120	47.40	2.47	.9933
2.50	.40000	150	47.45	2.42	.9732
3.00	.33333	180	47.50	2.37	.9531
3.50	.28571	210	47.54	2.33	.9370
4.00	.25000	240	47.61	2.26	.9089
4.50	.22222	270	47.66	2.21	.8888
5.00	.20000	300	47.75	2.12	.8526
10.00	.10000	600	48.12	1.75	.7038
15.00	.06667	900	48.45	1.42	.5711
20.00	.05000	1200	48.69	1.18	.4745
25.00	.04000	1500	49.07	.80	.3217
30.00	.03333	1800	49.30	.57	.2292
35.00	.02857	2100	49.37	.50	.2011
45.00	.02222	2700	49.59	.28	.1126
60.00	.01667	3600	49.70	.17	.0684
75.00	.01333	4500	49.87	.00	.0000

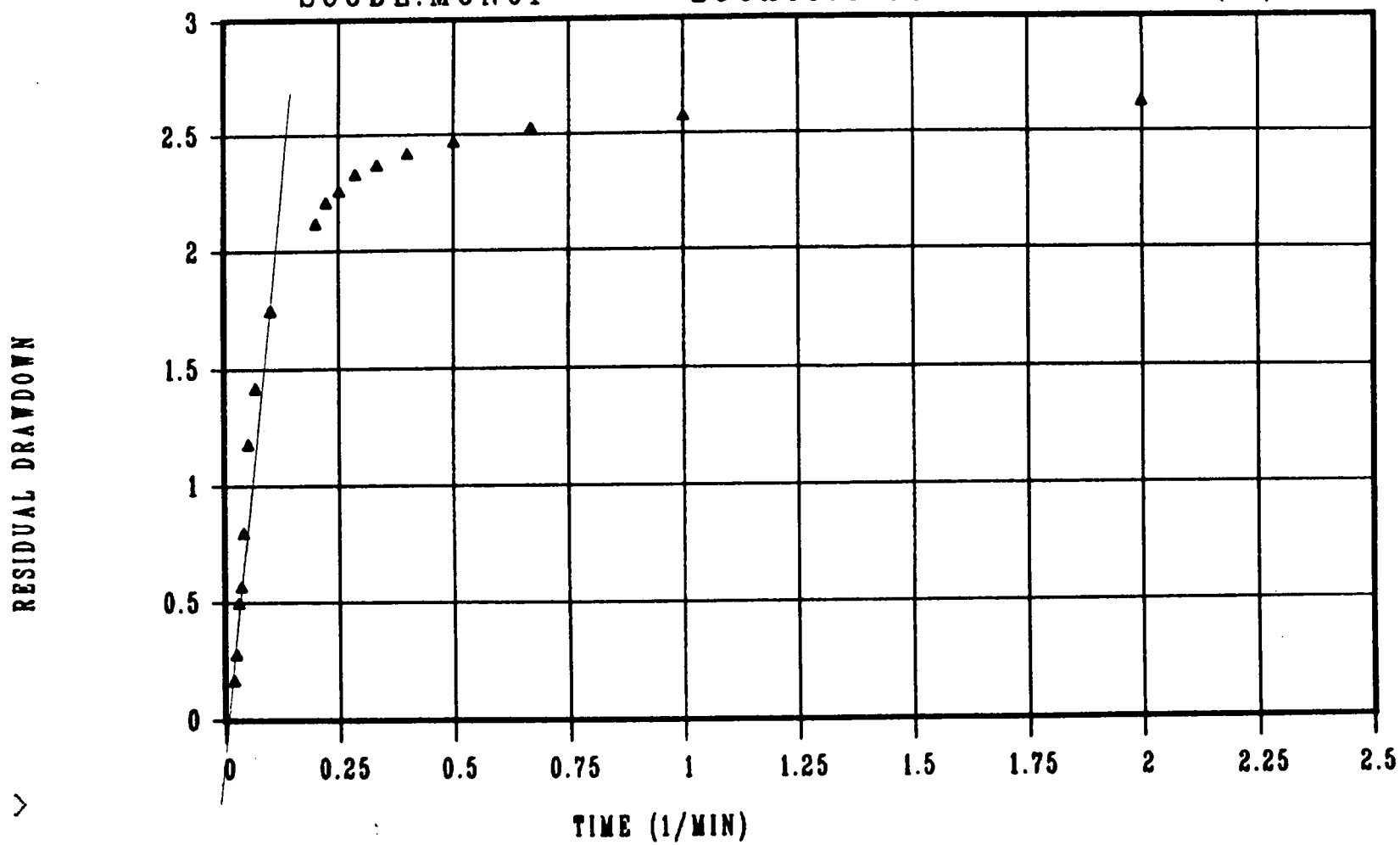
FERRIS-KNOWLES CF0019
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS CF0034
@@NOPR

UMTRA*EZPLOT ~~1428~~ 5181
UMTRA*EZPLOT ~~1429~~ 5182
UMTRA*EZPLOT ~~1430~~ 5183
UMTRA*EZPLOT ~~1431~~ 5184

105 RMP
7 of 7

FERRIS-KNOWLES SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:657 DATE:10/21/85

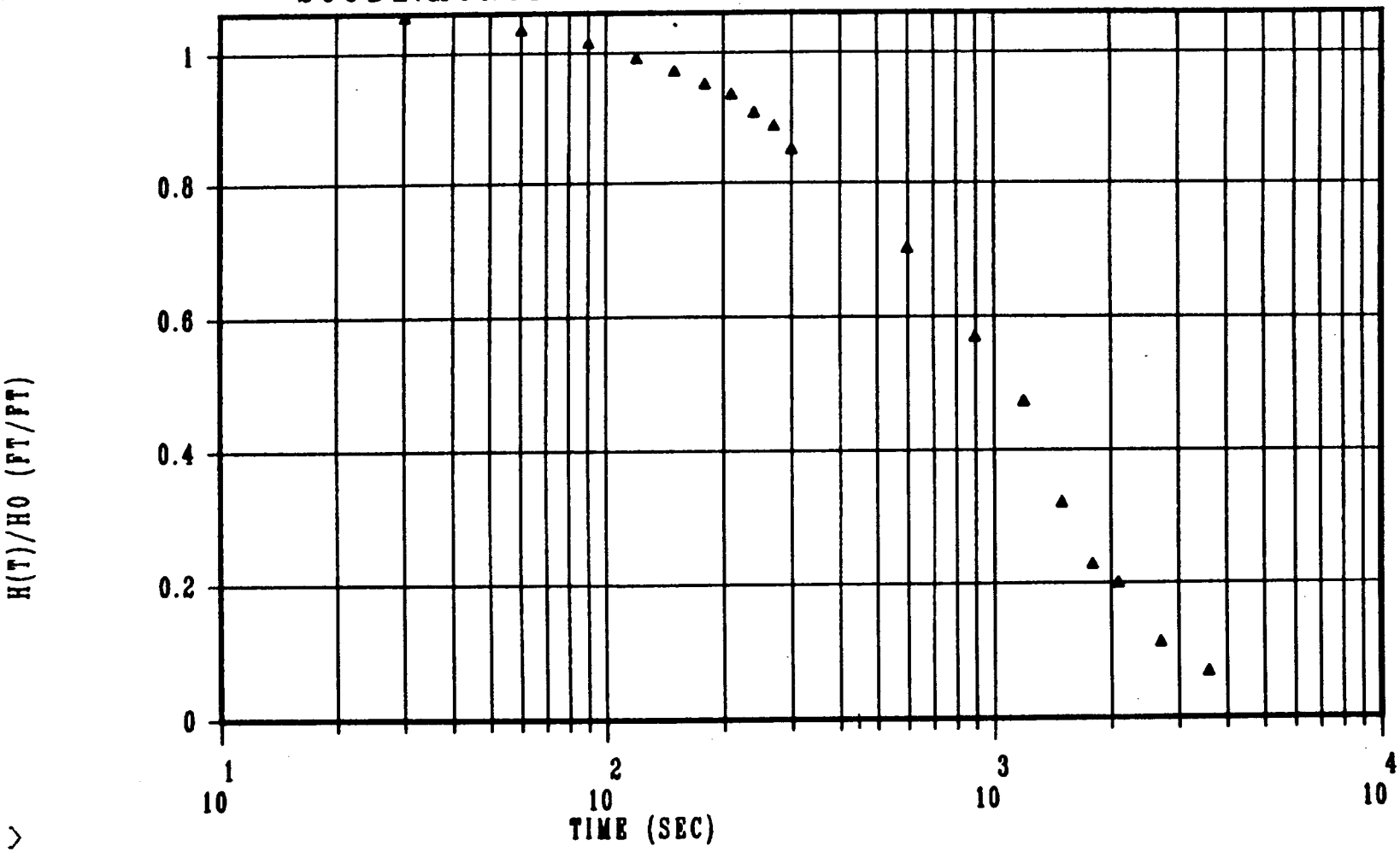


$1/t = 0.10$, $S = 1.75$ (ft)

106
RAP
7-92

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:657 DATE:10/21/85



t = 150 sec at $\frac{T t}{r_c^2} = 1$

Well 657

RAJ
7-92

```
*****************************************************************
WELL IDENTIFICATION- 657
DATE OF FIELD TEST- 10/21/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    15
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .1
DRAWDOWN (s)=  1.75
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  6.576404E-05   ft/min
*****************************************************************
```

$= 1.1 \times 10^{-6}$ ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 657
DATE OF FIELD TEST- 10/21/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    15
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .167
TIME(t)=  450
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  4.131703E-06   ft/sec
*****************************************************************
```

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

RAM 7-92

SLUG TEST DATA

SITE ID: MON 01 LOCATION ID: 658

STATIC WATER LEVEL:
DATE: 85/10/22 TIME: 1:56

SLUG VOLUME (ft.^{3}): 0.217

DEPTH (ft): 9.64

INITIAL WATER LEVEL:

OPEN INTERVAL (From TOC) 138 to 158

DATE: 85/10/21

TOTAL DEPTH OF WELL (ft): 160 (From TOC)

TIME: 1:30p

WELL DIAM. (ft): 0.333

DEPTH (ft FROM TOC): 9.61

OBSERVERS: D. Miller / W. Corder

ELAPSED TIME (MIN, SEC from t_o)	DEPTH TO WATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	9.64			
:50	7.51			
1:00	7.83			
:50	8.05			
2:00	8.30			
:50	8.46			
3:00	8.66			
:50	8.78			
4:00	8.91			
:50	8.99			
5:00	9.08			
6:00	9.24			
7:00	9.35			
8:00	9.40			
9:00	9.48			
10:00	9.50			
11:00	9.54			
12:00	9.55			
13:00	9.61			
14:00	9.63			
15:00	9.64			

COMMENTS:

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 658
DATE: 10/22/85

RAP
7-92

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT1/H0 [FT./FT.]
.00	.00000	0	9.64	.00	.0000
.50	2.00000	30	7.51	2.13	.8566
1.00	1.00000	60	7.83	1.81	.7279
1.50	.66667	90	8.05	1.59	.6394
2.00	.50000	120	8.30	1.34	.5389
2.50	.40000	150	8.46	1.18	.4745
3.00	.33333	180	8.66	.98	.3941
3.50	.28571	210	8.78	.86	.3458
4.00	.25000	240	8.91	.73	.2936
4.50	.22222	270	8.99	.65	.2614
5.00	.20000	300	9.08	.56	.2252
6.00	.16667	360	9.24	.40	.1609
7.00	.14286	420	9.35	.29	.1166
8.00	.12500	480	9.40	.24	.0965
9.00	.11111	540	9.48	.16	.0643
10.00	.10000	600	9.50	.14	.0563
11.00	.09091	660	9.54	.10	.0402
12.00	.08333	720	9.55	.09	.0362
13.00	.07692	780	9.61	.03	.0121
14.00	.07143	840	9.63	.01	.0040
15.00	.06667	900	9.64	.00	.0000

FERRIS-KNOWLES CF0015
HVORSLEV
BOWLER-RICE CF0018
COOPER, BREDHOEFT, PAPADOPULOS CF0035
@@NOPR

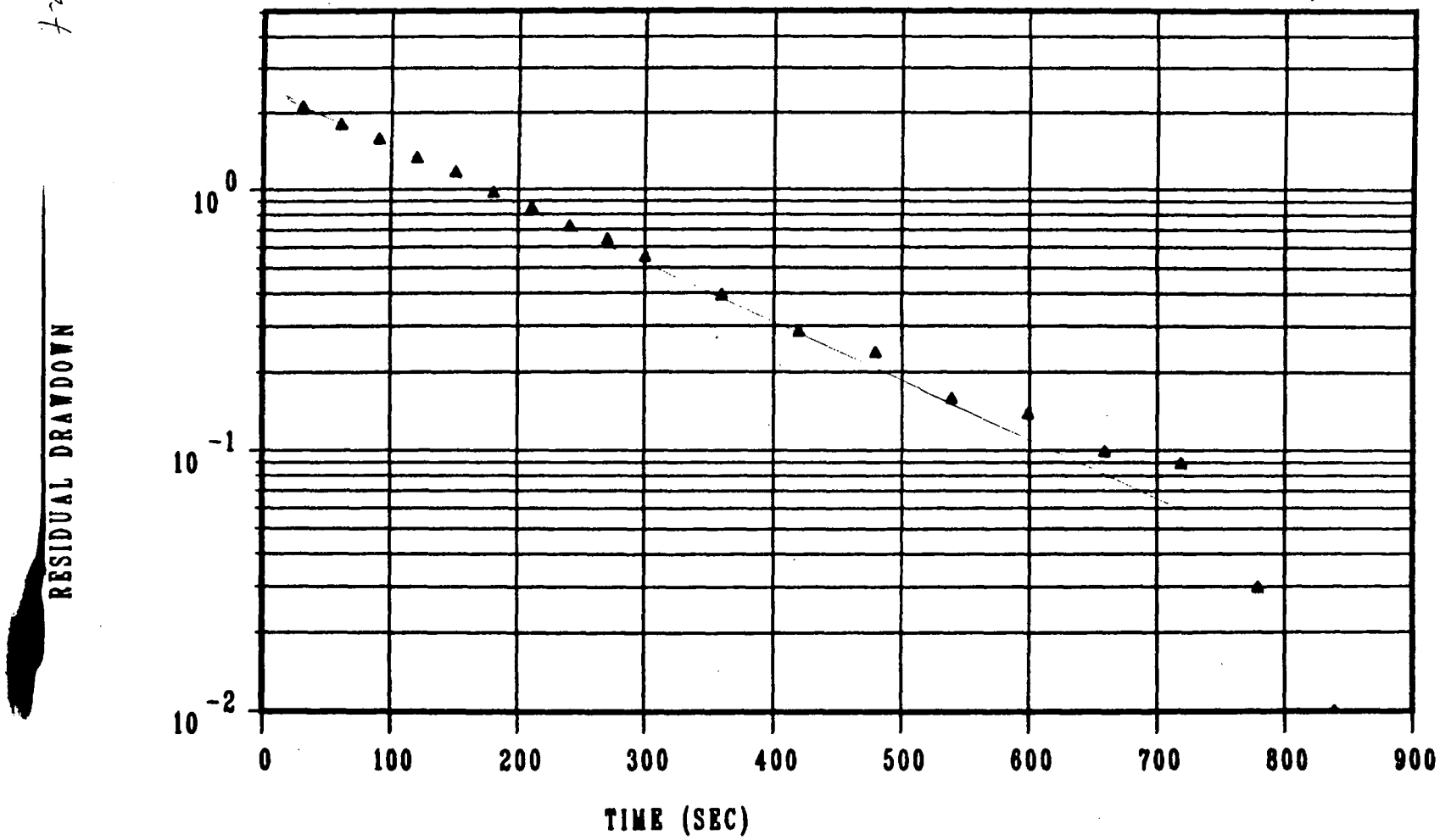
UMTRA*EZPLOT ~~1432~~ S185
UMTRA*EZPLOT ~~1433~~ S186
UMTRA*EZPLOT ~~1434~~ S187
UMTRA*EZPLOT ~~1435~~ S188

UMTRA*EZPLOT CF0018

110

BOUWER-RICE SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:658 DATE:10/22/85

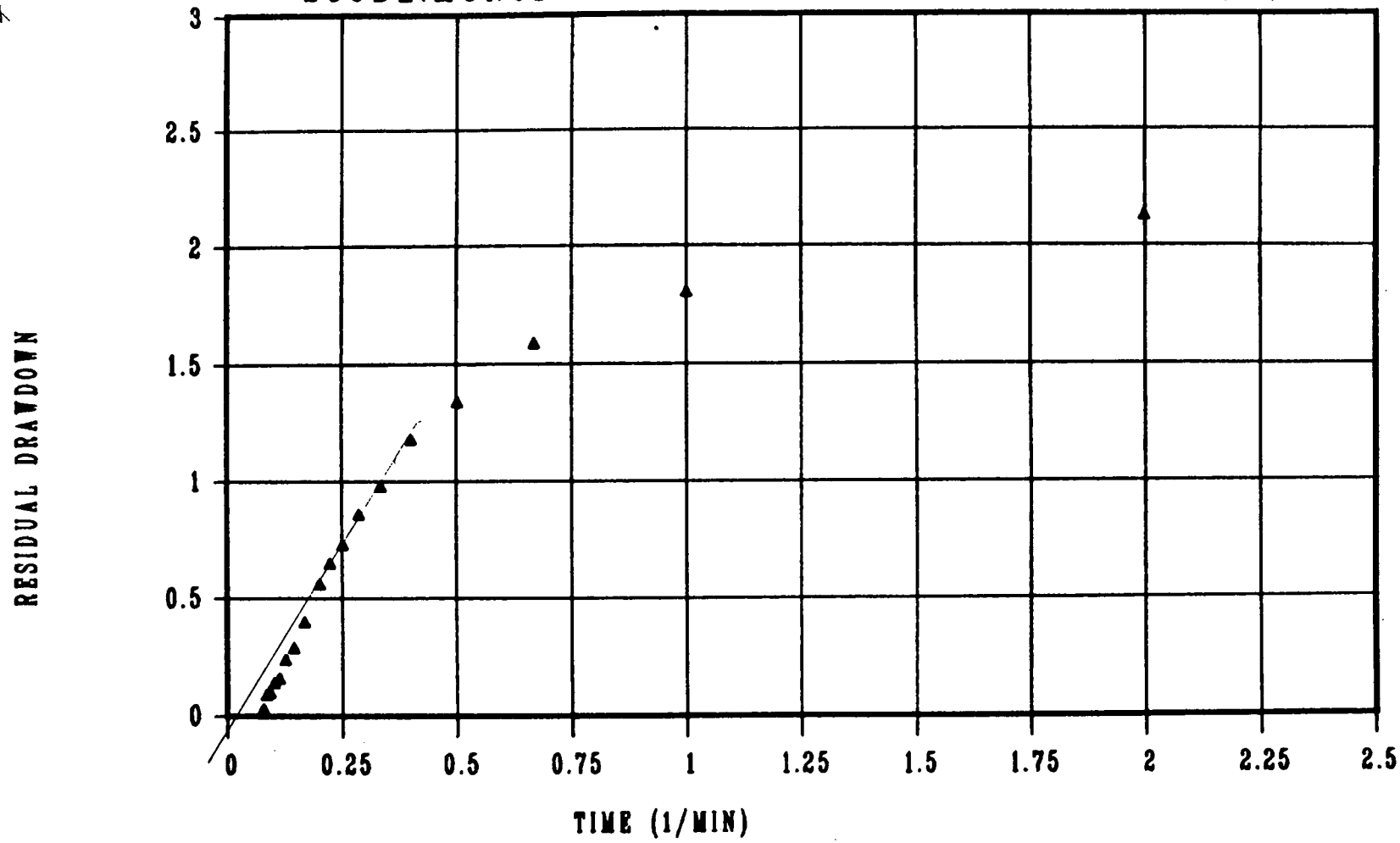


overall t = 420 sec y(t) = 0.29

111 Rdf 7-6-6

FERRIS-KNOWLES SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:658 DATE:10/22/85



T= 0.25 ft/min S= 0.73

RAP
7-92

Well 658

```
*****************************************************************
WELL IDENTIFICATION- 658
DATE OF FIELD TEST- 10/22/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .167
BOREHOLE RADIUS(Rw)=  .33
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  420
HEAD AT TIME t(Yt)=  .29
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  67
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  67
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.36471E-05   ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 658
DATE OF FIELD TEST- 10/22/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .25
DRAWDOWN (s)=  .73
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.956992E-04   ft/min
*****************************************************************
```

$= 4.93 \times 10^{-6}$ ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 658
DATE OF FIELD TEST- 10/22/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .167
TIME(t)=  60
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.324083E-05   ft/sec
*****************************************************************
```

