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TEMPORARY STORAGE AREA CHARACTERIZATION REPORT

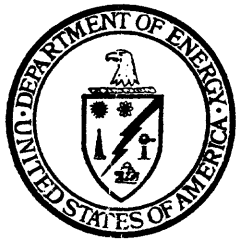
For The :

Weldon Spring Site Remedial Action Project

Weldon Spring, Missouri

Prepared By MK-Ferguson Company And Jacobs Engineering Group

JANUARY 1990 REV. 1



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Oak Ridge Operations Office

Weldon Spring Site Remedial Action Project

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TEMPSTOR/TXTJOANN

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Revision 1

January 1990

Prepared by

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For the

U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
Under Contract DE-AC05-86OR21548

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ABSTRACT

The preferred alternative identified in the Remedial Investigation/Feasibility Study (RI/FS) for the Weldon Spring Quarry Bulk Wastes is to remove the wastes from the quarry and transport them by truck to a temporary storage facility at the chemical plant site. To support the RI/FS, this report provides data to characterize the temporary storage area (TSA) site and to ensure the suitability of the proposed location.

The data are drawn from studies conducted in connection with the Weldon Spring Site Remedial Action Project but are focused specifically on that information pertinent to defining contamination within the proposed 13-acre TSA site. Information is also presented regarding the physical features of the surface of the TSA site and the geotechnical suitability of the earth materials for liner construction and foundation support.

The geotechnical data supports the suitability of the site for temporary storage. The engineering properties of the Ferrelview Formation and the underlying clay till unit are consistent with the design criteria for liner materials.

Prior to construction of the proposed facility three buildings will have to be removed, along with inactive utility lines, fencing and a decontamination pad. Active water lines will be relocated.

TABLE OF CONTENTS

SECTION		PAGE
1	INTRODUCTION	1
	1.1 Purpose of Report	1
	1.2 Scope of Report	1
	1.3 Site Background	4
	1.3.1 Site Description	4
	1.3.2 Facility Description	5
	1.3.3 Site History	7
	1.3.4 Overview of Investigations	9
	1.4 Report Organization	9
2	STUDY AREA INVESTIGATIONS	11
	2.1 Surface Features	11
	2.2 Meteorological Data	11
	2.3 Geological Investigations	12
	2.4 Contaminated Soil Investigations	13
	2.4.1 Chemical Soil Contamination	14
	2.4.2 Radiological Soil Contamination	15
	2.5 Surface Water Investigations	15
	2.6 Groundwater Investigations	16
	2.7 Building Characterization	16
3	PHYSICAL CHARACTERISTICS OF THE STUDY AREA	19
	3.1 Surface Features	19
	3.2 Meteorology	21
	3.3 Surface Water Hydrology	23
	3.3.1 The Mississippi River Drainage	23
	3.3.2 Missouri River Drainage	26
	3.3.3 Temporary Storage Area Drainage	26
	3.4 Geology	30
	3.4.1 Unconsolidated Materials	30
	3.4.2 Bedrock Geology	35
	3.4.3 Seismicity	37
	3.5 Soils - Physical Characteristics	39
	3.6 Groundwater Hydrology	42
	3.7 Buildings	47
	3.7.1 Building 435	47

TABLE OF CONTENTS (Continued)

SECTION		PAGE
3.7.2	Building 436	48
3.7.3	Building 437	48
3.7.4	Building 438	49
4	NATURE AND EXTENT OF CONTAMINATION	50
4.1	Soil	50
4.1.1	Chemical Contamination	50
4.1.1.1	Nitroaromatic Compounds	52
4.1.1.2	Inorganic Anions	55
4.1.1.2.1	Nitrate	56
4.1.1.2.2	Sulfate	56
4.1.1.2.3	Fluoride	56
4.1.1.3	Metals	56
4.1.1.4	Pesticides	59
4.1.1.5	Polychlorinated Biphenyls	59
4.1.1.6	Volatile Organic Compounds	59
4.1.1.7	Semi-Volatile Organic Compounds	59
4.1.2	Radiological Contamination	60
4.1.2.1	West Raffinate Pits Area - Region 8	61
4.1.2.1.1	Zone 1	61
4.1.2.1.2	Zone 2	63
4.1.2.1.3	Zone 3	64
4.1.2.1.4	Zone 4	65
4.1.2.2	East Raffinate Pits Area - Region 9, Zone 1	67
4.1.2.3	Southeast Area - Region 11 Zone 2	68
4.2	Water Quality	70
4.2.1	Nitroaromatic Compounds	70
4.2.2	Inorganic Anions and Groundwater Quality	71
4.2.2.1	Nitrates	72
4.2.2.2	Sulfates	72
4.2.3	Radiochemistry	73

TABLE OF CONTENTS (Continued)

SECTION		PAGE
4.2.4	Metals	73
4.3	Buildings 435, 436, 437, and 438	75
4.3.1	Building 435	77
4.3.1.1	Chemical Contamination	77
4.3.1.1.1	Asbestos-Containing Material	77
4.3.1.1.2	Polychlorinated Biphenyls	77
4.3.1.2	Radiological Contamination	78
4.3.2	Building 436	80
4.3.2.1	Chemical Contamination	80
4.3.2.1.1	Asbestos-Containing Material	80
4.3.2.1.2	Polychlorinated Biphenyls	81
4.3.2.2	Radiological Contamination	81
4.3.3	Building 437	83
4.3.3.1	Chemical Contamination	83
4.3.3.1.1	Asbestos-Containing Material	83
4.3.3.1.2	Polychlorinated Biphenyls	84
4.3.3.2	Radiological Contamination	84
4.3.4	Building 438	86
4.3.4.1	Chemical Contamination	86
4.3.4.1.1	Asbestos-Containing Material	86
4.3.4.1.2	Polychlorinated Biphenyls	86
4.3.4.2	Radiological Contamination	87

TABLE OF CONTENTS (Continued)

SECTION	PAGE
5 REFERENCES	89

APPENDICES

A Groundwater Quality Data, 1988
B Rain Gauge Data, 1988
C Borehole Logs and Well Completion Records
D Soil: Chemical Analysis, 1988
E Soil: Radiological Analysis, 1988
F Buildings: Chemical Contamination, 1989
G Buildings: Radiological Contamination, 1989

LIST OF FIGURES

NUMBER		PAGE
1-1	Location of Temporary Storage Area	2
1-2	Temporary Storage Area Plan	6
3-1	Topographic Map	20
3-2	Existing Buildings and Surface Features of TSA	22
3-3	Surface Water Flow Paths From WSS	24
3-4	Drainage Areas of the WSCP and WSRP	25
3-5	Total Overburden Thickness	31
3-6	Top of Bedrock Surface: Burlington-Keokuk Limestone	36
3-7	Generalized Stratigraphic Column	38
3-8	Potentiometric Surface of Shallower Burlington-Keokuk Limestone	44
3-9	Potentiometric Surface of Deeper Burlington-Keokuk Limestone	45
4-1	WSCP/WSRP Soil Sample Locations	51
4-2	Radiological Soil Sample Locations	62
4-3	Location of Buildings 435, 436, 437, and 438	76

LIST OF TABLES

NUMBER		PAGE
3-1	Temporary Storage Area Design Criteria	28
3-2	Borehole Statistics	32
3-3	Unconsolidated Material Thicknesses	33
3-4	Summary of Laboratory Testing of Overburden Samples	40
3-5	Monitoring Well Construction Data	46
4-1	Contaminants and Corresponding Reference Levels .	53
4-2	Maximum Depth of Contamination at Sampled Location	54