RAP
7-92

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MON01 LOCATION ID: 659

SLUG VOLUME (ft.^{3}): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/23

TIME: 9:45

DEPTH (ft FROM TOC): 36.45

STATIC WATER LEVEL:
DATE: 85/10/26 TIME: 3:55 p.m

DEPTH (ft): 35.69

OPEN INTERVAL (ft.) 90 to 110
From TOC

TOTAL DEPTH OF WELL (ft): 112
From TOC

WELL DIAM. (ft): .333

FIELD REP: D. Miller / Fritts

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	33.44			
.5	33.69			
1.0	33.88			
1.5	34.08			
2.0	34.27			
2.5	34.41			
3.0	34.63			
3.5	34.78			
4.0	34.93			
4.5	35.01			
5.0	35.12			
6.0	35.22			
7.0	35.31			
8.0	35.37			
10.0	35.47			
14.0	35.59			
18.0	35.62			
22.0	35.65			
26.0	35.66			
30.0	35.66			

COMMENTS:

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA
SITE: MONUMENT VALLEY
LOCATION ID: 659
DATE: 10/26/85

RAP
3-92

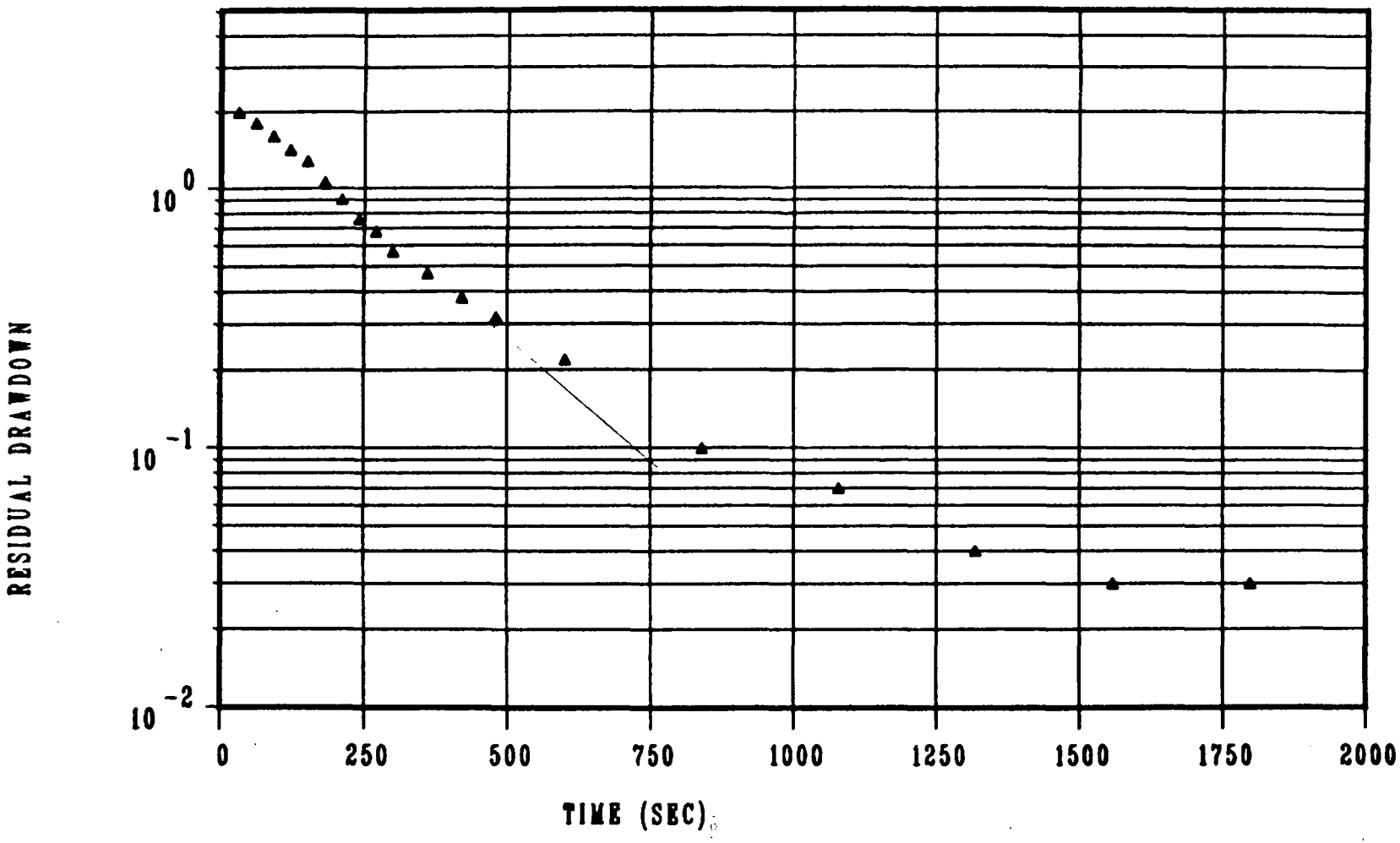
ELAPSED TIME (MIN)	(1/MIN)	(SEC)	GROUND WATER DEPTH (FT)	RESIDUAL DRAWDOWN (FT)	H(T)/H0 (FT/FT)
.00	.00000	0	~~35.69~~ 33.44	.00	.0000
.50	2.00000	30	33.69	2.00	.8046
1.00	1.00000	60	33.88	1.81	.7282
1.50	.66667	90	34.08	1.61	.6477
2.00	.50000	120	34.27	1.42	.5713
2.50	.40000	150	34.41	1.28	.5150
3.00	.33333	180	34.63	1.06	.4264
3.50	.28571	210	34.78	.91	.3661
4.00	.25000	240	34.93	.76	.3058
4.50	.22222	270	35.01	.68	.2736
5.00	.20000	300	35.12	.57	.2293
6.00	.16667	360	35.22	.47	.1891
7.00	.14286	420	35.31	.38	.1529
8.00	.12500	480	35.37	.32	.1287
10.00	.10000	600	35.47	.22	.0885
14.00	.07143	840	35.59	.10	.0402
18.00	.05556	1080	35.62	.07	.0282
22.00	.04545	1320	35.65	.04	.0161
26.00	.03846	1560	35.66	.03	.0121
30.00	.03333	1800	35.66	.03	.0121

MAPPER DATA FILE : MON01*UDPSTD100015

115
Rgd
7-96

BOUWER-RICE SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:659 DATE:10/26/85

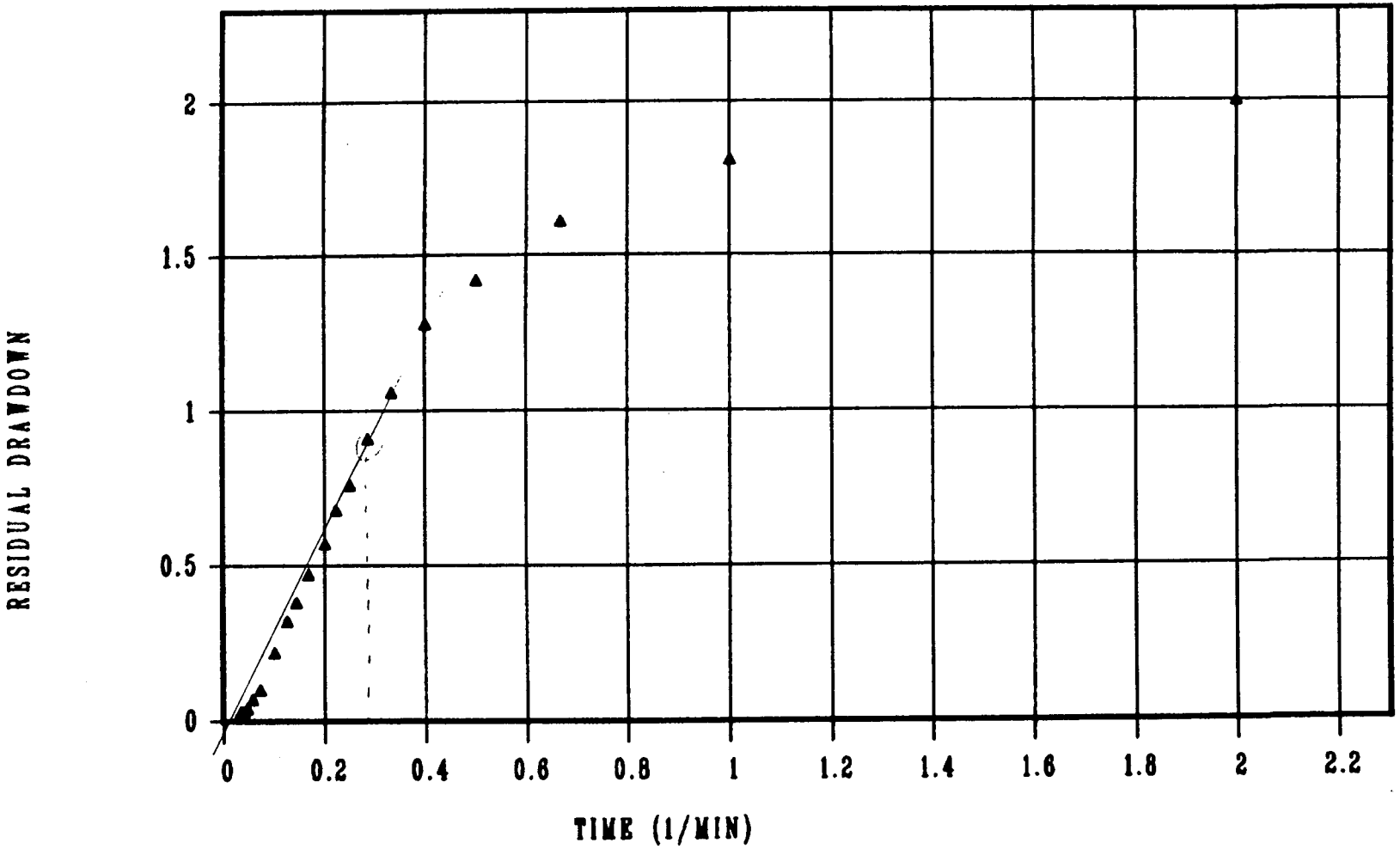


116

Rgb
7-92

FERRIS-KNOWLES SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:659 DATE:10/26/85



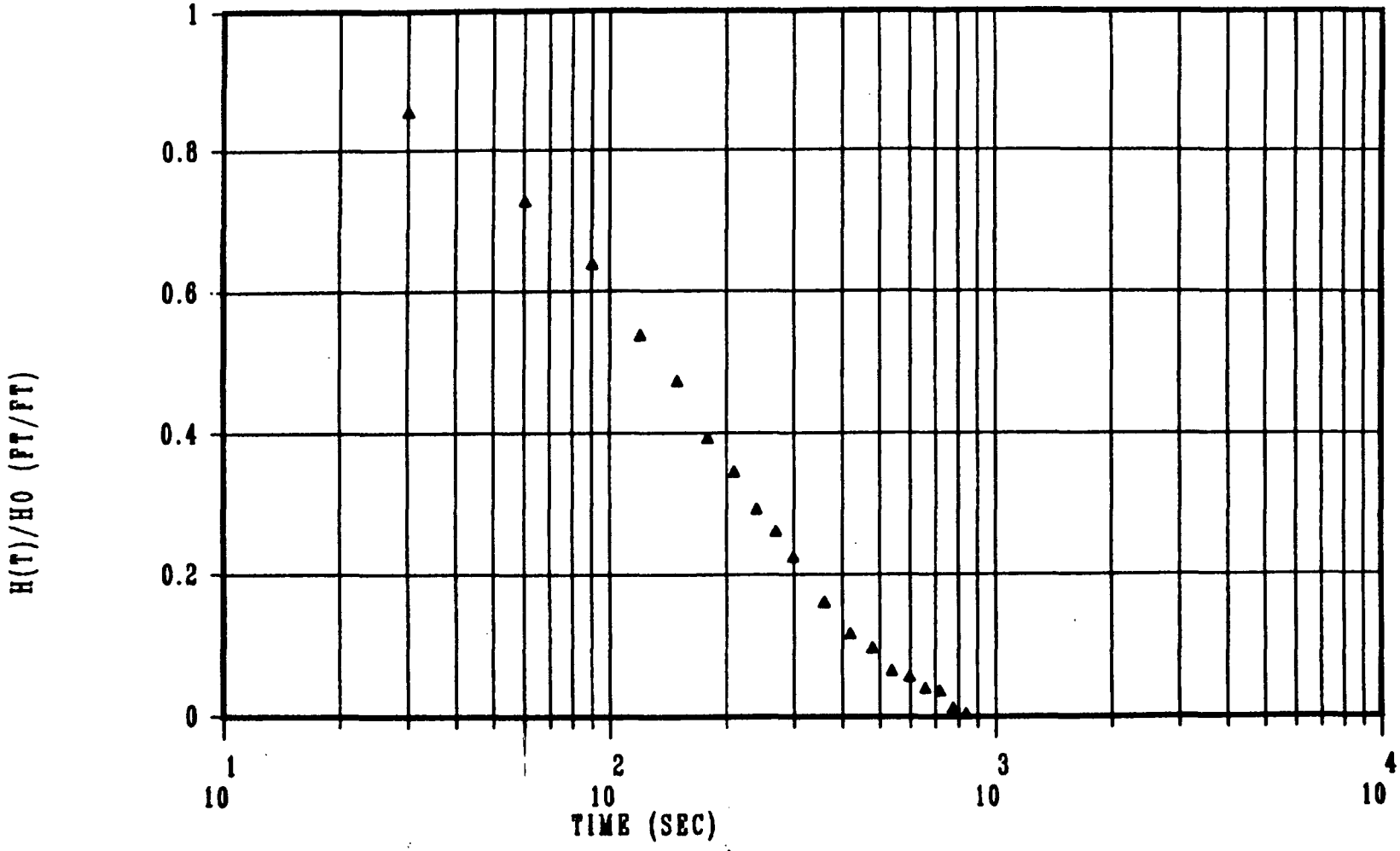
T_0 = 0.286 1/min, S = 0.91 ft

117 RMP + Mt

5

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

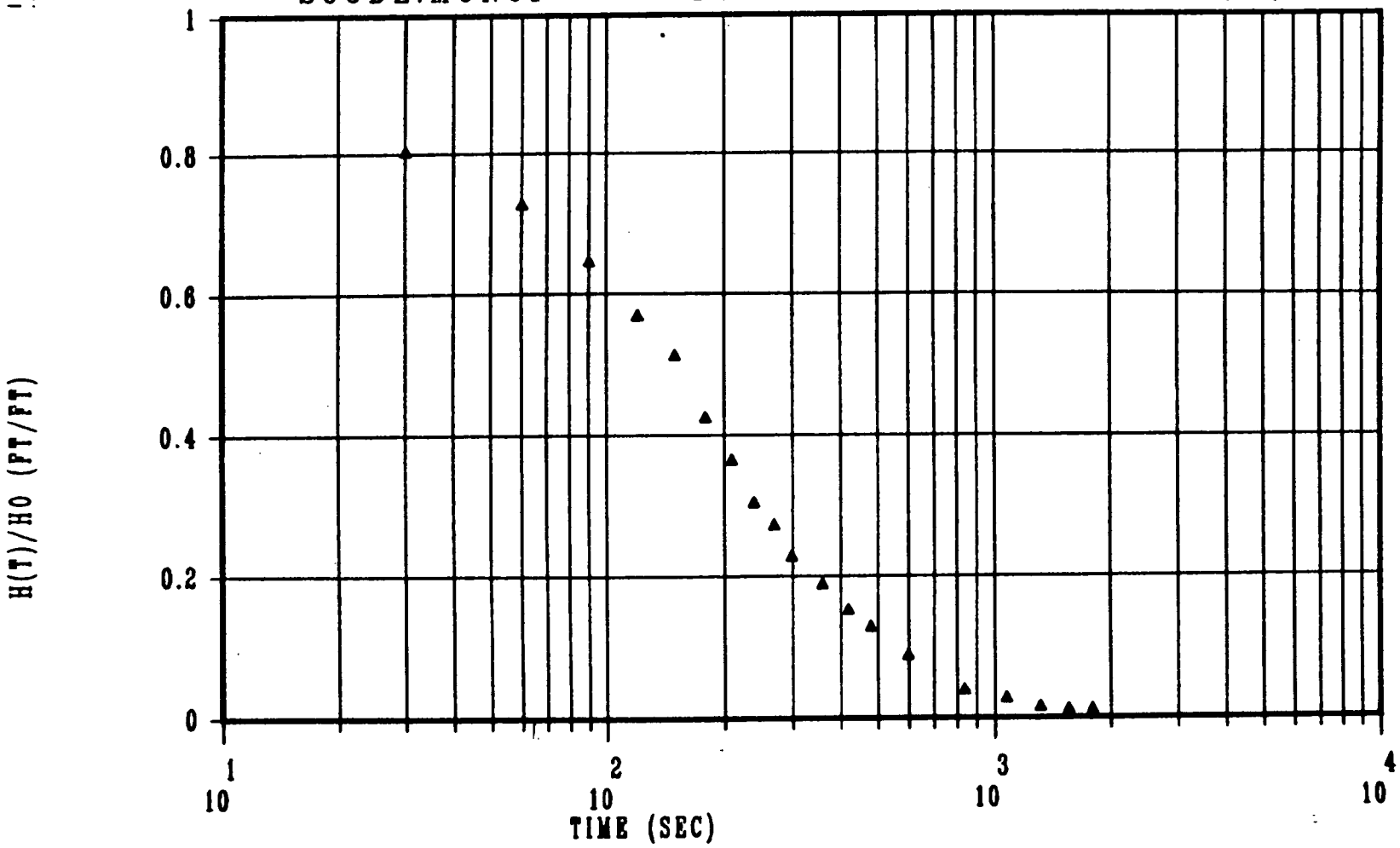
SCODE:MON01 LOCATION:658 DATE:10/22/85



t = 60 sec at T_c / r_c = 1

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:659 DATE:10/26/85



Well 659

RMP 7-92

```
*****************************************************************
WELL IDENTIFICATION- 659
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .167
BOREHOLE RADIUS(Rw)=  .33
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  420
HEAD AT TIME t(Yt)=  .38
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  70
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  70
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.201235E-05   ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 659
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .286
DRAWDOWN (s)= .091 es   0.91                    -4 e.5
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.713592E-03 ft/min
*****************************************************************
                                  = 4.52  x10^-6 ft/sec
                                          x10^-6  e.5.
```

```
*****************************************************************
WELL IDENTIFICATION- 659
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .167
TIME(t)=  65
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.145308E-05   ft/sec
*****************************************************************
```

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

RdP 7-4

SITE ID: MONØ1 LOCATION ID: 660

SLUG VOLUME (ft.³): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/26

TIME: 2:00

DEPTH (ft FROM TOC): 33.25

STATIC WATER LEVEL:
DATE: 85/10/27 TIME: 9:42

DEPTH (ft): 31.51

OPEN INTERVAL (ft.) From TOC ~~133~~ 136 to ~~158~~ 156

TOTAL DEPTH OF WELL (ft): from TOC ~~155~~ 158

WELL DIAM. (ft): .333

FIELD REP: D. Miller / S Frith

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	31.51			
:50	31.27			
1:00	31.34			
:50	31.39			
2:00	31.41			
:50	31.43			
3:00	31.43			
:50	31.46			
4:00	31.46			
:50	31.48			
5:00	31.48			
6:00	31.48			
7:00	31.48			
8:00	31.48			
9:00	31.49			
10:00	31.51			
11:00	31.51			

COMMENTS:

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 660
DATE: 10/27/85

RAP 7-92

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H(T)/H0 [FT./FT.]
.00	.00000	0	31.51	.00	.0000
.50	2.00000	30	31.27	.24	.0965
1.00	1.00000	60	31.34	.17	.0684
1.50	.66667	90	31.39	.12	.0483
2.00	.50000	120	31.41	.10	.0402
2.50	.40000	150	31.43	.08	.0322
3.00	.33333	180	31.43	.08	.0322
3.50	.28571	210	31.46	.05	.0201
4.00	.25000	240	31.46	.05	.0201
4.50	.22222	270	31.48	.03	.0121
5.00	.20000	300	31.48	.03	.0121
6.00	.16667	360	31.48	.03	.0121
7.00	.14286	420	31.48	.03	.0121
8.00	.12500	480	31.48	.03	.0121
9.00	.11111	540	31.49	.02	.0080
10.00	.10000	600	31.51	.00	.0000
11.00	.09091	660	31.51	.00	.0000

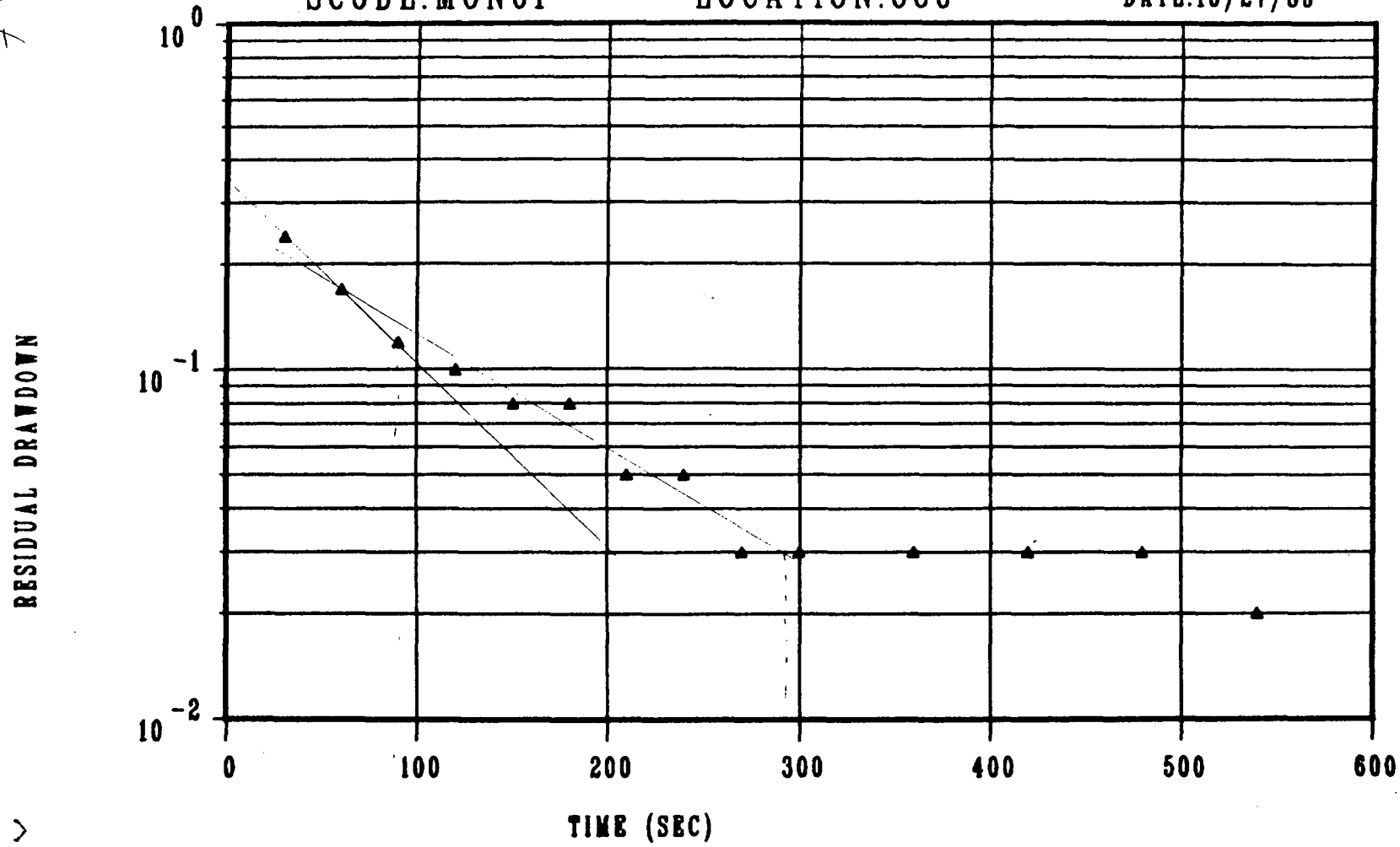
FERRIS-KNOWLES CF0024
HVORSLEV
BOWLER-RICE CF0025
COOPER, BREDHOEFT, PAPADOPULOS CF00 37
@@NOPR

UMTRA*EZPLOTH~~440~~ S193
UMTRA*EZPLOTH~~441~~ S194
UMTRA*EZPLOTH~~442~~ S195
UMTRA*EZPLOTH~~443~~ S196

122
R 9/1
7-9d

BOUWER-RICE SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:660 DATE:10/27/85



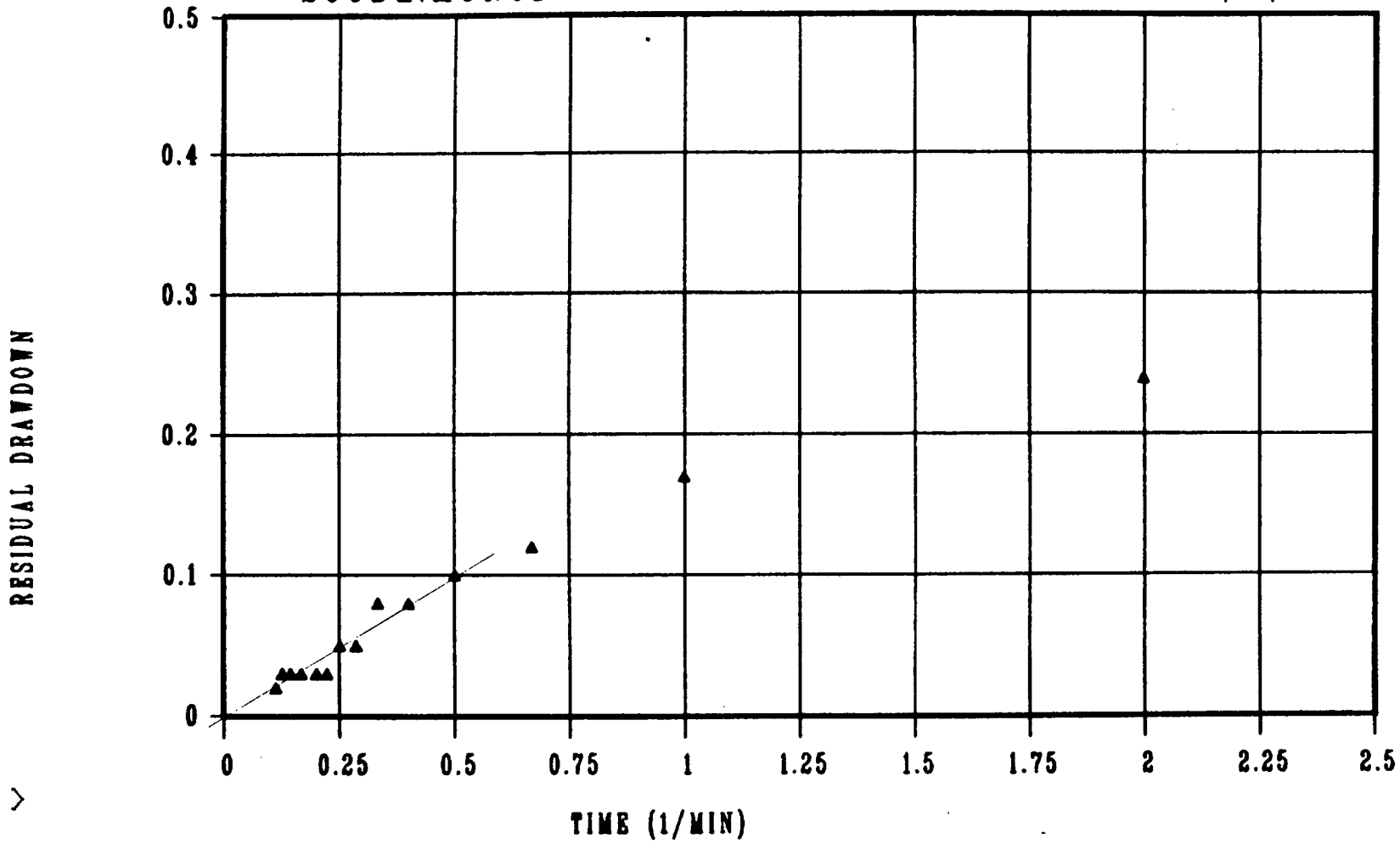
early time t = 90 sec y(t) = 0.12

Overall t = 290 sec y(t) = 0.03

123

FERRIS-KNOWLES SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:660 DATE:10/27/85



t=0.5 1/m, S=0.10ft

RJJ
7-92

Well 660

```
*****************************************************************
WELL IDENTIFICATION- 660
DATE OF FIELD TEST- 10/27/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .5
DRAWDOWN (s)=  .1
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  4.317077E-03   ft/min
*****************************************************************
```

$= 7.18 \times 10^{-5}$ ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 660
DATE OF FIELD TEST- 10/27/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
BOULTON-PRICE METHOD
FOR WELL RADIUS(Rc)=  .167
BOREHOLE RADIUS(Rw)=  .33
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  90
HEAD AT TIME t(Yt)=  .12
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  90
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  90
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  9.366776E-05
*****************************************************************
```

RAP 25

7-12

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MON #1 LOCATION ID: 661

SLUG VOLUME (ft.^{3}): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/28

TIME: 10:00 A

DEPTH (ft FROM TOC): 164.20

STATIC WATER LEVEL:

DATE: 85/10/28 TIME: 6:10 p.m

DEPTH (ft): 163.73

OPEN INTERVAL (ft.) 193 to 213
From TOC

TOTAL DEPTH OF WELL (ft): 215
from TOC

WELL DIAM. (ft): .333

FIELD REP: D. Miller / J. Fritts

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
.00	163.73			
.5	—			
1.0	161.30			
.5	161.47			
2.0	161.54			
.5	161.60			
3.0	161.65			
.5	161.70			
4.0	161.78			
.5	161.85			
5.0	161.94			
6.0	162.01			
7.0	162.08			
8.0	162.14			
10.0	162.28			
12.0	162.42			
16.0	162.54			
20.0	162.68			
25.0	162.74			
30.0	162.80			

COMMENTS: page 1 of 2

JEG-AL-ENG-8 (3/84)

RAP 7-4J

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Mon01 LOCATION ID: 661

SLUG VOLUME (ft.^{3}): _____

INITIAL WATER LEVEL (AT t_o):

DATE: _____

TIME: _____

DEPTH (ft FROM TOC): _____

STATIC WATER LEVEL:
DATE: 85/10/28 TIME: _____

DEPTH (ft): 163.73

OPEN INTERVAL (ft.) _____ to _____

TOTAL DEPTH OF WELL (ft): _____

WELL DIAM. (ft): _____

FIELD REP: Fritts/Miller

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
35.0	162.89			
45.0	162.92			
60.0	162.99			

COMMENTS: page 2 of 2

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

RMP
7-92

SITE: MON01 MONUMENT VALLEY
LOCATION: 661
DATE: 10/28/85

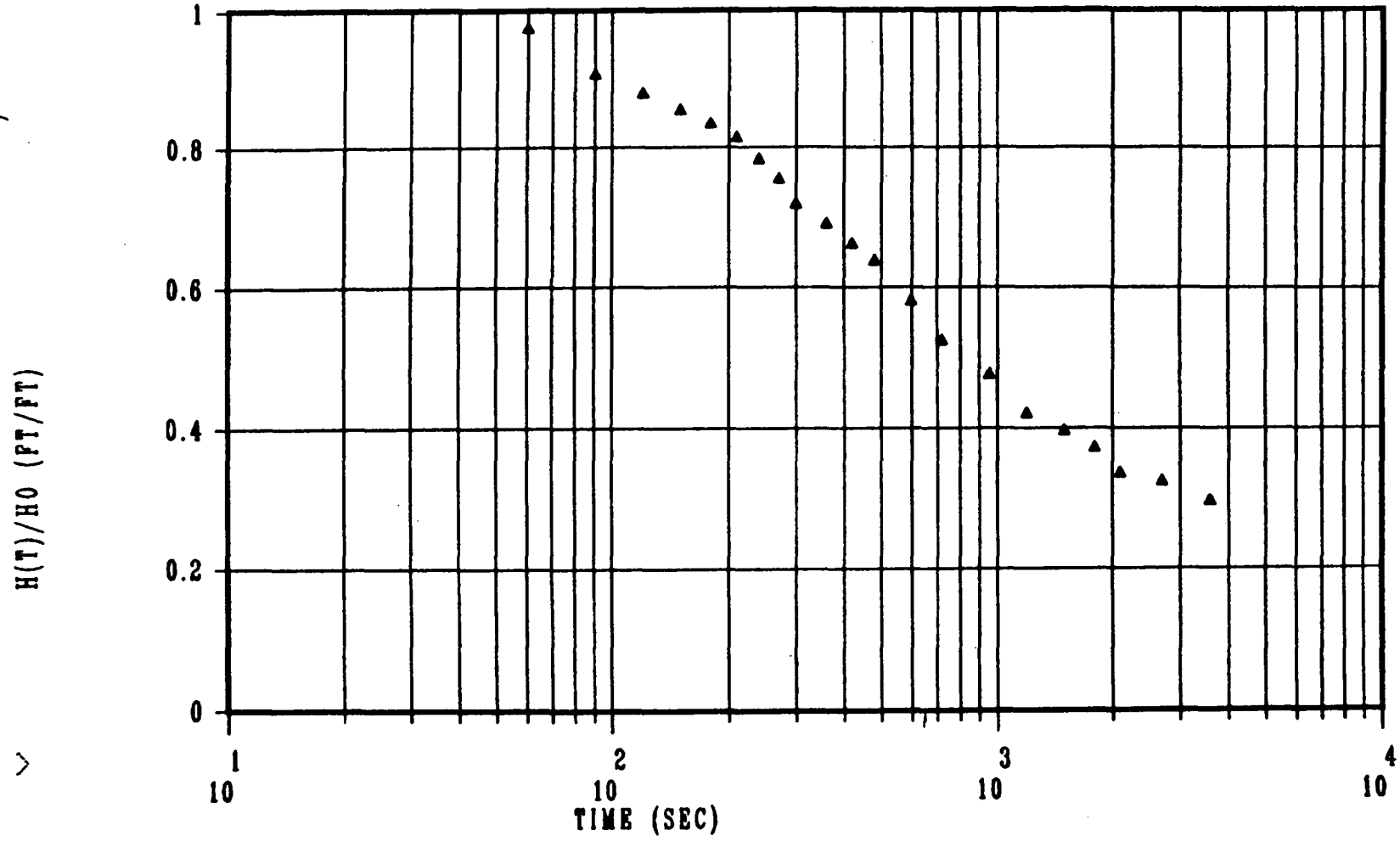
---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT1/H0 [FT./FT.]
.00	.00000	0	163.73	.00	.0000
1.00	1.00000	60	161.30	2.43	.9772
1.50	.66667	90	161.47	2.26	.9089
2.00	.50000	120	161.54	2.19	.8807
2.50	.40000	150	161.60	2.13	.8566
3.00	.33333	180	161.65	2.08	.8365
3.50	.28571	210	161.70	2.03	.8164
4.00	.25000	240	161.78	1.95	.7842
4.50	.22222	270	161.85	1.88	.7560
5.00	.20000	300	161.94	1.79	.7198
6.00	.16667	360	162.01	1.72	.6917
7.00	.14286	420	162.08	1.65	.6635
8.00	.12500	480	162.14	1.59	.6394
10.00	.10000	600	162.28	1.45	.5831
12.00	.08333	720	162.42	1.31	.5268
16.00	.06250	960	162.54	1.19	.4786
20.00	.05000	1200	162.68	1.05	.4223
25.00	.04000	1500	162.74	.99	.3981
30.00	.03333	1800	162.80	.93	.3740
35.00	.02857	2100	162.89	.84	.3378
45.00	.02222	2700	162.92	.81	.3257
60.00	.01667	3600	162.99	.74	.2976

FERRIS-KNOWLES CF0039
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS CF0038
@@NOPR

UMTRA*EZPLOT~~H444~~ 5197
UMTRA*EZPLOT~~H445~~ 5198
UMTRA*EZPLOT~~H446~~ 5199
UMTRA*EZPLOT~~H447~~ 5236

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:661 DATE:10/28/85



T = .50 sec @ $\frac{T_c}{r_c^2} = 1$

Well 661

RAM
7-92

```
*****************************************************************
WELL IDENTIFICATION- 661
DATE OF FIELD TEST- 10/28/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .167
TIME(t)=  650
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.145328E-06    ft/sec
*****************************************************************
```

R9
7-4

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

NOV

SLUG TEST DATA

SITE ID: MONU1 LOCATION ID: 662

SLUG VOLUME (ft.^{3}): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/19

TIME: 2:00 p

DEPTH (ft FROM TOC): 51.50

STATIC WATER LEVEL:

DATE: 85/10/22 TIME: 10:30

DEPTH (ft): 50.88

OPEN INTERVAL (ft.) 40 to 71
From TOC

TOTAL DEPTH OF WELL (ft): 73.00'
from TOC

WELL DIAM. (ft): .333

FIELD REP: D. Miller

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	50.88			
:50	50.00			
1:00	50.20			
:50	50.36			
2:00	50.48			
:50	50.58			
3:00	50.68			
:50	50.76			
4:00	50.76			
:50	50.78			
5:00	50.78			
6:00	50.80			
7:00	50.82			
8:00	50.83			
9:00	50.83			
10:00	50.85			
15:00	50.88			
20:00	50.88			

COMMENTS:

JEG-AL-ENG-8 (3/84)

RAP
7-92

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 662
DATE: 10/22/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	50.88	.00	.0000
.50	2.00000	30	50.00	.88	.3539
1.00	1.00000	60	50.20	.68	.2735
1.50	.66667	90	50.36	.52	.2091
2.00	.50000	120	50.48	.40	.1609
2.50	.40000	150	50.58	.30	.1206
3.00	.33333	180	50.68	.20	.0804
3.50	.28571	210	50.76	.12	.0483
4.00	.25000	240	50.76	.12	.0483
4.50	.22222	270	50.78	.10	.0402
5.00	.20000	300	50.78	.10	.0402
6.00	.16667	360	50.80	.08	.0322
7.00	.14286	420	50.82	.06	.0241
8.00	.12500	480	50.83	.05	.0201
9.00	.11111	540	50.83	.05	.0201
10.00	.10000	600	50.85	.03	.0121
15.00	.06667	900	50.88	.00	.0000
20.00	.05000	1200	50.88	.00	.0000

FERRIS-KNOWLES
HVORSLEV CF0040
BOWLER-RICE CF0041
COOPER, BREDHOEFT, PAPADOPULOS
@@NOPR

UMTRA*EZPLOT~~H446~~ S237
UMTRA*EZPLOT~~H447~~ S238
UMTRA*EZPLOT~~H450~~ S239
UMTRA*EZPLOT~~H451~~ S240

Pap 7-4J

Well 662