1 INTRODUCTION

1.1 PURPOSE OF REPORT

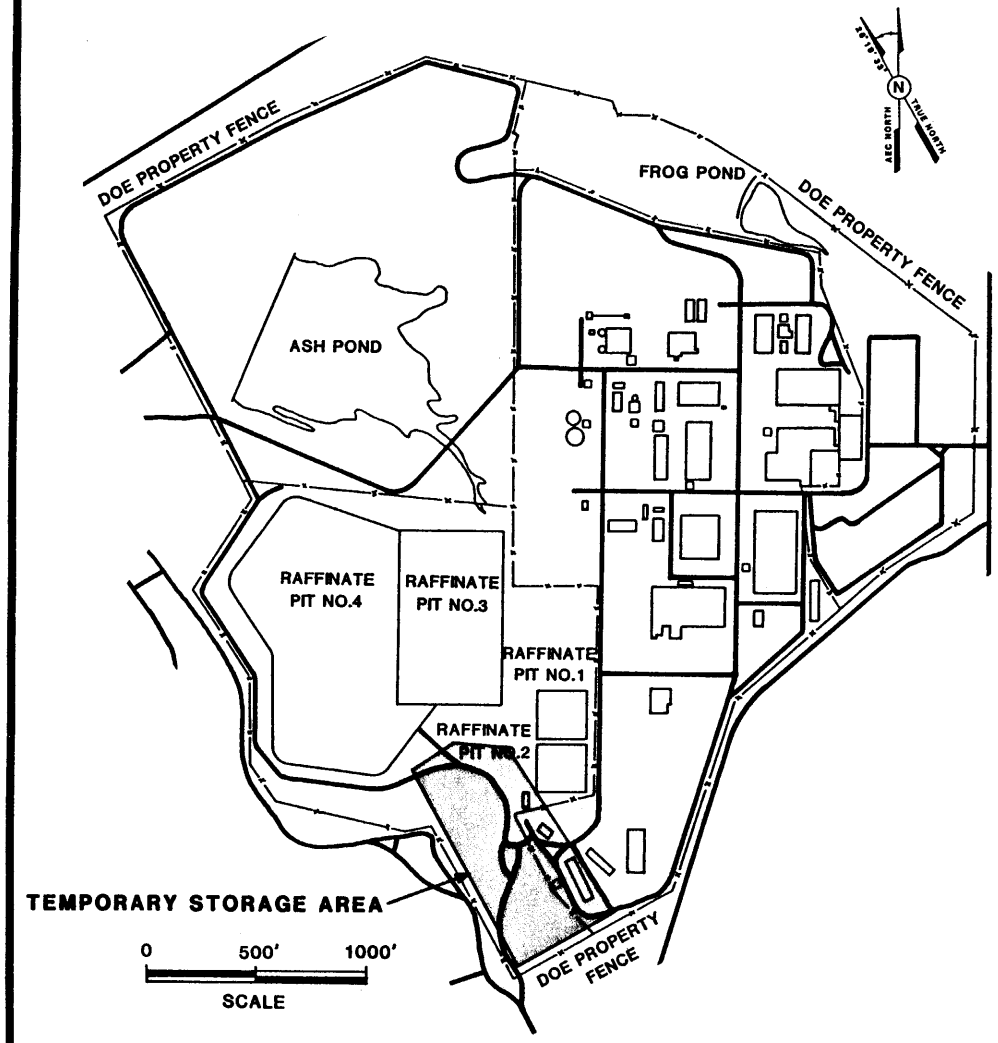
The U.S. Department of Energy (DOE) is proposing to remove contaminated bulk wastes from the Weldon Spring Quarry and transport the material to a temporary storage facility located at the Weldon Spring Chemical Plant (WSCP) site (Figure 1-1). This report summarizes the characterization data for the temporary storage area (TSA) site.

A Remedial Investigation/Feasibility Study (RI/FS) for the Weldon Spring Quarry Bulk Wastes has been completed. The preferred alternative described in the FS is to remove the bulk wastes and transport them by truck to a temporary storage facility at the chemical plant site. This report is intended to support the RI/FS by providing data to characterize the TSA site and to ensure the suitability of the proposed location for storing the contaminated bulk waste material removed from the quarry. The final disposition of this material will be determined as part of the record of decision for the chemical plant site.

1.2 SCOPE OF REPORT

The scope of this report includes evaluation of the radiological, chemical and geotechnical data to characterize the 13-acre site for the proposed TSA. The data presented focus on defining contamination within the 13 acres, and on describing the physical features of the surface. An additional objective is a preliminary determination regarding the geotechnical suitability of the site and construction materials.

A breakdown of the broad areas addressed in this report is provided below.



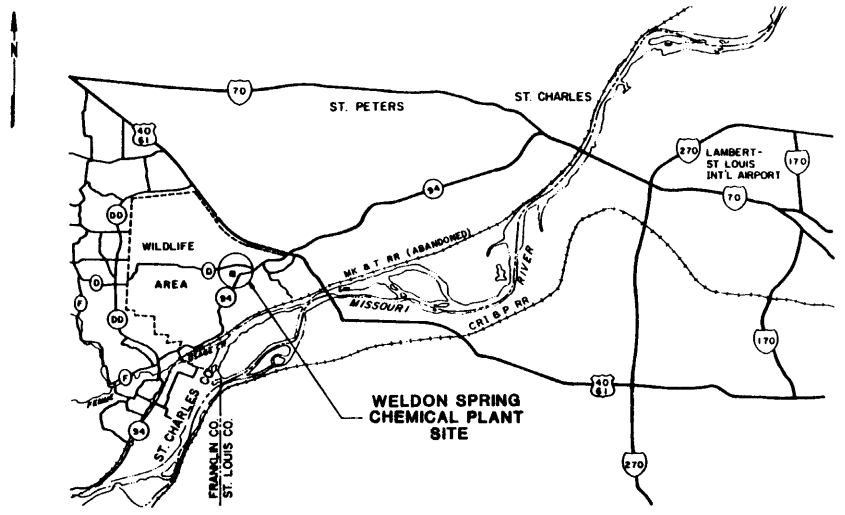


FIGURE 1-1

CHEMICAL PLANT TEMPORARY STORAGE AREA LOCATION PLAN

A general description of the conditions of the 13-acre TSA site as well as a description of the proposed facility is presented in Section 1.3.2. A more detailed discussion of site conditions is furnished in Sections 3 and 4. The proposed TSA facility is described in detail in a separate report, the WSSRAP Quarry Preliminary Engineering Report.

A detailed discussion of the surface features and various utilities is provided in Section 3, since an understanding of these features will be very important in assessing the characteristics of the site and during preparation of the area for construction activities.

Meteorological data pertinent to the operation of the TSA such as precipitation, wind speed and direction, evaporation and storm conditions is presented in Section 3.2.

A brief analysis of surface water hydrology is presented in Section 3. This section describes the presence and effect of a local drainage divide and defines appropriate flood elevations.

Discussions of geology are related to both the unconsolidated (overburden) materials and the bedrock. Information specific to the overburden in the TSA area is described in detail since these materials will provide the foundation for the facility and will be utilized to construct the soil liner. The geotechnical properties of the overburden materials are assessed by evaluating the engineering properties of the soil. The bedrock geology is applicable to the TSA only in a very broad sense and is comprehensively described in the Hydrogeologic Investigation Sampling Plan.

One of the primary areas addressed by this report is the radiological and chemical characterization of the soils at the TSA site. Data are presented to establish areas of

contamination, and conservative criteria that could be used to estimate the maximum amount of material that may require removal prior to construction of the facility.

Groundwater data are presented only to the extent necessary to describe the groundwater monitoring system to be used.

The final focus of the report is related to the buildings located within the footprint of the TSA facility. Since these buildings will be demolished prior to construction of the TSA, detailed characterization of the chemical and radiological contamination associated with the structures is addressed.

In summary, the information from each of the areas discussed above is presented to the extent that it is unique to the TSA site. Data that are only indirectly related to the facility are not included since the Weldon Spring Site Remedial Investigation Report will provide a comprehensive assessment of all available information.

1.3 SITE BACKGROUND

1.3.1 Site Description

The Weldon Spring Site (WSS) is located near the community of Weldon Spring, St. Charles County, Missouri, about 30 miles west of St. Louis. The site consists of two noncontiguous areas: (1) the raffinate pits and chemical plant area and (2) the quarry. The chemical plant is about two miles southwest of the junction of Missouri Route 94 and U.S. Route 40/61. The quarry is located about four miles south-southwest of the WSCP and about five miles southwest of the community. Both areas are accessible from State Route 94, and are fenced and closed to the public.

The temporary storage area will be located in the southwest corner of the chemical plant near the existing raffinate pits (Figure 1-1). The site is underlain by approximately 30 feet of fine-grained unconsolidated materials. The surface is relatively flat and is covered with vegetation. Several buildings and utility lines are located within the footprint of the proposed facility.