```
*****************************************************************
WELL IDENTIFICATION- 662
DATE OF FIELD TEST- 10/22/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    30
BOUWER-RICE METHOD
FOR WELL RADIUS(Rc)=  .167
BOREHOLE RADIUS(Rw)=  .33
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  120
HEAD AT TIME t(Yt)=  .4
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)=  22.12
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  61.66
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.0166165-05  ft/sec
*****************************************************************
```

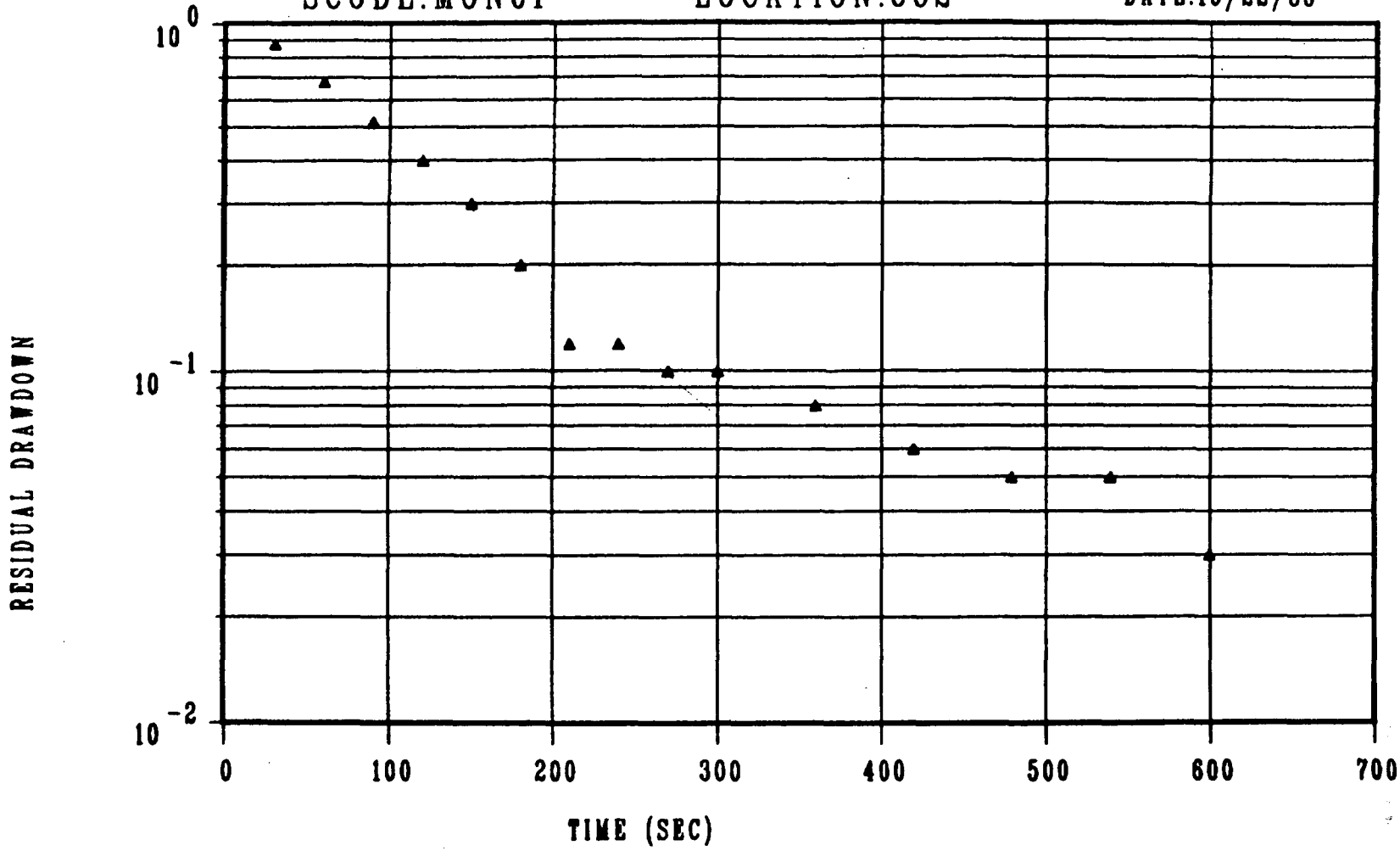
```
*****************************************************************
WELL IDENTIFICATION- 662
DATE OF FIELD TEST- 10/22/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    30
HVORSLEV METHOD
FOR WELL RADIUS(r)=  .167
BOREHOLE RADIUS(R)=  .33
AND TIME LAG(To)=  1.2
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.746882E-03  ft/min
*****************************************************************
```

$= 2.90 \times 10^{-5}$ ft/sec

133
RAP
7-96

BOUWER-RICE SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:662 DATE:10/22/85

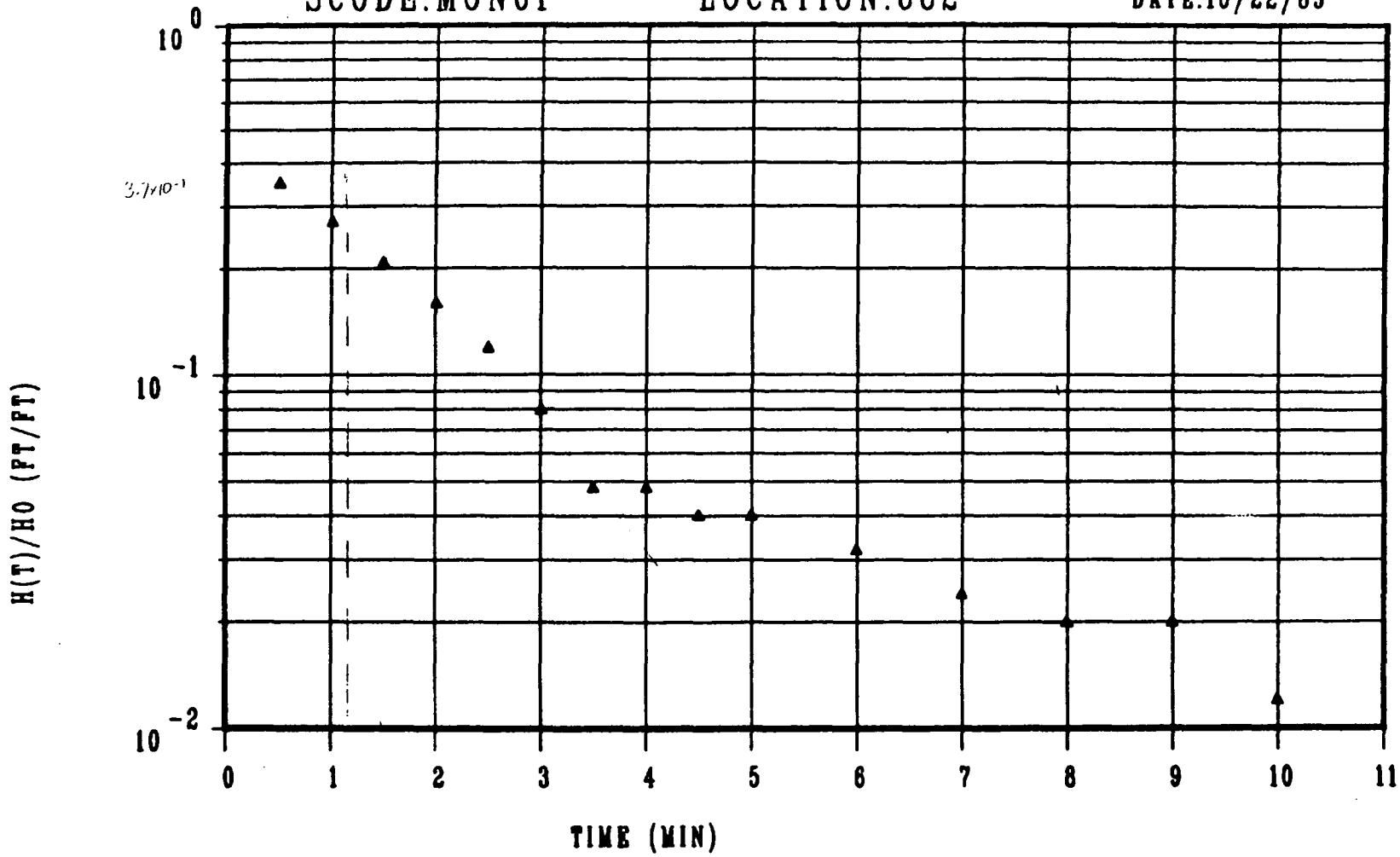


t = 1.0 sec y(t) = 0.40 ft

134

HVORSLEV SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:662 DATE:10/22/85



RAP 7-42

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MONØI LOCATION ID: 663

SLUG VOLUME (ft.³): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/20

TIME: 10:15a

DEPTH (ft FROM TOC): 33.15

STATIC WATER LEVEL:
DATE: 85/10/24 TIME: 7:45p

DEPTH (ft): 32.95

OPEN INTERVAL (ft.) ~~220~~ 180 to 220
From TOC

TOTAL DEPTH OF WELL (ft): 222
From TOC

WELL DIAM. (ft): .333

FIELD REP: D. Miller

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	32.95			
:50	30.31			
1:00	30.33			
:50	30.36			
2:00	30.39			
:50	30.39			
3:00	30.39			
:50	30.39			
4:00	30.43			
:50	30.49			
5:00	30.49			
10:00	30.63			
15:00	30.77			
30:00	31.08			
60:00	31.54			

COMMENTS:

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 663
DATE: 10/24/85

RAP 7-92

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	H[T]/H0 [FT./FT.]
.00	.00000	0	32.95	.00	.0000
.50	2.00000	30	30.31	2.64	1.0617
1.00	1.00000	60	30.33	2.62	1.0536
1.50	.66667	90	30.36	2.59	1.0416
2.00	.50000	120	30.39	2.56	1.0295
2.50	.40000	150	30.39	2.56	1.0295
3.00	.33333	180	30.39	2.56	1.0295
3.50	.28571	210	30.39	2.56	1.0295
4.00	.25000	240	30.43	2.52	1.0134
4.50	.22222	270	30.49	2.46	.9893
5.00	.20000	300	30.49	2.46	.9893
10.00	.10000	600	30.63	2.32	.9330
15.00	.06667	900	30.77	2.18	.8767
30.00	.03333	1800	31.08	1.87	.7520
60.00	.01667	3600	31.54	1.41	.5670

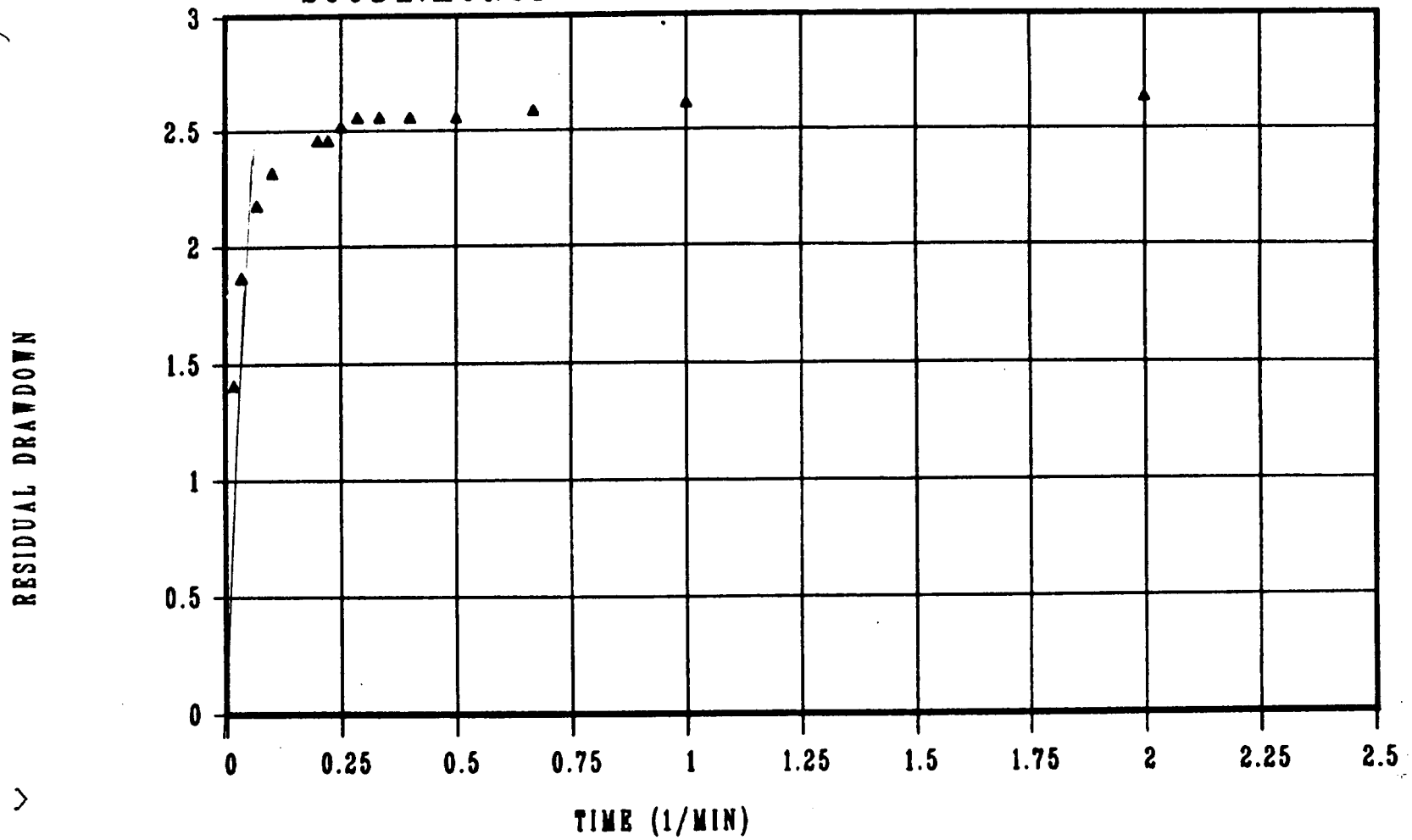
FERRIS-KNOWLES CF0042
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS CF0043
@@NOPR

UMTRA*EZPLOTU~~452~~ S241
UMTRA*EZPLOTH~~453~~ S242
UMTRA*EZPLOTH~~454~~ S243
UMTRA*EZPLOTH~~455~~ S244

137 Rapf 7-92

FERRIS-KNOWLES SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:663 DATE:10/24/85



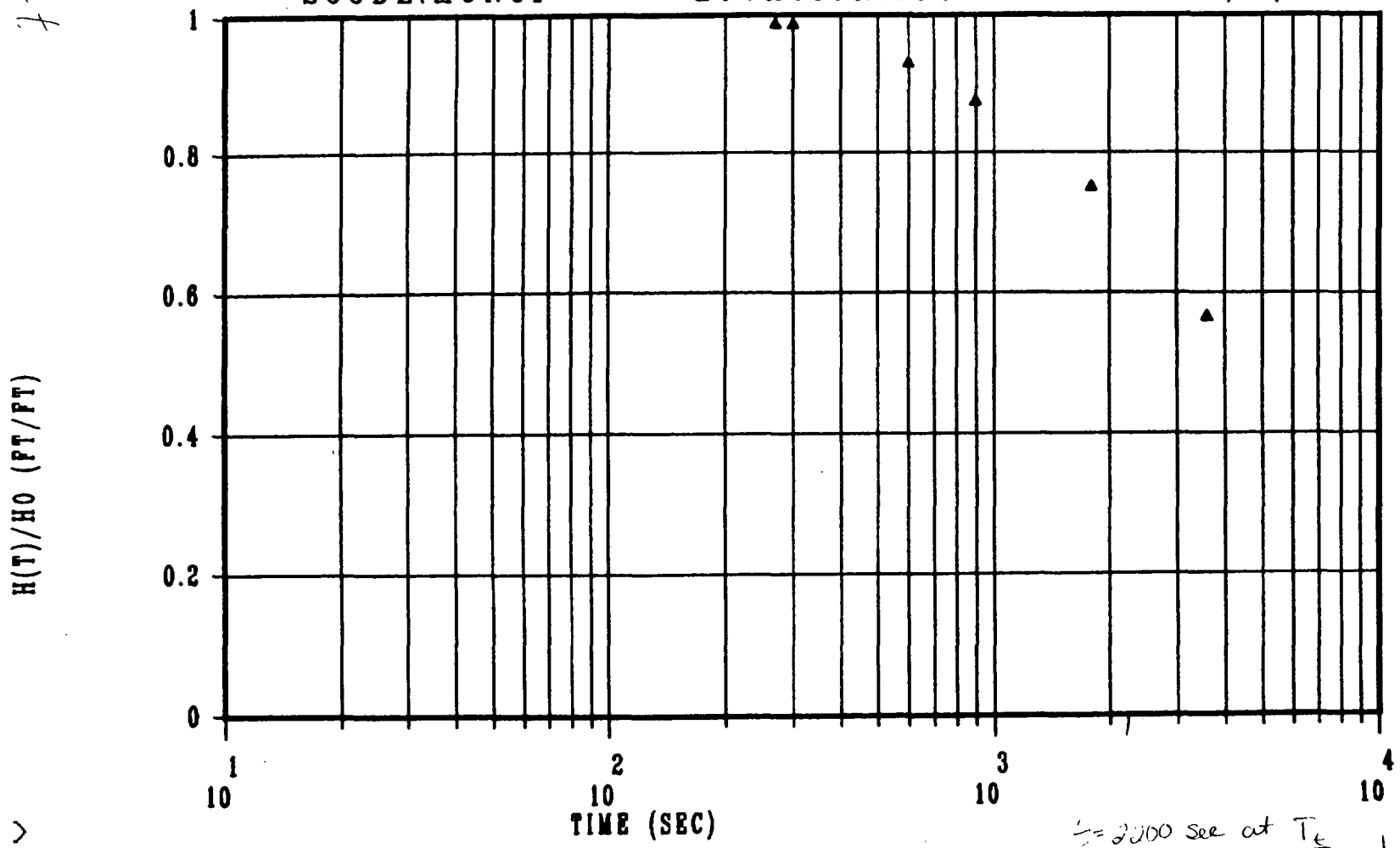
t = 0.067 1/min y(0) = 2.3 ft

138

R91P
7-91

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:663 DATE:10/24/85



$t = 2000$ sec at $\frac{T_t}{r_c^2} = 1$

RAP
I-92

Well 663

```
*****************************************************************
WELL IDENTIFICATION- 663
DATE OF FIELD TEST- 10/24/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    40
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .067
DRAWDOWN (s)=  2.3
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.257564E-05 ft/min
*****************************************************************
```

$= 2.10 \times 10^{-7}$ ft/sec

```
*****************************************************************
WELL IDENTIFICATION- 663
DATE OF FIELD TEST- 10/24/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    40
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .167
TIME(t)=  2200
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.169204E-07 ft/sec
*****************************************************************
```

RGD 7-90

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: MON01 LOCATION ID: 664

SLUG VOLUME (ft.³): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/27

TIME: 8:45

DEPTH (ft FROM TOC): 30.75

STATIC WATER LEVEL:

DATE: 85/10/27 TIME: 2:25p

DEPTH (ft): 30.12

OPEN INTERVAL (ft.) ~~210~~ 214 to ~~230~~ 234
From TOC

TOTAL DEPTH OF WELL (ft): ~~233~~ 236
From TOC

WELL DIAM. (ft): .333

FIELD REP: Frith/ Miller

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	30.12			
.5	28.16			
1.0	28.45			
.5	28.72			
2.0	28.96			
.5	29.18			
3.0	29.37			
.5	29.48			
4.0	29.61			
.5	29.71			
5.0	29.78			
6.0	29.86			
7.0	29.93			
8.0	29.97			
9.0	30.00			
10.0	30.03			
12.0	30.07			
15.0	30.07			
20.0	30.09			
25.0	30.10			

COMMENTS:

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

SITE: MON01 MONUMENT VALLEY
LOCATION: 664
DATE: 10/27/85

RAP
7-92

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT)/HO [FT./FT.]
.00	.00000	0	30.12	.00	.0000
.50	2.00000	30	28.16	1.96	.7882
1.00	1.00000	60	28.45	1.67	.6716
1.50	.66667	90	28.72	1.40	.5630
2.00	.50000	120	28.96	1.16	.4665
2.50	.40000	150	29.18	.94	.3780
3.00	.33333	180	29.37	.75	.3016
3.50	.28571	210	29.48	.64	.2574
4.00	.25000	240	29.61	.51	.2051
4.50	.22222	270	29.71	.41	.1649
5.00	.20000	300	29.78	.34	.1367
6.00	.16667	360	29.86	.26	.1046
7.00	.14286	420	29.93	.19	.0764
8.00	.12500	480	29.97	.15	.0603
9.00	.11111	540	30.00	.12	.0483
10.00	.10000	600	30.03	.09	.0362
12.00	.08333	720	30.07	.05	.0201
15.00	.06667	900	30.07	.05	.0201
20.00	.05000	1200	30.09	.03	.0121
25.00	.04000	1500	30.10	.02	.0080

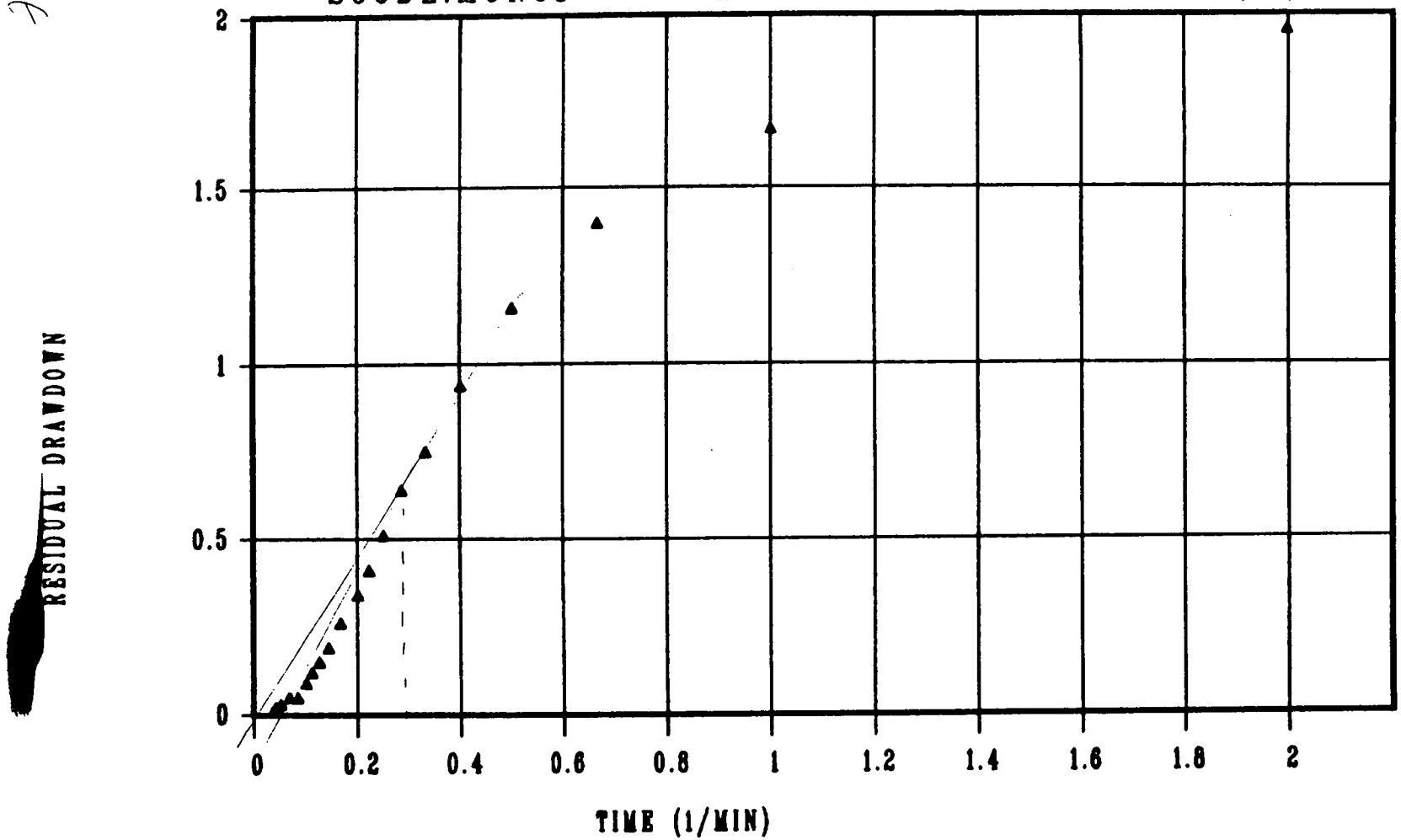
FERRIS-KNOWLES CF0044
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS CF0045
@@NOPR

UMTRA*EZPLOT ~~1456~~ S245
UMTRA*EZPLOT ~~1457~~ S246
UMTRA*EZPLOT ~~1458~~ S247
UMTRA*EZPLOT ~~1459~~ S248

142
Rdd
2-Pt

FERRIS-KNOWLES SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:664 DATE:10/27/85

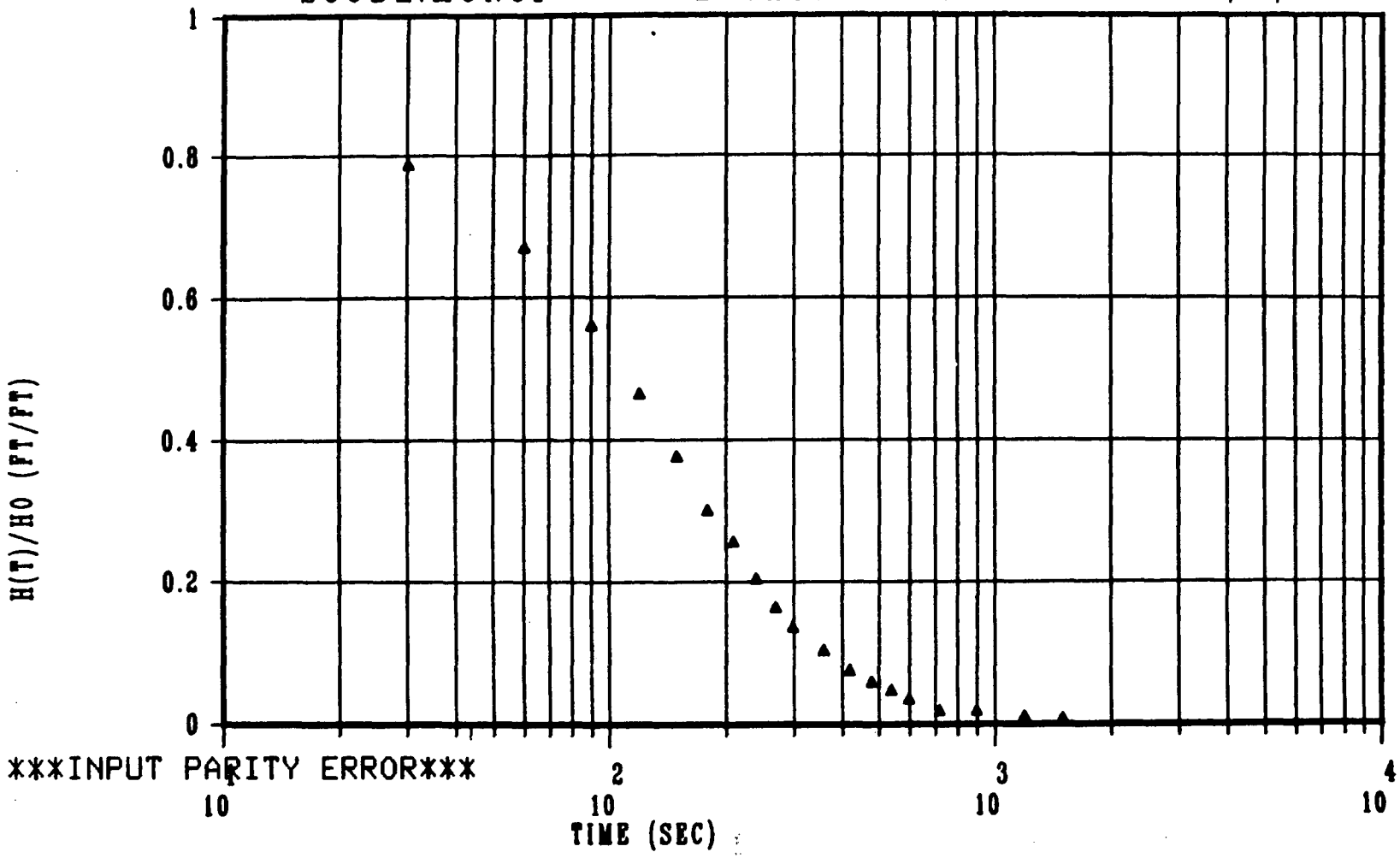


T= 0.286 ft/m S= 0.64 ft

143

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:664 DATE:10/27/85



INPUT PARITY ERROR

>

t = [illegible] sec at $\frac{Tt}{r_c^2} = 1$

Well 664

RPP
7-91

```
*****************************************************************
WELL IDENTIFICATION- 664
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .167
TIME(t)=  43
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.242907E-05  ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 664
DATE OF FIELD TEST- 10/27/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .286
DRAWDOWN (s)=  .64
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  3.658368E-04  ft/min
*****************************************************************
```

$= 5.97 \times 10^{-6}$ ft/sec

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

RAP 7-42

SLUG TEST DATA

SITE ID: Mon Ø1 LOCATION ID: 668

SLUG VOLUME (ft.³): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/28

TIME: 1:00p

DEPTH (ft FROM TOC): 41.30

STATIC WATER LEVEL:

DATE: 85/10/26 TIME: 12:15p

DEPTH (ft): 40.91

OPEN INTERVAL (ft.) 182.5 to 202.5
From TOC

TOTAL DEPTH OF WELL (ft): 217.5
From TOC

WELL DIAM. (ft): .33

FIELD REP: Fritts

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
100	40.91			
.5	38.18			
1.0	38.25			
1.5	38.38			
2.5	38.41			
3.0	38.48			
3.5	38.50			
4.0	38.58			
4.5	38.61			
5.0	38.66			
6.0	38.73			
7.0	38.81			
8.0	38.85			
10.0	38.98			
12.0	39.07			
14.0	39.17			
16.0	39.25			
20.0	39.40			
24.0	39.55			
28.0	39.67			

COMMENTS: Page 1 of 2

JEG-AL-ENG-8 (3/84)

nap
7-92

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Mon 01 LOCATION ID: 668

STATIC WATER LEVEL:
DATE: 85/10/26 TIME:

SLUG VOLUME (ft.^{3}):

DEPTH (ft):

INITIAL WATER LEVEL (AT t_0):

OPEN INTERVAL (ft.) to

DATE:

TOTAL DEPTH OF WELL (ft):

TIME:

WELL DIAM. (ft):

DEPTH (ft FROM TOC):

FIELD REP:

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
32.0	39.79			
36.0	39.85			
40.0	39.95			
45.0	40.00			
50.0	40.07			
55.0	40.11			
60.0	40.15			
100.0	40.26			
150.0	40.33			

1:20

COMMENTS: Page 2 of 2

JEG-AL-ENG-8 (3/84)

SLUG TEST DATA

RAP
7-92

SITE: MON01 MONUMENT VALLEY
LOCATION: 668
DATE: 10/26/85

---- ELAPSED TIME ---- [MIN]	[1/MIN]	[SEC]	GROUND WATER DEPTH [FT.]	RESIDUAL DRAWDOWN [FT.]	HCT1/H0 [FT./FT.]
.00	.00000	0	40.91	.00	.0000
.50	2.00000	30	38.18	2.73	1.0979
1.00	1.00000	60	38.25	2.66	1.0697
1.50	.66667	90	38.38	2.53	1.0174
2.50	.40000	150	38.41	2.50	1.0054
3.00	.33333	180	38.48	2.43	.9772
3.50	.28571	210	38.50	2.41	.9692
4.00	.25000	240	38.58	2.33	.9370
4.50	.22222	270	38.61	2.30	.9249
5.00	.20000	300	38.66	2.25	.9048
6.00	.16667	360	38.73	2.18	.8767
7.00	.14286	420	38.81	2.10	.8445
8.00	.12500	480	38.85	2.06	.8284
10.00	.10000	600	38.98	1.93	.7761
12.00	.08333	720	39.07	1.84	.7400
14.00	.07143	840	39.17	1.74	.6997
16.00	.06250	960	39.25	1.66	.6676
20.00	.05000	1200	39.40	1.51	.6072
24.00	.04167	1440	39.55	1.36	.5469
28.00	.03571	1680	39.67	1.24	.4987
32.00	.03125	1920	39.79	1.12	.4504
36.00	.02778	2160	39.85	1.06	.4263
40.00	.02500	2400	39.95	.96	.3861
45.00	.02222	2700	40.00	.91	.3660
50.00	.02000	3000	40.07	.84	.3378
55.00	.01818	3300	40.11	.80	.3217
60.00	.01667	3600	40.15	.76	.3056
100.00	.01000	6000	40.26	.65	.2614
150.00	.00667	9000	40.33	.58	.2332

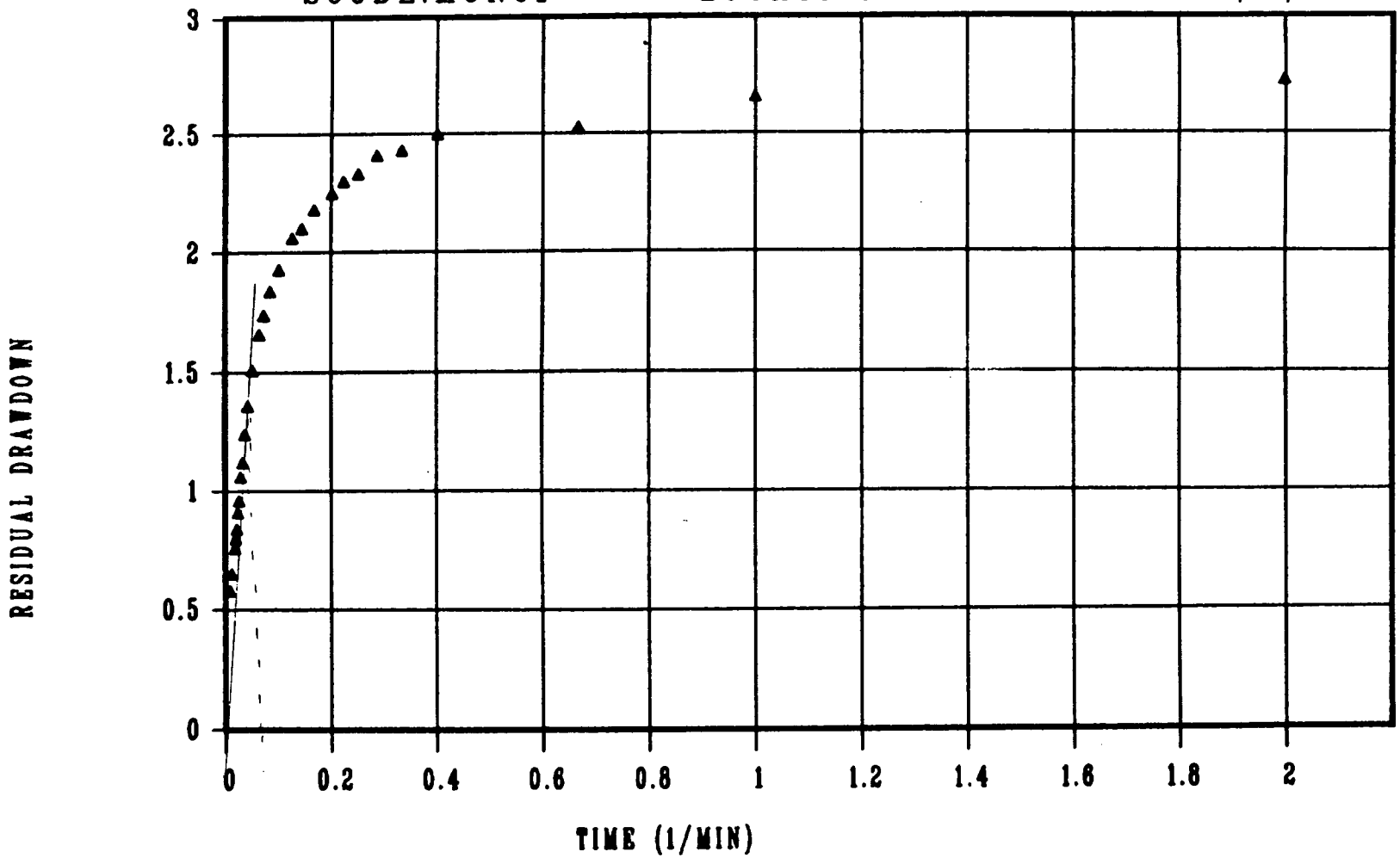
FERRIS-KNOWLES CF0046
HVORSLEV
BOWLER-RICE
COOPER, BREDHOEFT, PAPADOPULOS CF0047
@@NOPK

UMTRA*EZPLOTH~~460~~ 5249
UMTRA*EZPLOTH~~461~~ 5250
UMTRA*EZPLOTH~~462~~ 5251
UMTRA*EZPLOTH~~463~~ 5252

148 Rail Fate

FERRIS-KNOWLES SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:668 DATE:10/26/85

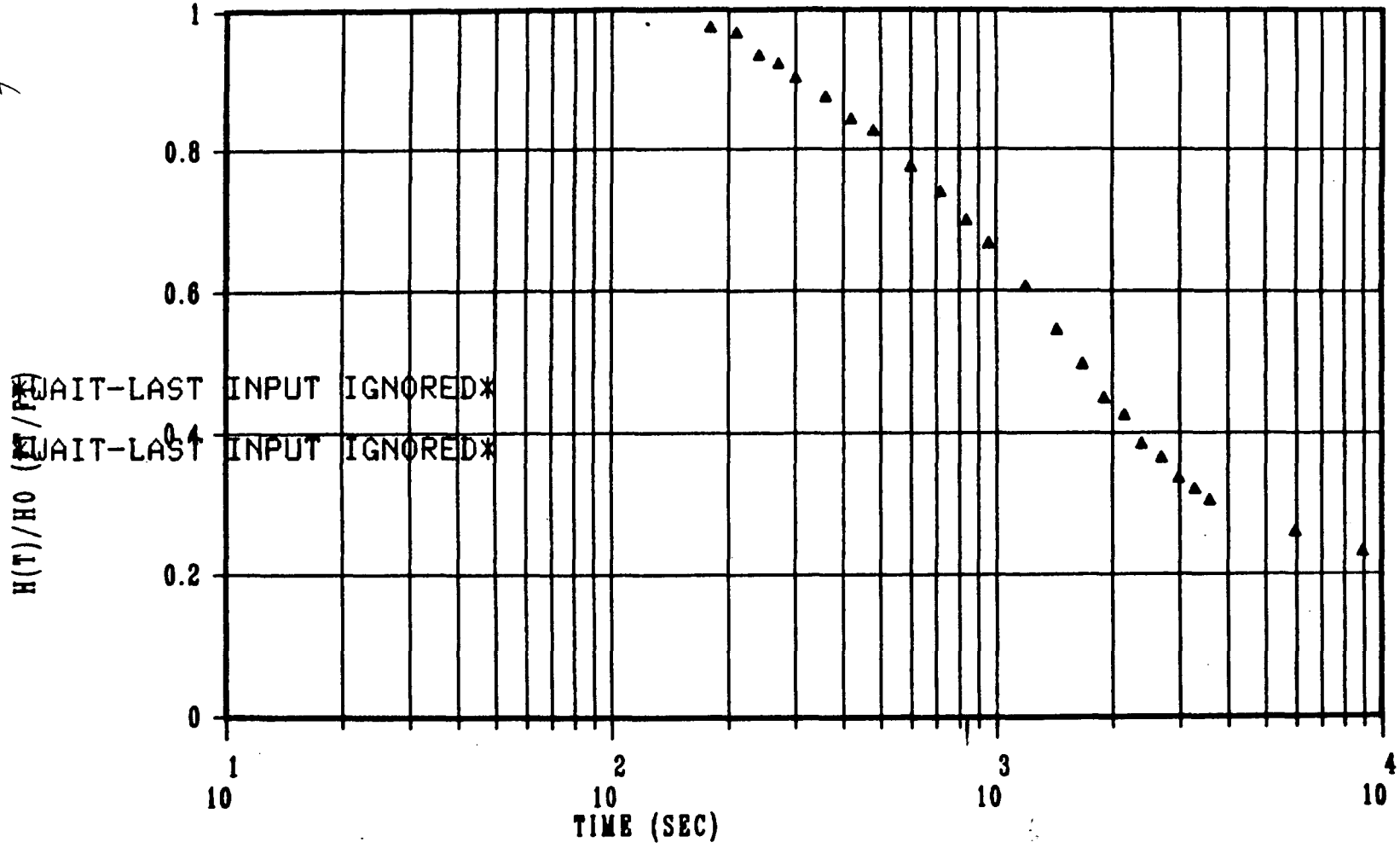


T = 0.042 ft/min S = 1.36 ft

149

COOPER,BREDEHOEFT,PAPADOPULOS SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:668 DATE:10/26/85



$t = 820$ sec at $\frac{T_t}{r_c^2} = 1$

Well 668

RAP 7-9-8