1.3.2 Facility Description

The TSA will be constructed for sorting and storing the bulk wastes excavated from the quarry. Contaminated material will be transported to the TSA by trucks along a private haul road. A receiving pad will be available for sorting the bulk wastes according to their physical properties. The facility will be designed to store the approximately 95,000 cy of waste plus a 15 percent contingency for each of up to eight separate subareas currently anticipated. Allowance is also made for variations in the quantities of contaminated materials due to swelling. The total design volume will accommodate 140,000 cy of material.

The waste storage area will consist of four-inch-thick asphalt concrete surfacing underlain by a 12-inch layer of clay with a maximum coefficient of permeability of 1×10^{-7} cm/sec.

Stormwater runoff and leachate will be directed to two collection ponds. The ponds will be double-lined with leachate collection systems (Figure 1-2).

Construction of the facility will require the removal/ relocation of three buildings, several utility lines and a groundwater monitoring well.

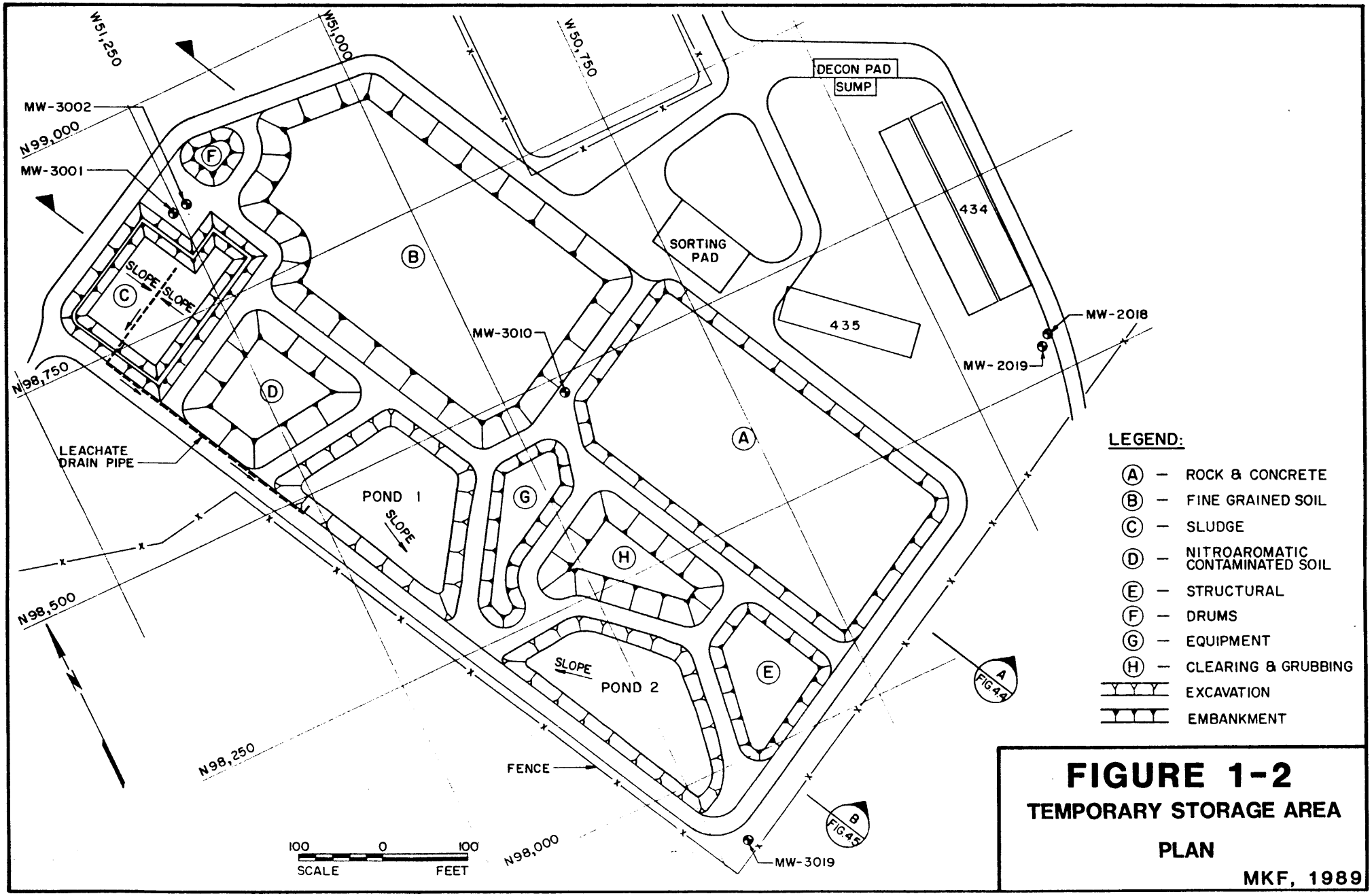


FIGURE 1-2

TEMPORARY STORAGE AREA

PLAN

MKF, 1989

1.3.3 Site History

The Department of the Army and the Department of Energy, formerly the Atomic Energy Commission (AEC), used the Weldon Spring Quarry (WSQ) for waste disposal during their operations from 1942 to 1969. Before 1942, limestone aggregate was mined from the quarry for use in construction of the Weldon Spring Ordnance Works, which was located at the site of the present Weldon Spring Chemical Plant.

Between 1942 and 1945, the Army used the quarry for disposal of wastes generated from manufacturing at the ordnance works. After 1945, rubble contaminated with TNT and other nitroaromatic compounds was dumped into the quarry until 1957.

The ordnance works, which produced both dinitrotoluene (DNT) and trinitrotoluene (TNT), were operated until 1944, and the property was declared as surplus two years later. By the end of 1949, most of the land around the ordnance works and the quarry had been transferred to the State of Missouri and the University of Missouri.

In the mid 1950s, 205 acres of the ordnance works property were transferred to the AEC. This property is now the raffinate pits and chemical plant area. An additional 15 acres were later transferred to the AEC for expansion of waste storage capacity. From 1957 to 1966, the AEC operated a uranium-processing facility at the Weldon Spring Uranium Feed Materials Plant, which subsequently became the Weldon Spring Chemical Plant. Ore concentrates were processed at the plant. Products that included uranium metal were shipped to other sites. Materials containing thorium were processed on an intermittent basis. Radioactive raffinates from the processing were placed in four on-site pits. Other radioactive wastes were disposed of in the quarry. Radioactive waste materials deposited in the quarry

during this period included drummed wastes, uncontained wastes, building rubble, and contaminated process equipment.

After closure by the AEC, the chemical plant was reacquired by the Army in 1967. The Army partially decontaminated several buildings, dismantled some of the equipment, and began converting the facilities to produce herbicides. In 1969, prior to becoming operational, the herbicide project was cancelled. As successor to the AEC, DOE assumed responsibility for the raffinate pits. In 1984, the Army repaired several of the buildings at the chemical plant, decontaminated some of the floors, walls, and ceilings, and isolated some contaminated equipment.

In May 1985, DOE designated the control and decontamination of the Weldon Spring site as a Major Project. (This project has since been designated as a Major System Acquisition.) In October 1985, custody of the chemical plant was transferred to the DOE. A project management contractor (PMC) for the Weldon Spring Site Remedial Action Project was selected in February 1986, and a DOE project office was established on the site in July 1986. The project management contractor, MK-Ferguson Company, assumed control of the Weldon Spring site on October 1, 1986.

On October 15, 1985, the U.S. Environmental Protection Agency (EPA) proposed to include the quarry on the National Priorities List (NPL), and on July 22, 1987, it was placed on the NPL (EPA, 1987). On June 24, 1988, the EPA proposed to expand this designation to include the raffinate pits and chemical plant area. On March 13, 1989, these areas were also included in the listing and resulted in a single designation as the Weldon Spring QY/Plant/Pits (EPA, 1989).

1.3.4 Overview of Investigations

Since the 1950s, government agencies and contractors have conducted intermittent investigations at the Weldon Spring Site to assess the hydrogeologic and environmental setting, and to determine the nature and extent of contaminant sources and environmental contamination of the WSCP and WSQ.