```
*****************************************************************
WELL IDENTIFICATION- 668
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
COOPER-BREDEHOEFT-PAPADOPULOS METHOD
FOR:WELL RADIUS (Rc)=  .167
TIME(t)=  620
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  1.700549E-04   ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 668
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
FERRIS-KNOWLES METHOD
FOR: DISCHARGE(Q)=  .217
RECIPROCAL TIME(1/t)=  .042
DRAWDOWN (s)=  1.36
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  2.66643E-05   ft/ min
*****************************************************************
```

$= 4.44 \times 10^{-7}$ ft/sec

RAP
7-9-8

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Mon01 LOCATION ID: 669

SLUG VOLUME (ft.³): 0.217

INITIAL WATER LEVEL (AT t_0):

DATE: 85/10/26

TIME: 10:30 A

DEPTH (ft FROM TOC): 49.30

STATIC WATER LEVEL:

DATE: 85/10/26 TIME: 2:50 p

DEPTH (ft): 49.10

OPEN INTERVAL (ft.) .37 to 57 from TOC

TOTAL DEPTH OF WELL (ft): 59 from TOC

WELL DIAM. (ft): .333

FIELD REP: Fritts

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
:00	47.50			
.5	47.61			
1.0	47.73			
1.5	47.84			
2.0	47.92			
2.5	48.02			
3.0	48.10			
3.5	48.18			
4.0	48.23			
4.5	48.31			
5.0	48.33			
6.0	48.47			
7.0	48.52			
8.0	48.59			
10.0	48.70			
12.0	48.80			
14.0	48.86			
16.0	48.90			
21.0	48.98			
26.0	49.02			

COMMENTS: Page 1 of 2

JEG-AL-ENG-8 (3/84)

RUP 7-41

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

SLUG TEST DATA

SITE ID: Mon Ø LOCATION ID: 669

STATIC WATER LEVEL:
DATE: 85/10/26 TIME:

SLUG VOLUME (ft.^{3}):

DEPTH (ft): 49.10

INITIAL WATER LEVEL (AT t_o):

OPEN INTERVAL (ft.) to

DATE:

TOTAL DEPTH OF WELL (ft):

TIME:

WELL DIAM. (ft):

DEPTH (ft FROM TOC):

FIELD REP:

ELAPSED TIME (MIN. from to)	GROUNDWATER (ft. from TOC)	RESIDUAL DDN (ft.)	$1/t_m$	H/H_o or $\frac{H-h}{H-H_o}$
31.0	49.04			
36.0	49.06			
41.0	49.06			
46.0	49.06			

COMMENTS: Page 2 of 2

JEG-AL-ENG-8 (3/84)

153
RJP
7-92

SLUG TEST DATA
SITE: MONUMENT VALLEY
LOCATION ID: 669
DATE: 10/26/85

ELAPSED TIME (MIN)	(1/MIN)	(SEC)	GROUND WATER DEPTH (FT)	RESIDUAL DRAWDOWN (FT)	H(T)/HO (FT/FT)
.00	.00000	0	49.10	.00	.0000
.50	2.00000	30	47.61	1.49	.5994
1.00	1.00000	60	47.73	1.37	.5512
1.50	.66667	90	47.84	1.26	.5069
2.00	.50000	120	47.92	1.18	.4747
2.50	.40000	150	48.02	1.08	.4345
3.00	.33333	180	48.10	1.00	.4023
3.50	.28571	210	48.18	.92	.3701
4.00	.25000	240	48.23	.87	.3500
4.50	.22222	270	48.31	.79	.3178
5.00	.20000	300	48.33	.77	.3098
6.00	.16667	360	48.47	.63	.2535
7.00	.14286	420	48.52	.58	.2333
8.00	.12500	480	48.59	.51	.2052
10.00	.10000	600	48.70	.40	.1609
12.00	.08333	720	48.80	.30	.1207
14.00	.07143	840	48.86	.24	.0966
16.00	.06250	960	48.90	.20	.0805
21.00	.04762	1260	48.98	.12	.0483
26.00	.03846	1560	49.02	.08	.0322
31.00	.03226	1860	49.04	.06	.0241
36.00	.02778	2160	49.06	.04	.0161
41.00	.02439	2460	49.06	.04	.0161
46.00	.02174	2760	49.06	.04	.0161

MAPPER DATA FILE : MON01*UDPSTD100015

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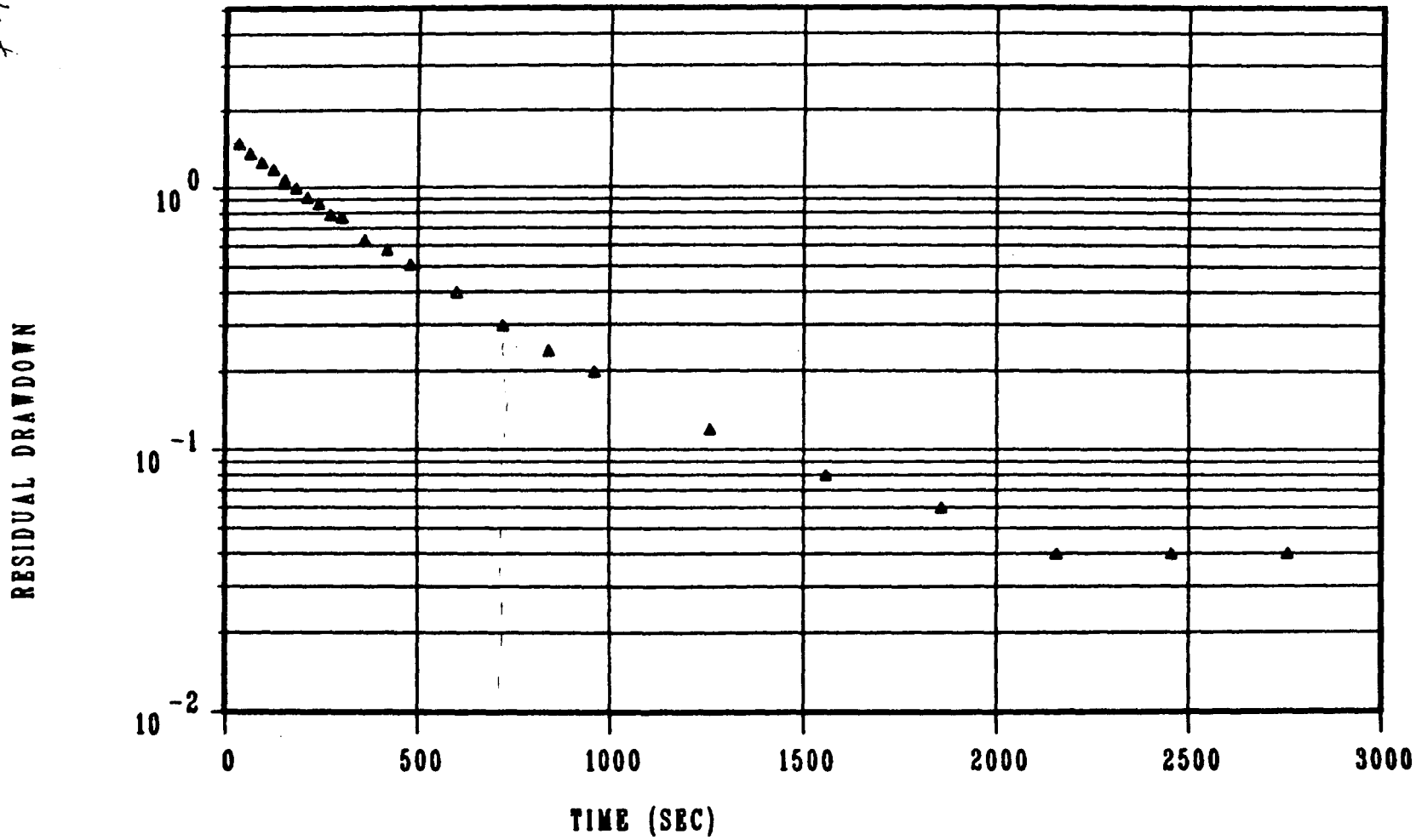
Rad 197

BOUWER-RICE SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:669 DATE:10/26/85

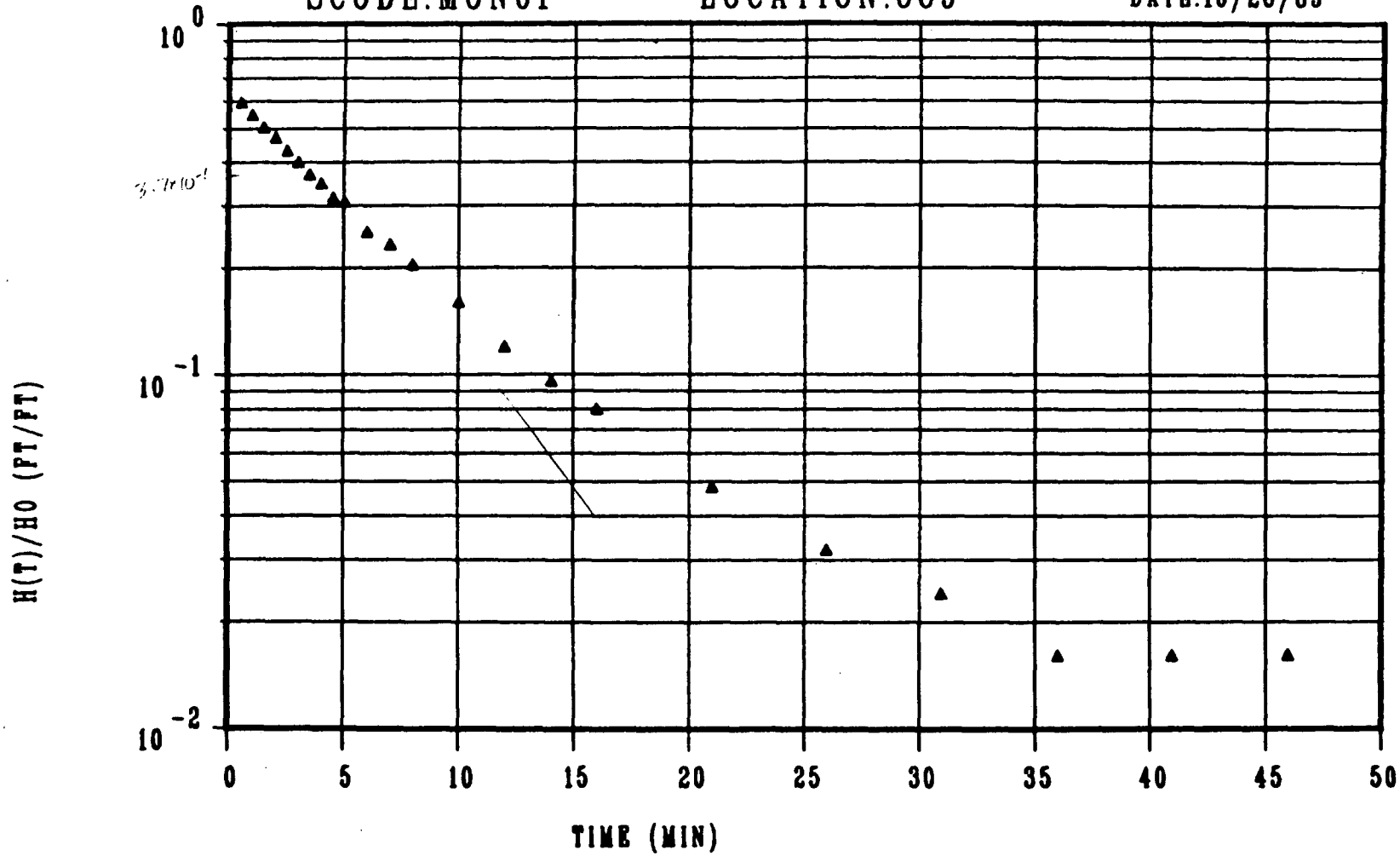


C= [illegible] sec, [illegible] = 0.30 ft

155

HVORSLEV SLUG TEST ANALYSIS

SCODE:MON01 LOCATION:669 DATE:10/26/85



T_0 = 3.5 min

RaP
7-9-92

Well 669

```
*****************************************************************
WELL IDENTIFICATION- 669
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
BOUWER-RICE METHOD
FOR WELL RADIUS(Re)=  .167
BOREHOLE RADIUS(Rw)=  .33
HEAD AT To(Yo)=  2.5
TIME TO HEAD MEASUREMENT(t)=  720
HEAD AT TIME t(Yt)=  .3
DISTANCE FROM WATERTABLE TO BOTTOM OF OPEN OR SCREENED INTERVAL(Lw)= 9.49
DISTANCE FROM WATERTABLE TO IMPERMEABLE BOUNDARY(H)=  9.49
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  5.36784E-06    ft/sec
*****************************************************************
```