Several types of site-specific studies have been conducted in the chemical plant and quarry areas to achieve these objectives. Geological and hydrogeological investigations have included field reconnaissance and mapping, borehole logging, and sampling programs, monitor well installation, groundwater level measurements, pumping tests, and other aquifer tests. Water quality sampling and analyses for radiological and chemical parameters have been conducted in bedrock and alluvial groundwater. Activities have included borehole and surface sampling of soils and wastes with analyses for radiological and chemical parameters. Sediment and water samples obtained from surface water bodies in and around the quarry have also been analyzed for radiological and chemical parameters. Environmental monitoring of air quality has also been conducted. These studies have confirmed the presence of both chemical and radiological contamination at the WSCP and WSQ.

1.4 REPORT ORGANIZATION

This report is organized according to the suggested Remedial Investigation report format as discussed in the October 1988 "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988). The report focuses on the characterization of the temporary storage area, geotechnical characteristics, soil contamination, and building characterization.

The characterization investigations are summarized in Section 2; the physical characteristics of the study area are presented in Section 3; and the nature and extent of contamination are discussed in Section 4. Data relevant to the characterization (i.e., borehole logs, chemical analysis of both the soil and the buildings, radiological analysis of both the soil and the building, etc.) are included in Appendixes A through G.

2 STUDY AREA INVESTIGATIONS

Numerous previous investigations provided preliminary information on the nature and extent of contamination at the proposed temporary storage area (TSA) site. Much of this data served as background information for the design of sampling plans for the characterization studies conducted by the project management contractor (PMC).

This section presents a brief description of the source of data for characterization of various media related to the TSA. These characterization reports include data from site reports conducted prior to PMC arrival and results generated by the PMC. The results of each of these investigations are described in Sections 3 and 4 of this document.

2.1 SURFACE FEATURES

Topographic mapping of the Weldon Spring Chemical Plant (WSCP), at 1" = 100' scale with a 1-foot contour interval was performed in the mid 1980s by Surdex Corporation. Roads, fences, and other surface features are described in Section 3.1.

2.2 METEOROLOGICAL DATA

Since 1983, various types of meteorological data have been collected at the Weldon Spring Site (WSS) but no long-term data are available. Between 1983 and 1985, meteorological data were collected near the raffinate pits by Shell Engineering and Associates, Inc. (BNI, 1986). Rainfall data have been collected at the chemical plant since 1987 by the PMC (MKF and JEG, 1989e).

Temperature data were collected on the site from April 1983 through March 1985. Temperatures were recorded near the

raffinate pits during that period by Shell Engineering and Associates, Inc.

A study is presently being finalized concerning the representativeness of the surface meteorology data from various meteorological stations.

2.3 GEOLOGICAL INVESTIGATIONS

The geology of the WSS has been described by Bechtel National, Inc. (1983, 1984, 1987) and to a lesser degree by Fishel and Williams (1944), Roberts (1951), Krummel (1956), Moylan and Elser (1967), and Kleeschulte and Emmett (1986).

Fishel and Williams (1944) performed the first hydrogeologic investigation related to contamination at the site. This investigation was related to the Army's ordnance works operation during World War II. In the report of this investigation, they described the area's general geology, structural geology, groundwater conditions, and occurrences of contamination. Roberts (1951) further describes the geology in the area as it relates to groundwater movement. Krummel (1956) mapped the geology of the area just to the south of the WSS. Moylan and Elser (1967) describe the geology at the raffinate pits area. Kleeschulte and Emmett (1986) provide additional information on the stratigraphic and geologic structure in the vicinity of the raffinate pits.

Bechtel National, Inc. performed an extensive geologic site characterization study of the raffinate pit area between December 1982 and April 1983. The study was designed to define the site stratigraphy, describe the lithology and general conditions of each geologic unit, and determine the existence of groundwater and its relationship with the geology. Within the

TSA site this study included: three borings which became observation wells; and two trenches.

Bechtel National, Inc. also conducted a hydrogeological characterization study of the Weldon Spring vicinity. Field work was conducted between January and August 1986. The study was designed to provide a groundwater monitoring system to determine if contaminants from the site had degraded groundwater quality, and to evaluate the site geology and hydrogeology for utilization of the site as a waste disposal facility. Two of the 21 geotechnical borings drilled were located within the TSA site. One trench was excavated in the TSA.

The PMC conducted geologic/geotechnical investigations as part of the 1988 and 1989 Remedial Investigation field programs. The purposes of these studies were to provide design parameters and information necessary to: evaluate the suitability of the site for construction of a waste facility; characterize soil and bedrock units; and fill any data gaps that may have existed. To determine the geotechnical properties of the unconsolidated material beneath the TSA, seven geotechnical borings were drilled and samples collected for laboratory analysis.

2.4 CONTAMINATED SOIL INVESTIGATIONS

Several soil investigations have been conducted to determine the nature and extent of radiological and chemical contamination of soils. The investigations were designed based on the knowledge of past operations of the Weldon Spring Ordnance Works (WSOW) and the Weldon Spring Uranium Feed Material Plant (WSUFMP) and the various chemicals used in the processing.

2.4.1 Chemical Soil Contamination

Chemical soil investigations have focused on determining the level of contamination from nitroaromatic compounds produced during WSOW operations. Numerous anions and metals have been identified which are the result of uranium processing activities at the WSUFMP. The following three major investigations have been conducted.

The primary focus of the 1975 U.S. Army Chemical Demilitarization and Installation Restoration team's efforts was to assess residual explosive material from the previous WSOW operations. Of the eight subsurface soil samples, one sample was located in the TSA.

The PMC conducted a Phase I Chemical Soil Investigation in 1987. Of the 30 sampling locations, two were located within the TSA. This Phase I report principally provided baseline data regarding chemical soil contamination and information on background metal concentrations.

The Phase II Chemical Soil Investigation was designed to fill data needs identified from the review of previous studies. Information obtained from the Phase II investigation, along with the previously existing soil data, was used to identify contamination source areas, determine the extent and magnitude of contamination, evaluate migration pathways, document uncontaminated areas, and provide a database for the preparation of the baseline risk assessment.

The information which is cited in this report comprises the results of the Phase II Chemical Soil Investigation.

2.4.2 Radiological Soil Contamination

Radiological soil contamination investigations have been conducted at the WSCP. The purpose of these studies is to assist in determining the volume of soil which needs remediation, in order to identify potential remedial technologies as part of the Feasibility Study. The investigations previously performed are described in the following paragraphs.

The U.S. Army Radiation Control (RADCON) team surveyed the perimeter of the fence and 10 meters inside the fence and performed surface water and soil investigations. At all sites where surface radiation levels significantly exceeded background levels, sample holes were bored and soil samples were taken. One of these soil samples was located in the TSA. The holes were then logged with an sodium iodide (NaI) probe and a vertical radiation profile was obtained, indicating the depth and extent of soil contamination.

A focused sampling effort was conducted by UNC Geotech from April through July, 1987 (Marutzky et al., 1988). The study report includes descriptions of radiometric measurement methods, data reduction, sampling techniques, and sample analytical methods, as well as data summaries. Boreholes were drilled and soil samples taken at 317 locations, 10 of which were located in the TSA footprint. Surface soil samples were taken at points located on a 25-foot grid pattern.

2.5 SURFACE WATER INVESTIGATIONS

Surface water and sediment investigations have been conducted to determine the nature and extent of chemical and radiological contamination in lakes and streams surrounding the area. The section describing the surface water hydrology

pertains to the drainage of the TSA and describes the run-on/ runoff controls.

2.6 GROUNDWATER INVESTIGATIONS

A number of investigations have been conducted by the PMC and others to characterize physical and chemical groundwater properties at the WSS.

Wells, piezometers, and borings have been installed at the WSS for groundwater monitoring, aquifer testing, geologic characterization, and geotechnical studies. Sections 3.6 and 4.2 describe the groundwater hydrology and water quality (respectively) beneath the TSA.

Groundwater monitoring data are collected as part of a routine environmental monitoring program for the site. The parameters analyzed are either present at elevated concentrations in groundwater samples from the Phase I water quality assessment, or are present on site. The Phase II Groundwater Quality Assessment for the Weldon Spring Site, Chemical Plant, Raffinate Pits, and Surrounding Vicinity Properties summarizes the contamination of the groundwater. The Phase II report analyzes water quality results from third quarter 1988. The analytical quality section of this report pertains only to the wells within the TSA footprint and those immediately upgradient and downgradient of the proposed facility.

2.7 BUILDING CHARACTERIZATION

Several studies have been undertaken to determine the types and amounts of chemical and radiological contamination associated with the chemical plant buildings and other facilities, including overhead outdoor utilities, railroad rails and ties, and electrical transformers.

A survey was conducted during the fall of 1977 by Ryckman/Edgerly/Tomlinson and Associates (RETA) for the Department of the Army. RETA was contracted to determine whether the buildings, equipment and realty of the WSCP could be released for public or private use where contamination was not detrimental to such use, or decontaminated for unrestricted use.

All buildings and sumps on the WSCP site were subjected to a radiological screening survey, including alpha, beta and gamma measurements. Selected sumps in every building were examined with sodium iodide (NaI) spectroscopy to determine isotopic composition and material quantity. The concrete pads and areas surrounding the buildings were also scrutinized for surface contamination. Beta, gamma, and alpha contact readings were taken at grid points and at some selected points outside the grids. Hand-held gamma detectors were used at the ground surface of the sewers to identify subsurface patterns of radiological contamination.

Beginning in 1986, the PMC has undertaken several radiological and chemical investigations of individual buildings, facilities and equipment.

The PMC has conducted sampling of buildings and equipment to determine levels of radiological contamination. This information has been used to determine which buildings and equipment can be released for unrestricted use.

The PMC also conducted surveys to determine the amount of asbestos-containing material (ACM) in the outdoor overhead utilities and in the buildings. A survey to characterize the asbestos content of insulation on outdoor overhead utilities was conducted in November 1986. Exterior bulk sampling was used for this characterization. Samples were collected from 10 locations

within the chemical plant complex. The sampling locations were selected so that insulation on all types of pipe (steam, raffinate, ethylene glycol, and process) and all sizes of each type of pipe could be sampled.

Sampling for preliminary identification of interior ACM was conducted in August 1986 and May 1987. The objective of the interior bulk sampling was to identify typical building materials, such as equipment insulation, that contain asbestos rather than to conduct a comprehensive survey of the site for ACM.

In late 1988 and early 1989, the PMC conducted a chemical sampling program in the non-process buildings. This program was designed to sample for asbestos and polychlorinated biphenyls (PCBs).

Contents of numerous tanks, drums, and miscellaneous containers were sampled as part of the containerized chemical inventory. These containers will be disposed of as part of an Interim Response Action.

3 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 SURFACE FEATURES

The Weldon Spring Site (WSS) is located in southwestern St. Charles County. The county, roughly triangular in shape, is bounded by the Mississippi River on the north and east and the Missouri River on the south. The site is situated at the southern edge of the dissected till plains of the Central Lowlands Physiographic Province.

Elevations at the temporary storage area (TSA) range from approximately 652 ft mean sea level (msl) near the southwest edge to approximately 671 ft msl near the southeast edge (Figure 3-1). Land surface slopes are generally gentle except in the vicinity of embankments or levees for the raffinate pits.

The major surface features in the area of the TSA are man-made. Raffinate pits 1, 2, 3, and 4 were constructed in the late 1950s and early 1960s for receiving process wastewater. In addition to process wastes, they have received precipitation and runoff. The topography of the raffinate pits influences the direction and rate of surface runoff in their vicinity. The man-made dikes for the raffinate pits extend up to 20 ft above the surrounding ground surface.

Buildings and structures associated with former ordnance works activities have been demolished and removed from the TSA site. The remaining buildings, facilities, and structures were used to support the Uranium Feed Materials Plant operations. The buildings and other facilities that will be removed from the area are:

- Buildings 435, 436, 437, and 438
- An active 30-inch water line

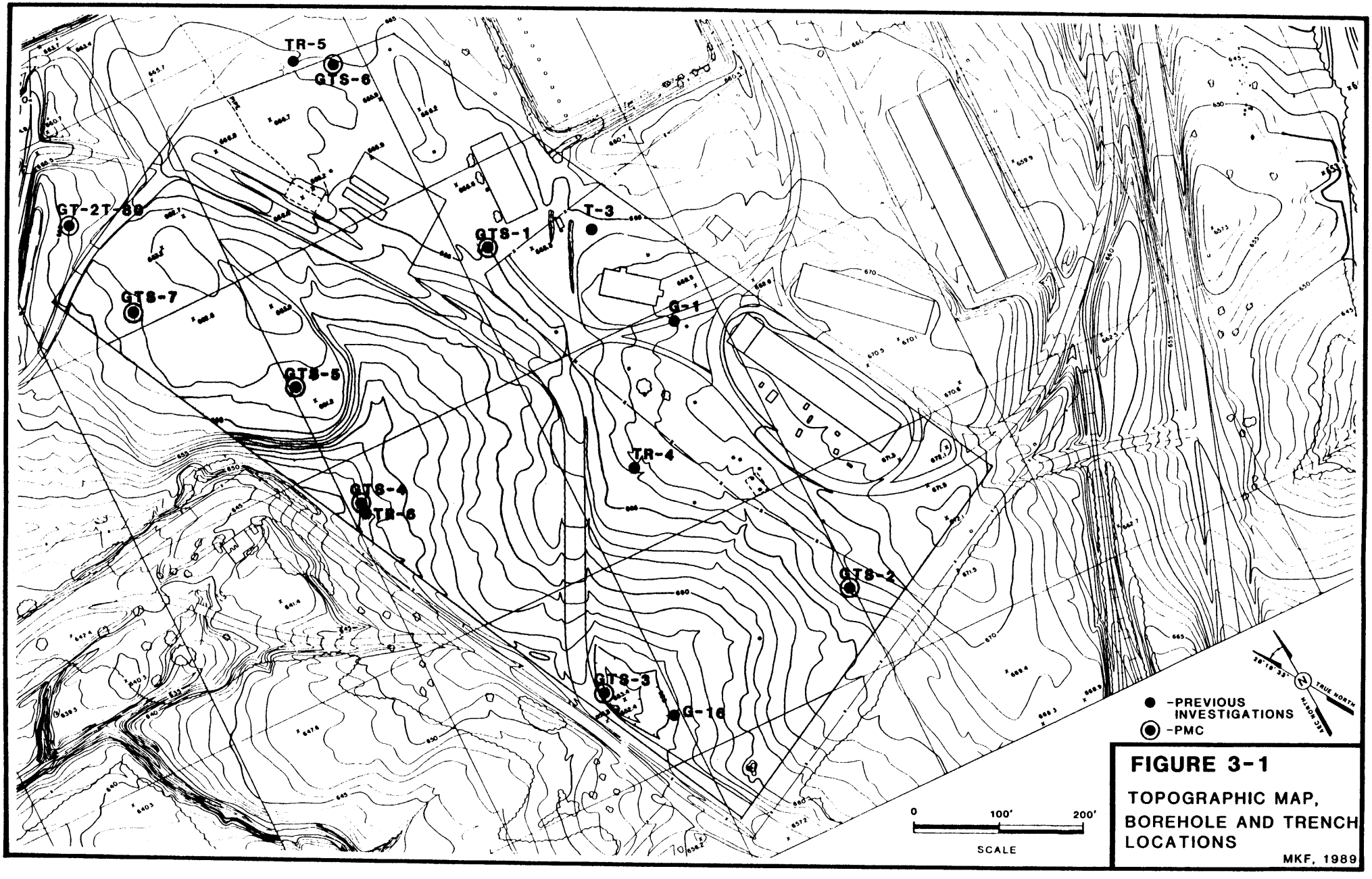


FIGURE 3-1

TOPOGRAPHIC MAP, BOREHOLE AND TRENCH LOCATIONS

MKF, 1989

- o An active 12-inch water line
- o Stockpiled road material
- o Fencing
- o Inactive water utilities
- o Buried tanks
- o Decon pad line to Pit 3
- o Abandoned sewer lines
- o Active electric line

Refer to Figure 3-2 for locations of these structures. The remainder of the TSA site is generally covered with vegetation or gravel.