```
*****************************************************************
WELL IDENTIFICATION- 669
DATE OF FIELD TEST- 10/26/85
LENGTH OF CONTRIBUTING INTERVAL,(L)=    20
HVORSLEV METHOD
FOR WELL RADIUS(r)=  .167
BOREHOLE RADIUS(R)=  .33
AND TIME LAG(Tc)=  5
*****************************************************************
THE CALCULATED HYDRAULIC CONDUCTIVITY(K)=  5.723373E-04    ft/min
```

$= 9.54 \times 10^{-6}$ ft/sec

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JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. MON&I-11-92-14-06 107-00 DISCIPLINE Hydrology NO. OF SHEETS ~~18~~ 27

PROJECT:
UMTRA

SITE:
MON&I

FEATURE:
Gradient calculations at Monument Valley UMTRA site.

SOURCES OF DATA:
Water level data + aquifer parameter data collected by TAC.

SOURCES OF FORMULAE & REFERENCES:
calc. sub MON08-92-14-02-00
calc. sub MON-08-92-14-03-00

PRELIMINARY CALC. ☐ FINAL CALC. ☑ SUPERSEDES CALC. NO. _____

REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
		C Bore	2/12/93	RMP	2-18-93		

MONUMENT VALLEY CALCULATION MON01-11-92-14-06/07-00

CALCULATION OF HORIZONTAL AND VERTICAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES, MONUMENT VALLEY PROCESSING SITE

A. PURPOSE OF CALCULATION

To calculate average linear groundwater flow velocities within the alluvium, Shinarump sandstone and De Chelly sandstone at the Monument Valley, Arizona site.

B. METHOD AND PROCEDURES

General groundwater flow directions were determined with water table or potentiometric surface maps. Monitor wells pairs (one upgradient and one downgradient) parallel flow directions were then selected. The distance between each pair and the hydraulic head change were then used to calculate a gradient for each date water level measurements were available.

C. ASSUMPTIONS

It is assumed that the hydraulic conductivities, hydraulic gradients, and porosities used in the calculations are sufficiently conservative to predict the maximum average linear velocity.

D. MATERIAL PROPERTIES

The data set of hydraulic conductivities consists of twenty values for the the alluvium, Shinarump conglomerate and De Chelly sandstone obtained from field investigations performed by the TAC. The data set is summarized in Table 1.

E. DATA SOURCES

Water level data and the aquifer parameter data collected by the TAC.

Average linear groundwater flow velocities were calculated using data from the following sources:

(1) hydraulic conductivites determined from slug tests (Calc. MON-08-92-14-02-00) and from an aquifer test (Calc. MON-08-92-14-03-00).

(2) hydraulic gradients determined from groundwater contour maps contained in this calculation.

(3) porosity values obtained from Freeze and Cherry (1979).

F. CALCULATION AND ANALYSIS

The average linear horizontal flow velocity was calculated using the following equation:

$$v = Ki/n$$

where:

v = horizontal flow velocity (ft/day)
K = horizontal hydraulic conductivity (ft/day)
i = horizontal gradient (dimensionless)
n = effective porosity (dimensionless)

Determination of effective porosity

Effective porosities for the each unit were taken from the literature (Freeze and Cherry, 1979). For the sake of conservatism, effective porosities were chosen at or near the low end of the range found in the literature. The porosities chosen for each for each water-bearing unit is shown in Table 2.

Table 2

Water-bearing Unit	Lithology	Value of Porsity n(%)
Alluvium	Well-sorted sand	25
Shinarump Conglomerate	Well-sorted sandstone	10
De Chelly Sandstone	Well-sorted sandstone	10

Determination of hydraulic gradient

The hydraulic gradient is the change in head (dh) over a given distance (dl) in the direction of groundwater flow. The hydraulic gradients were calculated using monitor wells 603 and 653 for the alluvium, 601 and 659 for the Shinarump, and 663 and 664 for the DeChelly (Figures 1 - 3).

Alluvium

The hydraulic gradient in the alluvium was calculated by determining the change in head and distance bewteen monitor wells 603 and 653. These monitor wells were chosen because a line drawn between them is nearly parallel to the direction of groundwater flow. The water level elevations for each of

these monitor wells is presented in Table 3. The distance between these monitor wells (dl in feet) as determined by their location coordinates is approximately 3482 feet. The resultant hydraulic gradient is 0.011 for each date.

Shinarump Conglomerate

The hydraulic gradient in the Shinarump Conglomerate was calculated by determining the change in head and distance between monitor wells 601 and 659. The water level elevations for each of these monitor wells is presented in Table 3. The distance between these two points (dl in feet) as determined by their location coordinates is approximately 4141 feet. The resultant hydraulic gradient is 0.010 for each date.

De Chelly Sandstone

The hydraulic gradient in the De Chelly Sandstone was calculated by determining the change in head over the distance between monitor wells 663 and 664. The water level elevations for each of these monitor wells is presented in Table 3. The distance between these two points (dl in feet) as determined by their location coordinates is approximately 2380 feet. The resultant hydraulic gradient is 0.011 for five dates and 0.012 for two dates with an average of 0.011.

Vertical Gradients

In the Monument Valley site area, there are three monitor well clusters that have wells completed in the DeChelly Sandstone, Shinarump, and alluvium aquifers. Two monitor well clusters have wells completed in the DeChelly Sandstone and alluvium only (Figure 4). A compilation of all historical water level elevations in these clusters in shown in Table 4. Water level differences between the alluvium and DeChelly in each cluster are also shown in this table.

In cluster 1, just north of the tailings pile within the alluvium contaminant plume, an upward gradient exists with an average water level difference of 3.8 feet. In other words, the potentiometric surface of the DeChelly Sandstone is 3.8 feet above the alluvium water table. In cluster 2 (Table 4), further to the north (Figure 4), the DeChelly Sandstone potentiometric surface historically averages 5.2 feet above the alluvium water table.

In cluster 3, north of 619 (Figure 4), the DeChelly Sandstone potentiometric surface historically averages 4.1 feet above the alluvium water table. In cluster 4, a head difference between the DeChelly and alluvium of over 10 feet is recorded up to 1987. Since 1989 however, the gradient has changed from upward to downward. The reason for this change in vertical

gradient over time is unknown. Incidently, there is no cause for concern about this condition because this area of the alluvium is not contaminated with the nitrate plume.

DeChelly well 625 and alluvium monitor well 604 are 400 feet apart, not close enough to be considered a cluster, but a comparison of water levels gives an indication of the upward gradient in this area. The average difference between the DeChelly pontentiometric surface and the alluvium water table in these wells is 8.3 feet.

These historical water level differences between the DeChelly potentiometric surface and the alluvium water table indicate that over the area of the site downgradient of the tailings piles, there has been an upward gradient from the DeChelly to the alluvium. This has prevented the nitrate contaminant plume in the alluvium from moving downward stratigraphically.

Determination of hydraulic conductivity

The hydraulic conductivities in the alluvium, Shinarump Conglomerate and De Chelly sandstone were obtained from analysis of slug test data collected by the TAC (See Calculation No. MON-01-08-92-14-02-00). An aquifer pumping test was also performed in a monitor well 651 screened in the alluvium (see Calculation No. MON-01-08-92-14-02-00). The hydraulic conductivities determined from the slug tests an aquifer aquifer test is summarized in Table 1.

Table 4 summarizes the calculated range of average linear groundwater flow velocity for each water-bearing unit.

G. CONCLUSIONS AND RECOMMENDATIONS

Alluvial Aquifer

Hydraulic conductivities computed from slug test data showed a variation in values ranging from 0.33 to 3.5 feet/day. The hydraulic conductivity computed from the aquifer test data resulted in a value of 19 feet/day. The range of average linear groundwater velocities in the alluvium were calculated using hydraulic conductivities ranging from 0.33 to 19 ft/day, a hydraulic gradient of 0.011 to the north (Figure 3.8), and an assumed effective porosity of 0.25. Using Darcy's Law, the range of average linear velocities for groundwater flow in the alluvium is from 5 to 300 ft/year.

Shinarump Conglomerate

Hydraulic conductivities computed from slug test data showed a variation in values ranging from 0.39 to 8.1 feet/day. The range of average linear groundwater velocities in the

Shinarump Conglomerate were calculated using these hydraulic conductivities, a hydraulic gradient of 0.010 to the north (Figure 3.8), and an assumed effective porosity of 0.10. Using Darcy's Law, the range of average linear velocities for groundwater flow in the alluvium is from 15 to 290 ft/year.

De Chelly Sandstone

Hydraulic conductivities computed from slug test data showed a variation in values ranging from 0.018 to 2.8 feet/day. The range of average linear groundwater velocities in the De Chelly sandstone were calculated using these hydraulic conductivities, a hydraulic gradient of 0.011 to the north (Figure 3.8), and an assumed effective porosity of 0.10. Using Darcy's Law, the range of average linear velocities for groundwater flow in the alluvium is from 0.8 to 120 ft/year.

Vertical Gradient

There is an upward vertical gradient from the DeChelly to the Shinarump and alluvium over most of the site area.

H. REFERENCES

Calculation Set MON-08-92-14-02-00
Slug Test Analyses for Monitor Wells: Monument Valley Site

Calculation Set MON-08-92-14-03-00
Aquifer Pumping Test Analysis of Monitor Well 651

Freeze and Cherry, 1979, Groundwater, Prentice-Hall Inc. Englewood Cliffs, New Jersey, 604 pp.

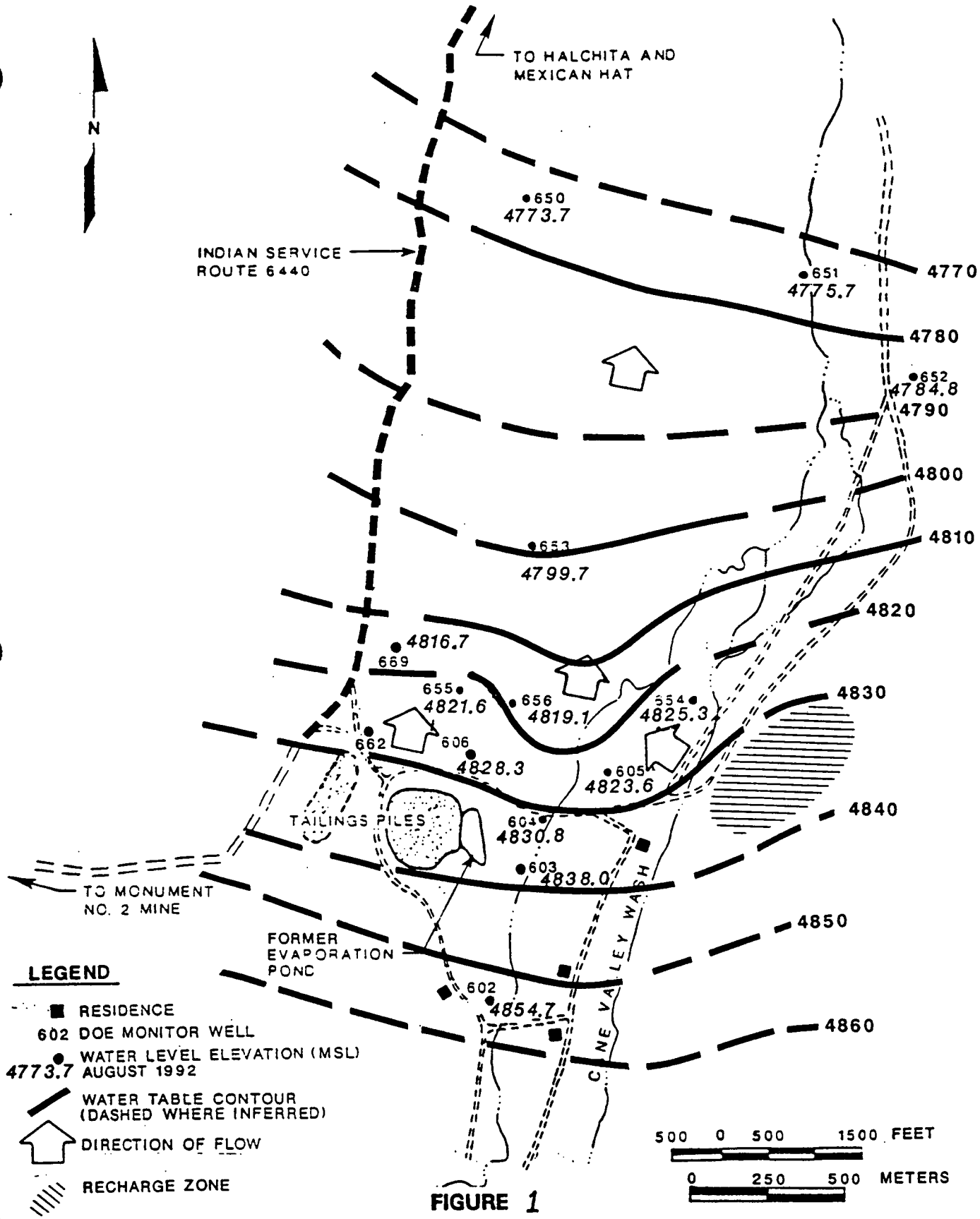
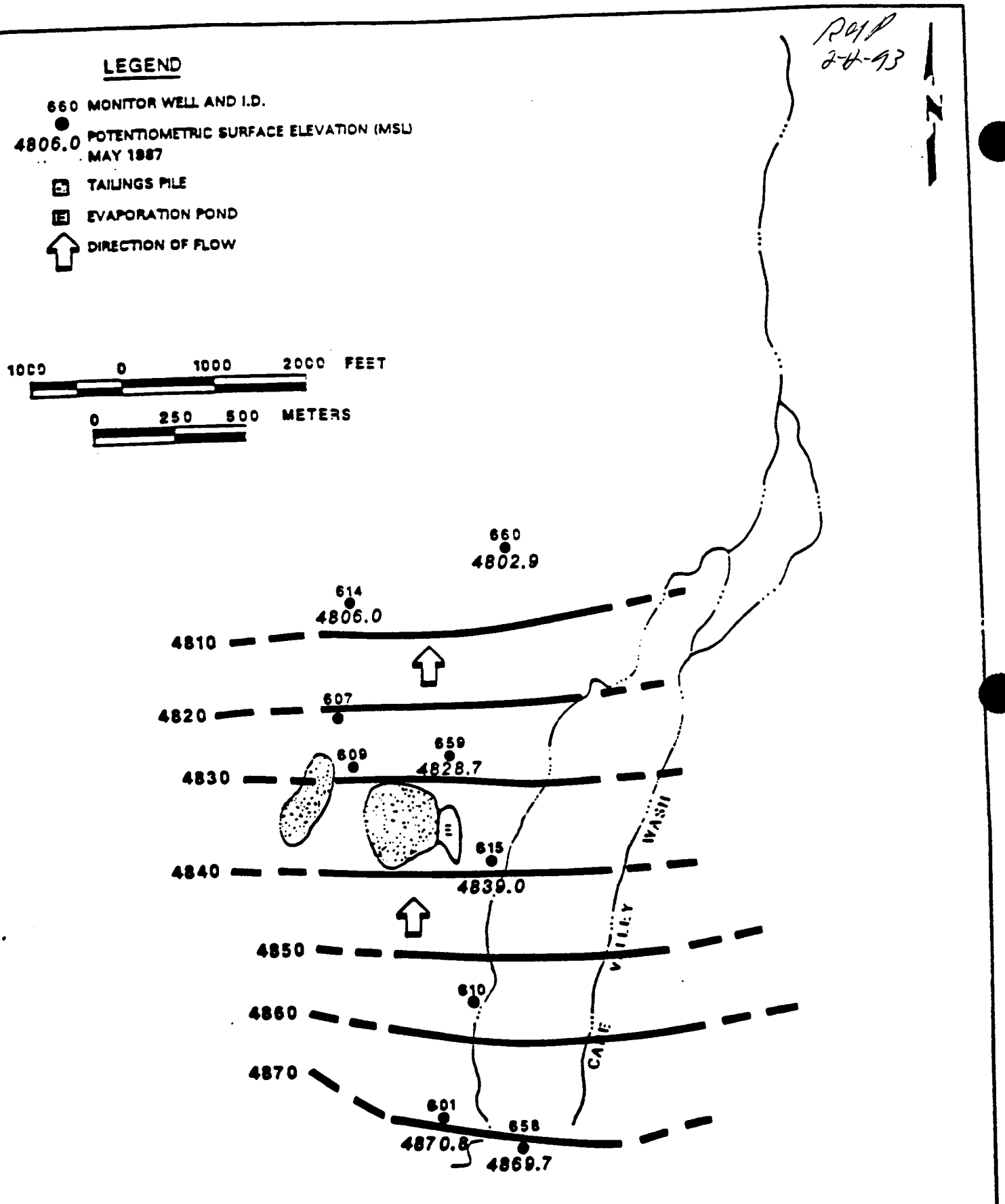


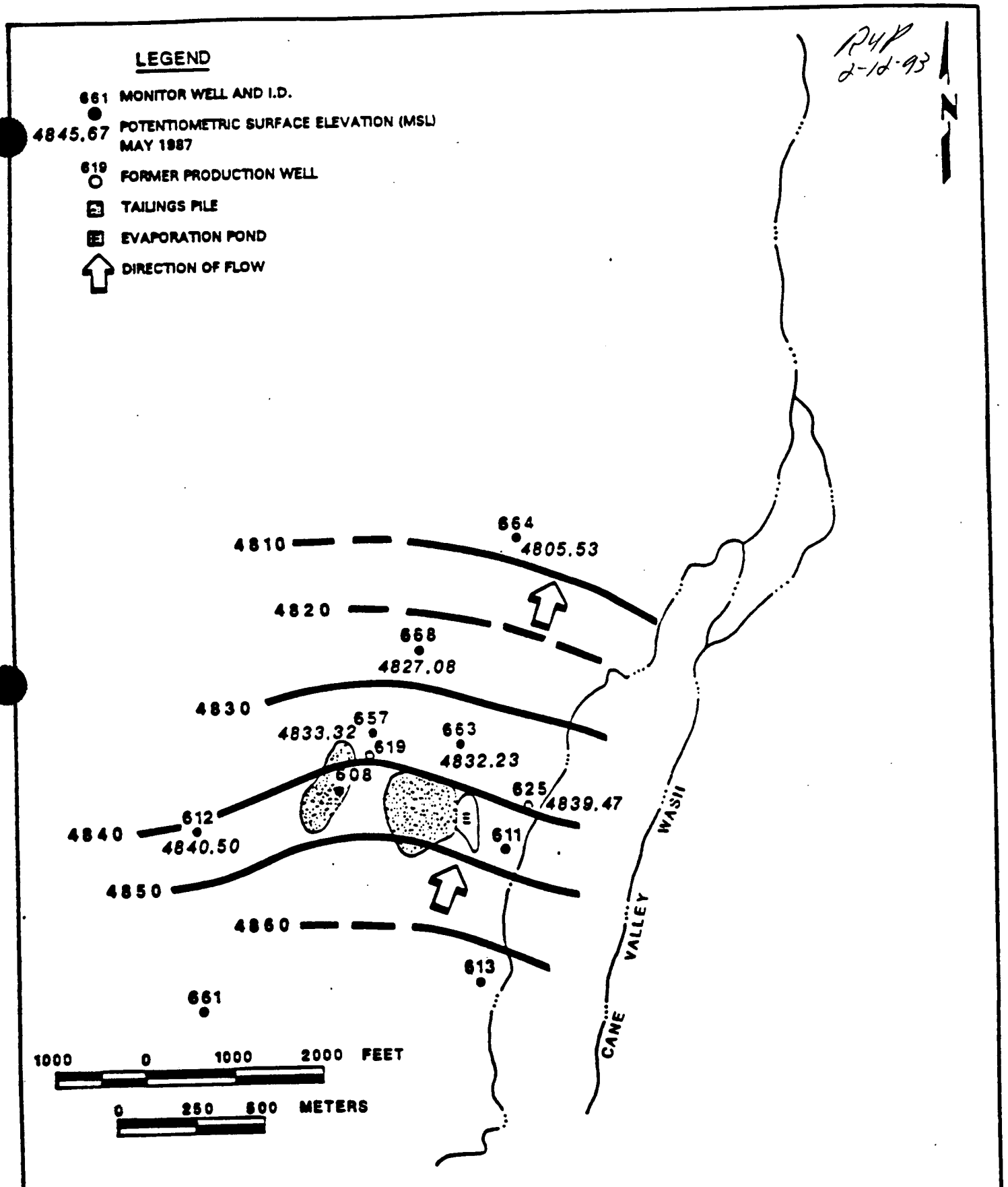
FIGURE 1

ALLUVIUM MONITOR WELL LOCATIONS AND WATER TABLE SURFACE MONUMENT VALLEY SITE



LOCATIONS OF SHINARUMP MONITOR WELLS AND POTENTIOMETRIC SURFACE MONUMENT VALLEY SITE

Figure 2



LOCATIONS OF DE CHELLY SANDSTONE AQUIFER MONITOR WELLS AND POTENTIOMETRIC SURFACE MONUMENT VALLEY SITE

Figure 3

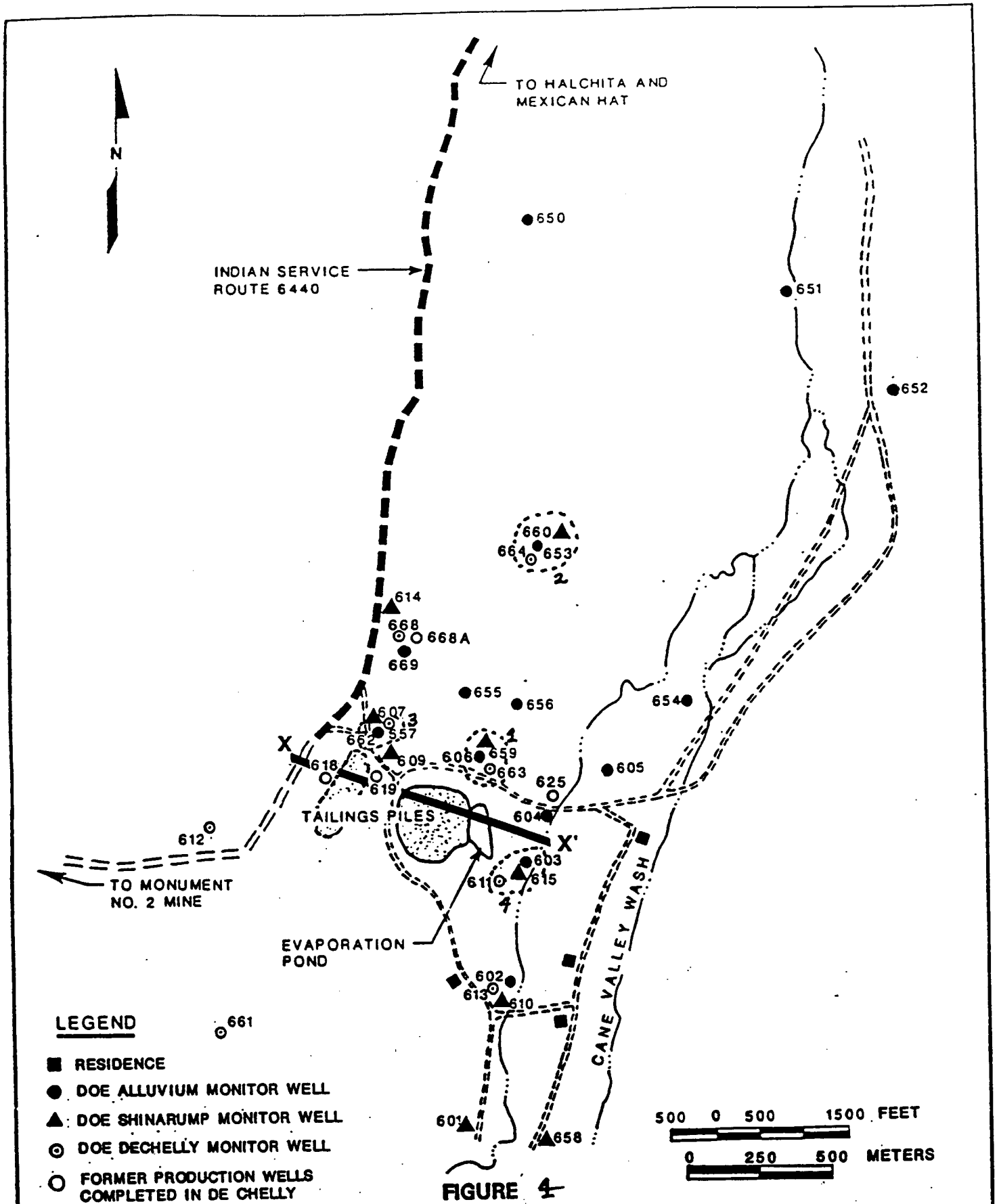


FIGURE 4

LOCATIONS OF ALL MONITOR WELLS IN ALLUVIUM, SHINARUMP, AND DECHELLY AQUIFERS MONUMENT VALLEY SITE

TABLE 1
SUMMARY OF HYDRAULIC CONDUCTIVITIES CALCULATED FROM SLUG TESTS AND ONE AQUIFER TEST (Monitor well 651)

		HYDRAULIC CONDUCTIVITY (K) – FEET/SEC					
Formation	Well I.D.	Bouwer–Rice	Hvorslev	Ferris–Knowles	CBP	Arithmetic Mean K	Geometric Mean K
AL	602	4.3E–06	3.3E–06	N/A	N/A	3.8E–06	N/A
AL	604	1.7E–05	N/A	N/A	N/A	1.7E–05	N/A
AL	605	3.6E–05	4.6E–05	N/A	N/A	4.1E–05	N/A
AL	651	N/A	N/A	N/A	N/A	2.2E–04	N/A
AL	653	3.3E–05	4.5E–05	N/A	N/A	3.9E–05	N/A
AL	655	3.9E–05	4.6E–06	N/A	N/A	4.3E–06	N/A
AL	656	2.8E–05	3.2E–05	N/A	N/A	3.0E–05	N/A
AL	662	2.0E–05	2.9E–05	N/A	N/A	2.5E–05	N/A
AL	669	5.4E–06	9.5E–06	N/A	N/A	7.5E–06	N/A
DC	610	2.2E–06	2.7E–06	9.5E–07	3.1E–06	2.2E–06	2.0E–06
DC	612	N/A	N/A	1.8E–06	2.9E–06	2.4E–06	N/A
DC	657	N/A	N/A	1.1E–06	4.1E–06	2.6E–06	N/A
DC	661	N/A	N/A	N/A	2.1E–06	2.1E–06	N/A
DC	663	N/A	N/A	2.1E–07	3.2E–07	2.7E–07	N/A
DC	664	N/A	N/A	3.2E–05	6.0E–06	1.9E–05	1.4E–05
DC	668	N/A	N/A	4.4E–07	1.7E–06	1.1E–06	8.6E–07
SR	601	5.5E–06	N/A	N/A	N/A	5.5E–06	N/A
SR	658	1.4E–05	N/A	4.9E–06	2.3E–05	1.4E–05	1.2E–05
SR	659	1.2E–05	N/A	4.5E–06	2.1E–05	1.3E–05	1.0E–05
SR	660	9.4E–05	N/A	7.2E–05	N/A	8.3E–05	N/A

AL – ALLUVIUM
DC – DECHELLEY MEMBER OF THE CUTLER FORMATION
SR – SHINARUMP MEMBER OF THE CHINLE FORMATION
CPB – COOPER–BREDEHOEFT–PAPADOPULOS METHOD
NOTE: Single Aquifer Test Conducted in Alluvial MW 651

ALLUVIUM K RANGE: 3.3E–06 to 2.2E–04 ft/s = 0.28 to 19 ft/day
DECHELLY K RANGE: 2.1E–05 to 3.2E–05 ft/s = 0.018 to 2.8 ft/day
SHINARUMP K RANGE: 4.5E–06 to 9.4E–05 ft/s = 0.39 to 8.1 ft/day

RAP
2-12-95

TABLE 2
EFFECTIVE POROSITY OF MON01 GEOHYDROSTRATIGRAPHIC UNITS

Water–Bearing Unit	Lithology	Value of Porosity n(%)
Alluvium	Well–Sorted Sand	25
Shinarump Conglomerate	Well–Sorted Sandstone	10
De Chelly Sandstone	Well–Sorted Sandstone	10

TABLE 3

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MONO1 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)	659	Δ	i
0601	54980.4	88017.7	SR	U	4884.43	15.00	10.0	02/15/85	18.40	4866.03			
								03/07/85	13.70	4870.73			
								03/12/85	14.00	4870.43			
								06/04/85	14.03	4870.40			
								08/15/85	14.50	4869.93			
								04/07/86	13.84	4870.59			
								10/09/86	14.16	4870.27	4828.2	42.1	0.010
								03/26/87	13.98	4870.45	4827.9	42.6	0.010
								05/08/87	13.67	4870.76	4828.7	42.1	0.010
								05/31/91	13.91	4870.52			
								02/23/92	13.98	4870.45	4828.4	42.1	0.010
								08/11/92	15.50	4868.93	4828.4	40.5	0.010
								11/22/92	13.70	4870.73	4828.9	41.8	0.010
0602	56377.4	88661.2	AL	N	4864.02	22.00	10.0	03/07/85	8.10	4855.92			
								03/12/85	8.30	4855.72			
								04/23/85	8.41	4855.61			
								06/04/85	8.50	4855.52			
								08/18/85	9.43	4854.59			
								04/06/86	8.57	4855.45			
								10/09/86	9.03	4854.99			
								03/26/87	8.79	4855.23			
								05/08/87	8.32	4855.70			
								04/21/88	8.03	4855.99			
								06/04/89	9.04	4854.98			
								05/30/91	8.57	4855.45			
								02/25/92	8.66	4855.36			
								08/10/92	9.32	4854.70			
								11/22/92	8.60	4855.42			
0603	57812.7	89036.9	AL	C	4848.56	45.00	10.0	02/15/85	13.90	4834.66	653	Δ	i
								03/07/85	10.20	4838.36			
								03/12/85	14.40	4834.16			
								04/23/85	10.25	4838.31			
								06/04/85	10.31	4838.25			
								08/15/85	10.88	4837.68			
								04/06/86	10.33	4838.23			
								10/09/86	10.37	4838.19	4799.7	38.5	0.011
								03/26/87	10.40	4838.16	4798.9	39.3	0.011
								05/08/87	9.96	4838.60	4799.95	38.7	0.011

FORMATION OF COMPLETION CODE:
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
U - UPGRADIENT
N - UNKNOWN
C - CROSS GRADIENT

TABLE 3 (cont.)

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)	653	Δ	i
0603	57812.7	89036.9	AL	C	4848.56	45.00	10.0	04/22/88	9.75	4838.81	4800.0	38.8	0.011
								06/04/89	10.38	4838.18			
								05/31/91	10.25	4838.31			
								02/22/92	10.46	4838.10	4799.7	38.4	0.011
								08/10/92	10.56	4838.00	4799.7	38.3	0.011
								11/21/92	10.05	4838.51	4799.8	38.7	0.011
0604	58397.0	89424.6	AL	C	4839.09	15.00	15.0	02/15/85	12.20	4826.89			
								03/07/85	8.10	4830.99			
								03/12/85	8.20	4830.89			
								04/23/85	8.11	4830.98			
								06/04/85	8.26	4830.83			
								08/18/85	8.89	4830.20			
								04/06/86	8.09	4831.00			
								10/09/86	8.23	4830.86			
								03/26/87	7.80	4831.29			
								05/08/87	7.71	4831.38			
								06/05/89	8.19	4830.90			
								05/31/91	7.99	4831.10			
								02/22/92	8.09	4831.00			
								08/11/92	8.30	4830.79			
								11/19/92	7.75	4831.34			
0605	58707.6	90066.7	AL	D	4833.96	17.00	15.0	02/15/85	15.20	4818.76			
								03/07/85	9.70	4824.26			
								03/12/85	9.50	4824.46			
								04/23/85	9.63	4824.33			
								06/04/85	9.68	4824.28			
								08/20/85	10.53	4823.43			
								04/05/86	9.67	4824.29			
								10/09/86	10.12	4823.84			
								03/26/87	9.53	4824.43			
								05/08/87	9.35	4824.61			
								04/21/88	9.27	4824.69			
								06/05/89	9.91	4824.05			
								12/04/89	10.76	4823.20			
								06/19/90	10.30	4823.66			
								01/25/91	9.98	4823.98			
								05/31/91	9.80	4824.16			
								08/15/92	10.40	4823.56			
								11/22/92	9.65	4824.31			

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
C - CROSS GRADIENT
D - DOWN GRADIENT

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0606	59034.2	88634.0	AL	D	4863.31	35.00	10.0	03/07/85	35.20	4828.11
								03/12/85	35.40	4827.91
								04/23/85	35.37	4827.94
								06/04/85	35.39	4827.92
								04/05/86	34.95	4828.36
								10/09/86	35.18	4828.13
								03/26/87	34.89	4828.42