3.2 METEOROLOGY

Total annual precipitation for the two years for which data is complete were 36.89 inches in 1984 and 32.07 inches in 1988 (BNI, 1986 and MKF and JEG, 1989e). It is reported that local rains can be very heavy, with 10 inches having been recorded in one 24-hour period (DOE, 1987).

The average annual temperature for 1984, the only year of complete temperature data, was 56.5°F. For comparison, the average 1984 temperature recorded at St. Charles was 54.7°F.

Wind speeds and directions were recorded during 1985. Prevailing winds are from the south during the summer and fall. Wind speeds during these months average 8.7 mph. Winds during the winter months are from the northwest and west-northwest, averaging 11 mph (BNI, 1986b).

Evaporation/evapotranspiration data are limited to a 7-month period between April 1983 and April 1984. Freezing conditions prevented the operation of monitoring equipment from November to March. Total evaporation ranged from 31.5 inches to

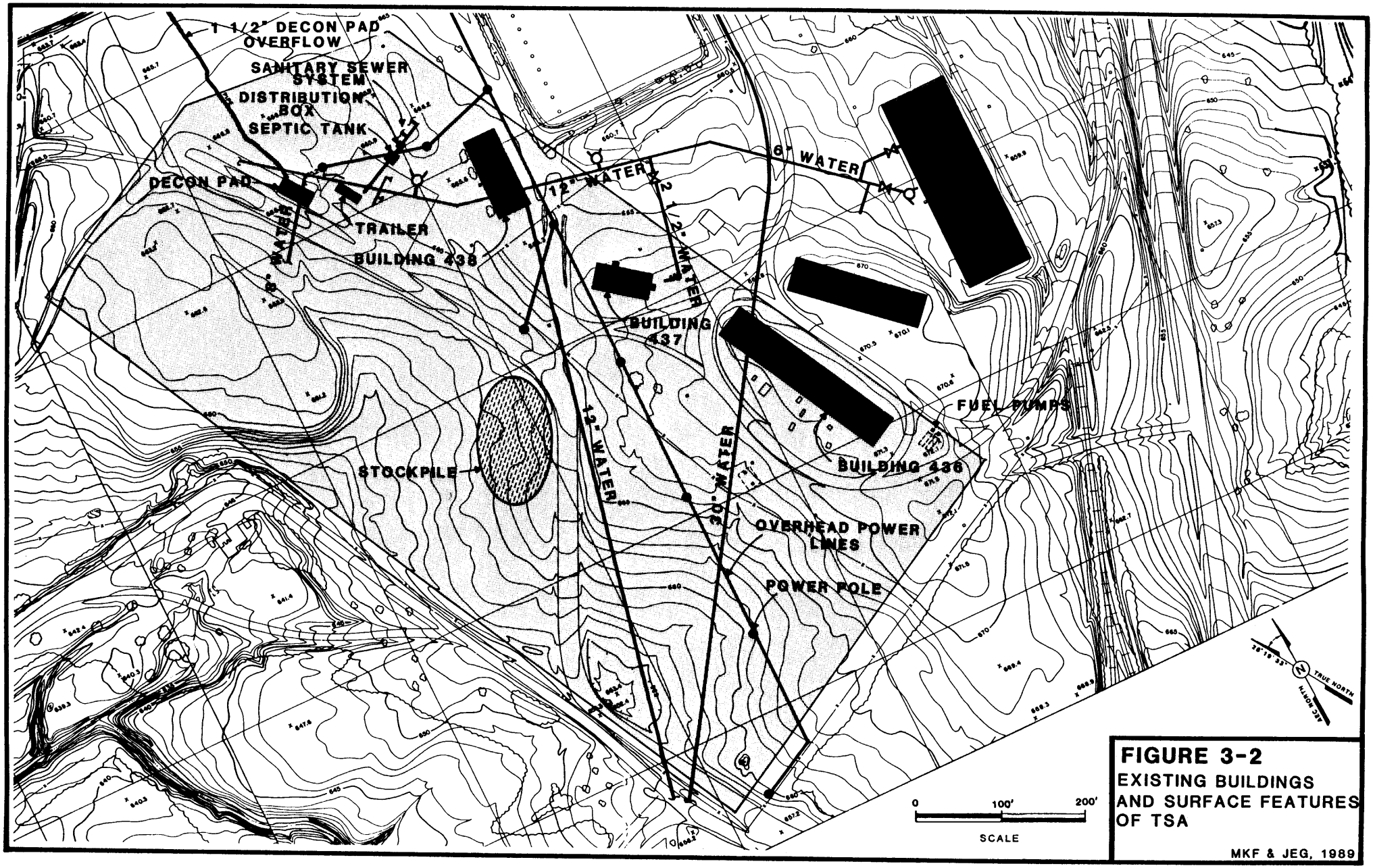


FIGURE 3-2
EXISTING BUILDINGS AND SURFACE FEATURES OF TSA

MKF & JEG, 1989

38.3 inches during the 7-month period. Corresponding precipitation was 27.0 inches and 27.9 inches, respectively (BNI, 1986a). However, based on regional annual averages, the precipitation and evaporation rates are equal.

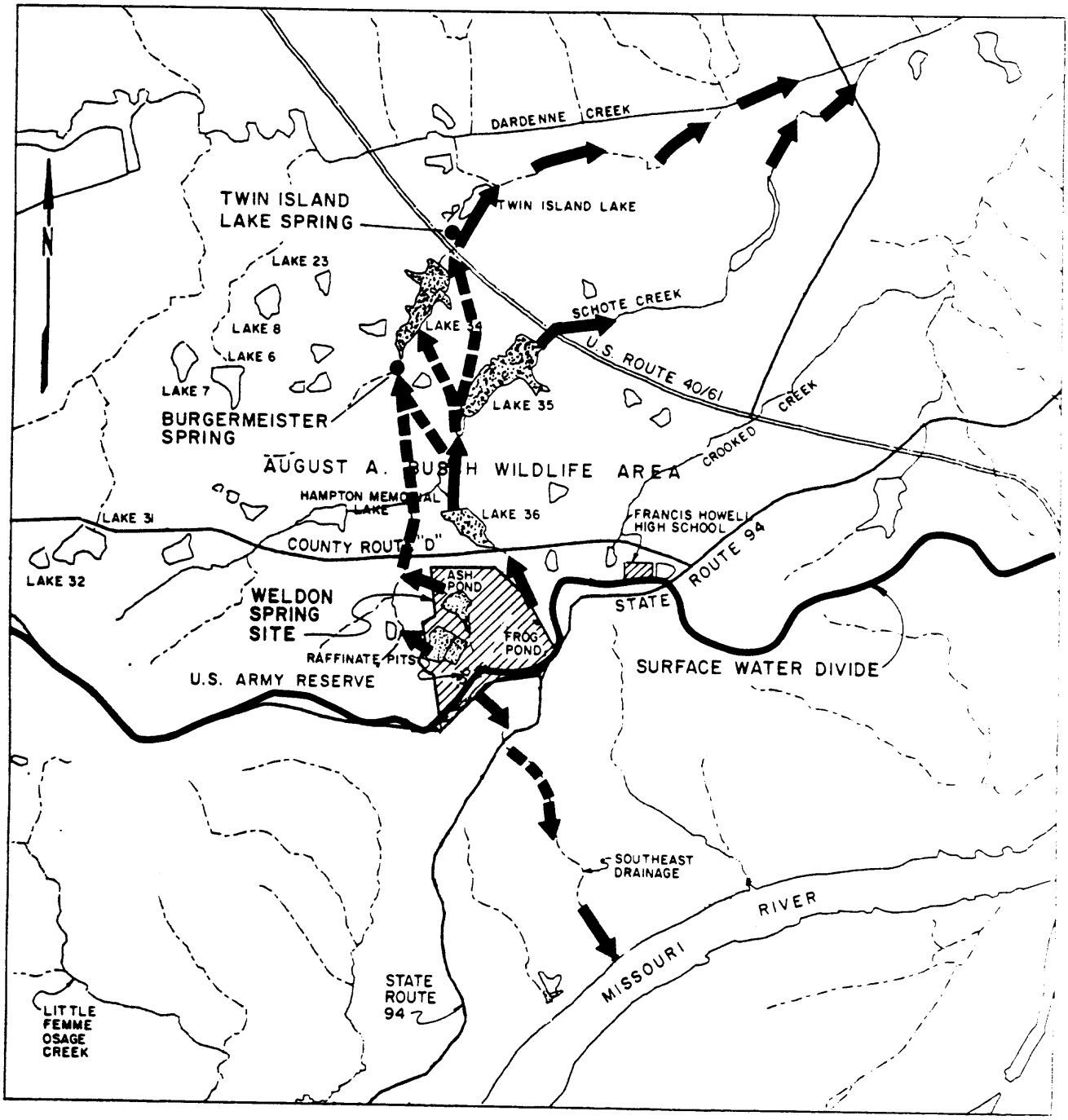
Between 1916 and 1958, 446 tornadoes were reported in Missouri, an average of about 10 each year. About 70 percent of these storms occurred from March through June. About 82 percent occurred between noon and midnight, with the greatest activity between 4:00 and 6:00 p.m. Tornadoes occur in the St. Louis area once or twice per year, but they usually have a narrow path and often dissipate after a few miles. During the most recent 40-year period of records for the St. Louis area, there have been a limited number of tornadoes that produced extensive damage and loss of life. The probability of a severe tornado touchdown at any location within the state of Missouri is once every 2,080 years (RETA, 1978).

3.3 SURFACE WATER HYDROLOGY

The site is located on a drainage divide between the Mississippi and Missouri rivers (Figure 3-3). The northern part of the WSS drains to Schote Creek, then to Dardenne Creek, and then to the Mississippi River. Drainage from the southern portion of the site flows to unnamed tributaries flowing into the Missouri River (Figure 3-4).

3.3.1 The Mississippi River Drainage

The Mississippi River drainage area on-site is divided into three major drainage basins: the Ash Pond area, the Frog Pond area, and the raffinate pit vicinity. This report is concerned only with the raffinate pit vicinity.



LEGEND:

- PRESENTLY CONTAMINATED WATER BODY
- SPRINGS
- SURFACE WATER FLOW PATH FROM THE WSS
- KNOWN GROUNDWATER FLOW PATH TO SPRING AT SURFACE
- CREEK OR DRAINAGE DITCH

0 3200 6400
SCALE FEET

FIGURE 3-3

SURFACE WATER FLOW PATHS FROM THE WSS

MKF, 1988

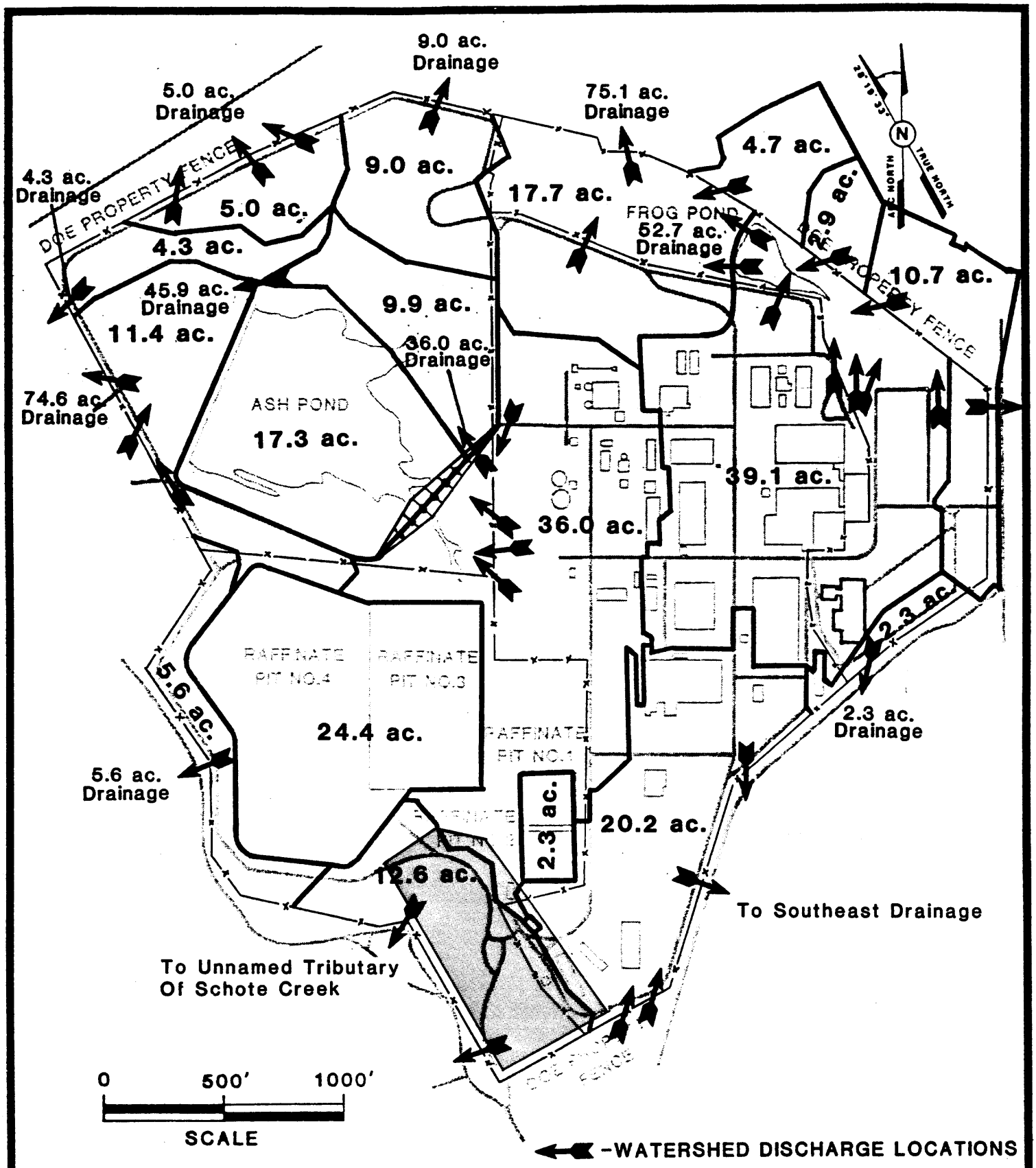


FIGURE 3-4

DRAINAGE AREAS OF THE WSCP AND WSRP

MKF, 1980

The drainage in the raffinate pit vicinity enters an unnamed tributary to Schote Creek and flows to Lake 35. Lake 35 overflows to Schote Creek during extreme precipitation events. Schote Creek joins Dardenne Creek just east of Highway K (see Figure 3-3).

The unnamed tributary and Schote Creek lose water to the subsurface. Much of this lost flow resurfaces at Burgermeister Spring just south of Lake 34.

Lake 35 has lost water to the subsurface since its construction. In early 1987, a small swallow hole opened near the headwaters of Lake 35. Missouri Department of Natural Resources dye studies determined that some of this lost water resurfaces in Lake 34. Subterranean flow surfacing at Burgermeister Spring flows into Lake 34. Lake 34 outflow enters an unnamed tributary of Dardenne Creek. Dardenne Creek flows northeast to the Mississippi River.

3.3.2 Missouri River Drainage

The southeast portion of the Weldon Spring Chemical Plant (WSCP) drains toward the Missouri River. Drainage is overland via the southeast drainage easement, an intermittent stream valley approximately 1.5 miles long. Some of the rainwater and snow melt enters various man-made drains in the chemical plant area. These drains flow into the process sewer which exits southward from the site to a drainage ditch and flows to the Missouri River.

3.3.3 TSA Drainage

The U.S. Army Corps of Engineers has developed some preliminary estimates of hydrologic parameters for Schote Creek at the site (DOE, 1987). According to these estimates, the

100-year and 500-year flood peak discharges for the main stem of Schote Creek are 2,100 cfs and 2,700 cfs, respectively. The 500-year flood elevation near the raffinate pits is approximately 530 feet above mean sea level, which is considerably lower than the elevation of the site.