								05/08/87	34.82	4828.49
								04/22/88	34.61	4828.70
								06/07/89	34.08	4829.23
								12/01/89	36.20	4827.11
								06/23/90	35.11	4828.20
								01/27/91	34.74	4828.57
								06/01/91	34.96	4828.35
								02/21/92	35.06	4828.25
								08/11/92	35.0	4828.31
								11/24/92	34.62	4828.69
0607	59657.2	87519.2	SR	D	4871.26	12.50	10.0	02/15/85	DRY	-
								03/07/85	DRY	-
								03/12/85	DRY	-
								04/23/85	DRY	-
								06/04/85	DRY	-
								04/06/86	DRY	-
								03/26/87	DRY	-
								05/08/87	DRY	-
								06/06/89	DRY	-
								11/23/92	DRY	-
0608	58685.7	87189.4	DC	O	4903.11	100.00	20.0	04/23/85	58.38	4844.73
								06/04/85	57.80	4845.31
								08/16/85	58.00	4845.11
								04/07/86	57.62	4845.49
								10/09/86	57.25	4845.86
								03/26/87	57.64	4845.47
								05/08/87	57.44	4845.67
0609	59052.1	87652.9	SR	O	4880.17	9.00	5.0	02/15/85	DRY	-
								03/07/85	DRY	-
								03/12/85	DRY	-

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT
O - ON-SITE

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0609	59052.1	87652.9	SR	O	4880.17	9.00	5.0	04/23/85	DRY	-
								06/04/85	DRY	-
								04/06/86	DRY	-
								03/26/87	DRY	-
								05/08/87	DRY	-
								06/06/89	DRY	-
0610	56338.8	88611.6	SR	N	4861.81	65.00	20.0	02/15/85	DRY	-
								03/07/85	DRY	-
								03/12/85	DRY	-
								04/23/85	5.39	4856.42
								06/04/85	5.52	4856.29
								08/18/85	6.32	4855.49
								04/06/86	5.40	4856.41
								10/09/86	5.87	4855.94
0611	57811.0	89017.5	DC	N	4848.35	155.00	20.0	03/07/85	FLOWING	-
								03/12/85	FLOWING	-
								04/23/85	FLOWING	-
								06/04/85	FLOWING	-
								03/26/87	FLOWING	-
								05/08/87	FLOWING	-
								06/07/89	10.71	4837.64
								08/15/92	10.98	4837.37
								11/23/92	10.40	4837.95
0612	58437.2	85614.8	DC	N	5001.74	170.00	20.0	02/19/85	160.60	4841.14
								02/28/85	158.50	4843.24
								03/07/85	158.40	4843.34
								04/23/85	161.97	4839.77
								06/04/85	158.92	4842.82
								08/18/85	161.33	4840.41
								04/07/86	160.86	4840.88
								10/09/86	160.17	4841.57
								03/26/87	160.40	4841.34
								05/08/87	161.24	4840.50
								04/23/88	160.65	4841.09
								08/15/92	161.25	4840.49
								11/22/92	160.50	4841.24
0613	56377.8	88643.7	DC	N	4862.82	140.00	20.0	03/07/85	FLOWING	-

FORMATION OF COMPLETION CODE:
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION

FLOW RELATIONSHIP CODE:
O - ON-SITE
N - UNKNOWN

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0613	56377.8	88643.7	DC	N	4862.82	140.00	20.0	03/12/85	FLOWING	-
								04/23/85	FLOWING	-
								06/04/85	FLOWING	-
								04/06/86	FLOWING	-
								10/09/86	FLOWING	-
								03/26/87	FLOWING	-
								05/08/87	FLOWING	-
								06/04/89	FLOWING	-
								06/22/90	FLOWING	-
								01/25/91	FLOWING	-
								05/30/91	-4.74	4867.56
								02/26/92	-5.22	4868.04
								08/10/92	FLOWING	-
								11/21/92	FLOWING	-
0614	60940.5	87832.6	SR	D	4855.66	50.00	20.0	03/07/85	48.30	4807.36
								03/12/85	48.50	4807.16
								04/23/85	49.90	4805.76
								06/04/85	49.61	4806.05
								08/19/85	49.59	4806.07
								04/05/86	49.67	4805.99
								10/09/86	50.08	4805.58
								03/26/87	50.24	4805.42
								05/08/87	49.64	4806.02
								04/19/88	49.35	4806.31
								06/07/89	49.40	4806.26
								12/02/89	50.16	4805.50
								06/23/90	49.58	4806.08
								01/28/91	49.26	4806.40
								06/01/91	49.68	4805.98
								08/10/92	49.70	4805.96
								11/24/92	49.43	4806.23
0615	57794.4	88980.7	SR	C	4849.29	68.00	20.0	04/23/85	10.67	4838.62
								06/04/85	10.71	4838.58
								08/15/85	11.25	4838.04
								04/06/86	10.71	4838.58
								10/09/86	10.76	4838.53
								03/26/87	11.06	4838.23
								05/08/87	10.33	4838.96

FORMATION OF COMPLETION CODE:
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION

FLOW RELATIONSHIP CODE:
N - UNKNOWN
D - DOWN GRADIENT
C - CROSS GRADIENT

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0615	57794.4	88980.7	SR	C	4849.29	68.00	20.0	06/08/89	FLOWING	-
								08/15/92	FLOWING	-
								11/23/92	FLOWING	-
0618	58868.3	87016.1	DC	O	4921.02	-	-	04/23/85	60.21	4860.81
								06/04/85	89.56	4831.46
								04/07/86	88.15	4832.87
								10/09/86	89.14	4831.88
								03/26/87	93.39	4827.63
0619	58876.5	87587.9	DC	O	4887.42	-	-	02/15/85	57.90	4829.52
								03/07/85	55.40	4832.02
								03/12/85	55.60	4831.82
								06/04/85	55.49	4831.93
								04/07/86	55.24	4832.18
								10/09/86	54.90	4832.52
								03/26/87	55.29	4832.13
								05/08/87	54.20	4833.22
0625	58272.5	89803.1	DC	C	4840.09	-	-	02/15/85	FLOWING	-
								03/07/85	FLOWING	-
								03/12/85	FLOWING	-
								04/23/85	0.62	4839.47
								06/04/85	0.63	4839.46
								04/23/86	0.54	4839.55
								10/09/86	1.37	4838.72
								03/26/87	0.59	4839.50
								05/08/87	0.62	4839.47
								02/26/92	FLOWING	-
								08/15/92	1.35	4838.74
								11/21/92	FLOWING	-
0650	64970.2	89923.8	AL	D	4793.29	80.50	20.0	10/19/85	19.34	4773.95
								04/29/86	19.15	4774.14
								03/26/87	19.87	4773.42
								05/08/87	19.05	4774.24
								04/25/88	18.91	4774.38
								06/05/89	19.30	4773.99
								06/03/91	19.26	4774.03
								02/25/92	19.43	4773.86

FORMATION OF COMPLETION CODE:
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
C - CROSS GRADIENT
O - ON-SITE
D - DOWN GRADIENT

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0650	64970.2	89923.8	AL	D	4793.29	80.50	20.0	08/13/92	19.57	4773.72
								11/21/92	19.37	4773.92
0651	63788.9	92734.3	AL	D	4784.51	23.00	60.0	10/19/85	5.70	4778.81
								04/29/86	8.11	4776.40
								10/09/86	8.62	4775.89
								03/26/87	8.87	4775.64
								05/08/87	7.98	4776.53
								04/19/88	7.54	4776.97
								06/03/89	8.30	4776.21
								12/03/89	8.81	4775.70
								06/21/90	5.50	4779.01
								01/26/91	8.10	4776.41
								06/02/91	8.14	4776.37
								02/25/92	8.05	4776.46
								08/13/92	8.80	4775.71
								11/21/92	8.36	4776.15
0652	62581.5	93759.3	AL	D	4803.84	37.00	20.0	10/19/85	18.96	4784.88
								04/29/86	18.58	4785.26
								10/09/86	19.00	4784.84
								03/26/87	19.55	4784.29
								05/08/87	18.42	4785.42
								06/01/91	18.60	4785.24
								02/23/92	18.67	4785.17
								08/12/92	19.08	4784.76
								11/21/92	18.92	4784.92
0653	61249.3	89596.3	AL	D	4834.94	58.00	20.0	10/19/85	35.55	4799.39
								04/28/86	35.06	4799.88
								10/09/86	35.25	4799.69
								03/26/87	36.07	4798.87
								05/08/87	34.99	4799.95
								04/21/88	34.93	4800.01
								06/22/89	35.00	4799.94
								12/01/89	33.50	4801.44
								06/19/90	35.05	4799.89
								01/24/91	34.98	4799.96
								06/04/91	35.14	4799.80
								02/25/92	35.28	4799.66
								08/13/92	35.20	4799.74
								11/19/92	35.18	4799.76

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0654	59351.4	91063.4	AL	C	4827.01	60.00	20.0	10/19/85	1.72	4825.29
								04/27/86	1.23	4825.78
								10/09/86	1.83	4825.18
								03/26/87	2.18	4824.83
								05/08/87	1.15	4825.86
								04/23/88	0.78	4826.23
								06/06/89	1.42	4825.59
								12/03/89	2.04	4824.97
								06/19/90	1.52	4825.49
								01/27/91	1.31	4825.70
								06/02/91	1.28	4825.73
								08/12/92	1.75	4825.26
								11/22/92	1.42	4825.59
0655	59754.6	88624.1	AL	D	4860.39	41.00	20.0	10/19/85	39.23	4821.16
								04/29/86	38.80	4821.59
								10/09/86	38.87	4821.52
								03/26/87	39.47	4820.92
								05/08/87	38.65	4821.74
								04/20/88	38.55	4821.84
								06/08/89	33.60	4826.79
								12/03/89	39.47	4820.92
								06/22/90	38.86	4821.53
								01/23/91	38.65	4821.74
								06/02/91	38.80	4821.59
								02/22/92	38.83	4821.56
								08/13/92	38.80	4821.59
								11/19/92	38.80	4821.59
0656	59545.2	89175.1	AL	D	4854.61	43.00	20.0	10/19/85	35.98	4818.63
								04/29/86	35.47	4819.14
								10/09/86	35.79	4818.82
								03/26/87	37.08	4817.53
								05/08/87	35.30	4819.31
								06/23/89	35.25	4819.36
								08/13/92	35.50	4819.11
								11/22/92	35.34	4819.27
0657	59266.0	87596.5	DC	O	4883.21	124.00	15.0	10/19/85	50.20	4833.01
								04/28/86	49.90	4833.31

FORMATION OF COMPLETION CODE:
AL - ALLUVIUM
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION

FLOW RELATIONSHIP CODE:
C - CROSS GRADIENT
D - DOWN GRADIENT
O - ON-SITE

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0657	59266.0	87596.5	DC	O	4883.21	124.00	15.0	10/09/86	50.75	4832.46
								03/26/87	51.10	4832.11
								05/08/87	49.89	4833.32
								04/22/88	49.66	4833.55
								06/21/89	49.80	4833.41
								12/04/89	50.58	4832.63
								06/21/90	50.31	4832.90
								01/24/91	49.73	4833.48
								11/23/92	48.70	4834.51
0658	54763.4	88857.0	SR	N	4878.82	138.00	20.0	10/19/85	9.61	4869.21
								04/29/86	9.27	4869.55
								10/09/86	9.60	4869.22
								03/26/87	10.64	4868.18
								05/08/87	9.15	4869.67
								08/14/92	9.83	4868.99
								11/24/92	9.45	4869.37
0659	59069.8	88670.3	SR	D	4863.63	90.00	20.0	10/19/85	36.45	4827.18
								04/27/86	35.33	4828.30
								10/09/86	35.43	4828.20
								03/26/87	35.71	4827.92
								05/08/87	34.96	4828.67
								04/25/88	34.83	4828.80
								06/22/89	35.00	4828.63
								12/02/89	36.18	4827.45
								06/20/90	36.30	4827.33
								01/28/91	35.10	4828.53
								06/04/91	35.20	4828.43
								02/20/92	35.28	4828.35
								08/13/92	35.22	4828.41
								11/18/92	35.20	4828.43
								11/24/92	34.73	4828.90
0660	61303.4	89584.3	SR	D	4834.16	136.00	20.0	10/19/85	33.25	4800.91
								04/28/86	31.35	4802.81
								10/09/86	31.54	4802.62
								03/26/87	32.28	4801.88
								05/08/87	31.30	4802.86
								04/20/88	31.04	4803.12

FORMATION OF COMPLETION CODE:
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION

FLOW RELATIONSHIP CODE:
O - ON-SITE
N - UNKNOWN
D - DOWN GRADIENT

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0660	61303.4	89584.3	SR	D	4834.16	136.00	20.0	06/22/89	31.15	4803.01
								12/01/89	32.09	4802.07
								06/23/90	31.30	4802.86
								01/26/91	31.17	4802.99
								08/13/92	31.43	4802.73
								11/19/92	31.40	4802.76
0661	56366.1	85447.7	DC	N	5059.99	193.00	20.0	10/19/85	164.20	4895.79
								04/29/86	162.75	4897.24
								10/09/86	162.18	4897.81
								03/26/87	163.67	4896.32
								05/08/87	163.57	4896.42
0662	59236.5	87577.5	AL	D	4879.81	41.00	30.0	10/19/85	51.50	4828.31
								04/28/86	50.97	4828.84
								10/09/86	50.52	4829.29
								03/26/87	51.75	4828.06
								05/08/87	50.82	4828.99
								06/21/89	50.75	4829.06
								06/05/91	51.00	4828.81
								02/26/92	50.85	4828.96
								11/23/92	40.57	4839.24
0663	59069.6	88593.5	DC	D	4864.41	180.00	40.0	10/19/85	33.15	4831.26
								04/27/86	32.56	4831.85
								10/09/86	32.03	4832.38
								03/26/87	32.70	4831.71
								05/08/87	32.18	4832.23
								04/24/88	31.93	4832.48
								06/23/89	32.10	4832.31
								12/02/89	33.33	4831.08
								06/22/90	32.80	4831.61
								01/25/91	32.20	4832.21
								06/04/91	32.58	4831.83
								02/20/92	32.32	4832.09
								08/15/92	32.42	4831.99
								11/20/92	31.37	4833.04
0664	61255.9	89537.0	DC	D	4835.76	214.00	20.0	10/19/85	30.75	4805.01
								04/28/86	30.22	4805.54

664	Δ	i
~~4805.0~~	26.3	0.011
4805.5	26.4	0.011
4805.5	26.9	0.011
4804.2	27.5	0.012
4805.5	26.7	0.011
4805.7	26.3	0.011
4805.6	27.4	0.012

FORMATION OF COMPLETION CODE:
SR - SHINARUMP MEMBER OF THE CHINLE FORMATION
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT
N - UNKNOWN

TABLE 3 cont.

STATIC GROUNDWATER LEVELS
ALL MONITOR WELLS - ALL DATES
SITE: MON01 MONUMENT VALLEY
REPORT DATE: 02/22/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	FORMATION OF COMPLETION	FLOW CODE	CASING ELEVATION (FT MSL)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	LOG DATE	DEPTH FROM TOP OF CASING (FT)	GROUNDWATER ELEVATION (FT MSL)
0664	61255.9	89537.0	DC	D	4835.76	214.00	20.0	10/09/86	30.27	4805.49
								03/26/87	31.60	4804.16
								05/08/87	30.23	4805.53
								08/13/92	30.10	4805.66
								11/19/92	30.17	4805.59
0668	60171.4	88287.0	DC	D	4866.71	182.50	20.0	10/19/85	41.30	4825.41
								04/29/86	40.04	4826.67
								10/09/86	39.55	4827.16
								03/26/87	40.28	4826.43
								05/08/87	39.63	4827.08
								06/24/89	39.70	4827.01
								08/13/92	39.94	4826.77
								11/24/92	39.40	4827.31
0669	60146.3	88247.8	AL	D	4865.78	37.00	20.0	10/19/85	49.30	4816.48
								04/28/86	49.03	4816.75
								10/09/86	49.21	4816.57
								03/26/87	49.41	4816.37
								05/08/87	48.85	4816.93
								06/24/89	48.80	4816.98
								02/24/92	49.07	4816.71
								08/13/92	49.10	4816.68
								11/24/92	48.89	4816.89

FORMATION OF COMPLETION CODE:
DC - DECHELLEY MEMBER OF THE CUTLER FORMATION
AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
D - DOWN GRADIENT

DATA FILE: M:\DART\MON01\GWL10005.DAT

FIELDS DISPLAYED WITH A DASH INDICATE THE DATA IS UNAVAILABLE

TABLE 4

MONUMENT VALLEY: WATER LEVEL ELEVATIONS: Alluvium, DeChelly, Shinarump

Negative head difference = upward flow from DC to Alluvium

	[---------- Cluster 1 ----------]			
DATE	Well 606 (Al)	Well 663 (DC)	Well 659 (SR)	Al/DC Head Difference
07-Mar-85	4828.11			
12-Mar-85	4827.91			
23-Apr-85	4827.94			
04-Jun-85	4827.92			
19-Oct-85		4831.26	4827.18	
06-Apr-86	4828.36			
28-Apr-86		4831.85	4828.3	
09-Oct-86	4828.13	4832.38	4828.2	-4.25
26-Mar-87	4828.42	4831.71	4827.92	-3.29
08-May-87	4828.49	4832.23	4828.67	-3.74
22-Apr-88	4828.7	4832.48	4828.8	-3.78
04-Jun-89	4829.23			
22-Jun-89		4832.31	4828.63	
01-Dec-89	4827.11	4831.08	4827.45	-3.97
23-Jun-90	4828.2	4831.61	4827.33	-3.41
27-Jan-91	4828.57	4832.21	4828.53	-3.64
31-May-91	4828.35	4831.83	4828.42	-3.48
22-Feb-92	4828.25	4832.09	4828.35	-3.84
12-Aug-92	4828.31	4831.99	4828.41	-3.68
20-Nov-92	4828.69	4833.04	4828.43	-4.35
17-Dec-92	4828.1	4832	4828.39	-3.9

TABLE 4 (Continued)
MONUMENT VALLEY: WATER LEVEL ELEVATIONS: Alluvium, DeChelly, Shinarump
Negative head difference = upward flow from DC to Alluvium

	[---------- Cluster 2 ----------]			
DATE	Well 653 (Al)	Well 664 (DC)	] (SR)	Al/DC Head Difference
19–Oct–85	4799.39	4805.01	4800.91	–5.62
28–Apr–86		4805.54	4802.81	
09–Oct–86		4805.49	4802.62	
26–Mar–87	4799.69	4804.16	4801.88	–4.47
08–May–87	4799.95	4805.53	4802.86	–5.58
22–Apr–88	4800.01		4803.12	
22–Jun–89	4799.94		4803.01	
01–Dec–89	4801.44		4802.07	
23–Jun–90	4799.89		4802.86	
27–Jan–91	4799.96		4802.99	
31–May–91	4799.8			
22–Feb–92	4799.66			
12–Aug–92	4799.74	4805.66	4802.73	–5.92
20–Nov–92	4799.76	4805.59	4802.76	–5.83
16–Dec–92	4799.3	4802.85	4802.25	–3.55
17–Dec–92		4803.15		

TABLE 4 (Continued)
MONUMENT VALLEY: WATER LEVEL ELEVATIONS: Alluvium, DeChelly, Shinarump
Negative head difference = upward flow from DC to Alluvium

	[-------- Cluster 3 --------]		
DATE	Well 662 (Al)	Well 657 (DC)	Al/DC Head Difference
28-Apr-86	4828.84		
09-Oct-86	4829.29	4832.46	-3.17
26-Mar-87	4828.06	4832.11	-4.05
08-May-87	4828.99	4833.32	-4.33
22-Apr-88		4833.55	
22-Jun-89	4829.06	4833.41	-4.35
01-Dec-89		4832.63	
23-Jun-90		4832.9	
27-Jan-91		4833.48	
31-May-91	4828.81		
22-Feb-92	4828.96		
20-Nov-92		4834.51	
17-Dec-92	4829.1	4833.71	-4.61
18-Dec-92	4828.69	4832.91	-4.22
19-Dec-92	4828.44	4832.61	-4.17
20-Dec-92	4828.44	4832.63	-4.19

TABLE 4 (Continued)
MONUMENT VALLEY: WATER LEVEL ELEVATIONS: Alluvium, DeChelly, Shinarump
Negative head difference = upward flow from DC to Alluvium

	[---------- Cluster 4 ----------]			
DATE	Well 603 (Al)	Well 611 (DC)	Well 615 (SR)	Al/DC Head Difference
15-Feb-85	4834.66	4848.35		-13.69
07-Mar-85	4838.36	4848.35		-9.99
12-Mar-85	4834.16	4848.35		-14.19
23-Apr-85	4838.31	4848.35	4838.62	-10.04
04-Jun-85	4838.25	4848.35	4838.58	-10.1
15-Aug-85	4837.68	4848.35	4838.04	-10.67
06-Apr-86	4838.23		4838.58	
09-Oct-86	4838.19		4838.53	
26-Mar-87	4838.16	4848.35	4838.23	-10.19
08-May-87	4838.6	4848.35	4838.96	-9.75
22-Apr-88	4838.81			
04-Jun-89	4838.18	4837.64	F	0.54
31-May-91	4838.31			
22-Feb-92	4838.1			
12-Aug-92	4838	4837.34	F	0.66
20-Nov-92	4838.51	4837.95	F	0.56
17-Dec-92	4838.12	4837.63	F	0.49

Table 5

Water-bearing Unit	Effective Porosity	Hydraulic Gradient	Range in Hydraulic Conductivity (feet/sec)	Range of average linear groundwater flow velocities (feet/sec)
Alluvium	0.25	0.011	0.33 to 19	5 to 300
Shinarump Conglom-erate	0.10	0.010	0.39 to 8.1	15 to 290
De Chelly Sandstone	0.10	0.011	0.018 to 2.8	0.8 to 120