The volume of surface water drainage in the TSA could be quite large. For example, according to the data presented in Appendix B (the most recent available), the total rainfall in 1988 was 32.5 inches. Assuming no infiltration (impervious soil) or evapotranspiration, the volume of runoff for the temporary storage area in 1988 would have been over 11 million gallons.

All stormwater runoff and leachate from the TSA will drain by ditches and swales to collection ponds within the TSA. The stormwater runoff and drainage system will be designed for a 25-year, 24-hour storm (approximately 5.67 inches of rainfall in 24 hours). See Table 3-1. These collection ponds will be sized to accommodate the design storm with one foot of freeboard provided. The design will also include a double liner and a leachate collection system. The retention ponds will be pumped directly to the site water treatment plant in order to maintain freeboard.

Design flow rates of the run-on control system will be based on a 25-year storm event with a minimum time of concentration of 2.5 minutes. Erosion protection of ditches will normally be limited to grass lining. Diversion ditches will be utilized to route surface water away from the TSA (see Section 4.1.2, Environmental Concerns, in the WSSRAP Quarry Preliminary Engineering Report (MKF and JEG, 1989f)).

TABLE 3-1 Temporary Storage Area Design Criteria

Location Requirements

- o place 10 ft above the historical high water table
- o locate above the 100 yr floodplain

Liner Requirements

- o design, construct, and install to prevent any migration of wastes to the surrounding environment

- o construct of materials having appropriate chemical properties and sufficient thickness to prevent failure due to:

  - pressure gradients (static head and external hydrogeologic forces)
  - physical contact with the waste or leachate
  - climatic conditions
  - installation stress
  - daily operation stress
  - uneven loads

- o install to cover all surrounding earth expected to come in contact with the waste

- o have sufficient thickness to prevent migration

- o sustain integrity for a design life of 20 years

- o have a maximum permeability of 1×10^{-7} cm/sec

Leachate/Run-Off Collection Systems (LRCS)

- o design to contain a water volume resulting from a 25-year, 24-hour storm

- o allow no more than one foot of leachate over the lining system for the given design storm

- o ponds will consist of a double liner and a leachate collection system

- o construct of materials that are:

  - chemically resistant to the waste
  - of sufficient strength and thickness to prevent collapse under the pressure exerted by the overlying wastes, waste cover materials, and operational equipment

- o design and operate to function without clogging through the design life of 20 years

TABLE 3-1 Temporary Storage Area Design Criteria (Continued)

Run-On Control System

- o prevent flow onto the active portion of the facility during peak discharge from a 25-yr storm

Cover Requirements

- o minimize moisture infiltration
- o prevent wind dispersion of particulate matter during operations and closure
- o concentration of radon 222 shall not exceed:
  - 100 pCi/L at any point
  - an annual average of 30 pCi/L over the facility
  - an annual average of 3 pCi/L at the facility perimeter
- o provide proper drainage to the LRCS

3.4 GEOLOGY

The geology of the WSCP and raffinate pits area has been described in various studies. The rocks in the area have a regional strike of N60°W and a regional dip of approximately 1/2 degree to the northeast. The regional dip is predominantly from the Ozark Dome, though several other features influence the dip. These include the northwest-trending Eureka/House Springs anticline, which is the structural feature nearest to the site. The axis of this feature is located approximately four miles to the southeast.

3.4.1 Unconsolidated Materials

The unconsolidated materials, or overburden, in the TSA area can be categorized into six units from younger to older:

- Topsoil/fill
- Loess (wind-blown)
- Ferrelview Formation
- Clay till
- Basal till/clay till
- Residuum

The unconsolidated material underlying the TSA ranges from 27 ft to 50 ft thick, thinning west and south of the area. (See Figure 3-5.) Table 3-2 presents a summary of borehole data collected from previous investigations and PMC investigations within the TSA site.

Table 3-3 presents unconsolidated material thickness as determined from trench logs. The topsoil/fill unit is the uppermost unconsolidated material. The topsoil/fill is generally a black, organically rich, silty clay or clayey silt. Topsoil thickness ranges from less than 6 in. to 3 ft 9 in.

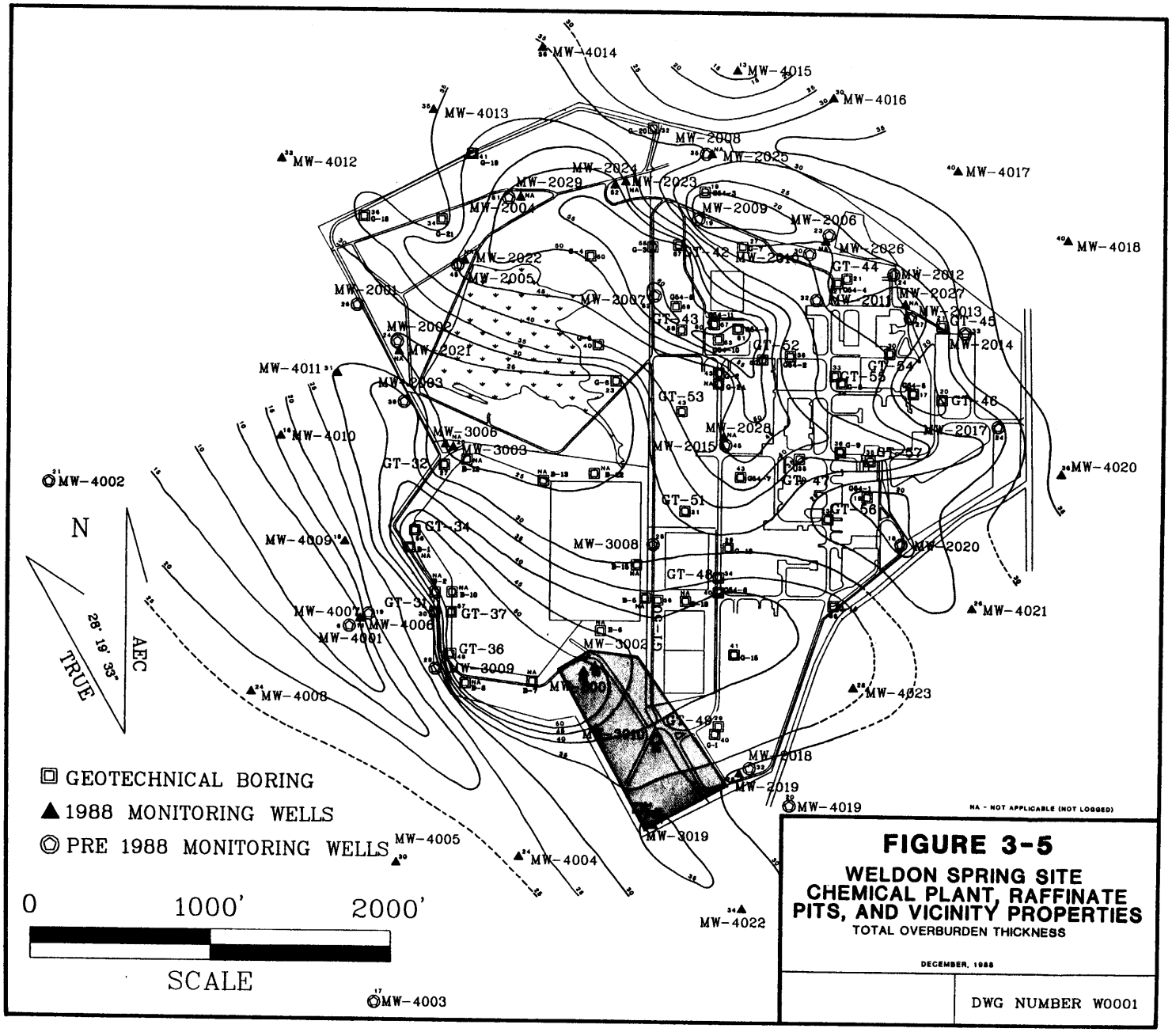


FIGURE 3-5

WELDON SPRING SITE CHEMICAL PLANT, RAFFINATE PITS, AND VICINITY PROPERTIES

TOTAL OVERBURDEN THICKNESS

DECEMBER, 1988

DWG NUMBER W0001

TABLE 3-2 Borehole Statistics

Borehole Number	Ground Elevation (ft - MSL)	Overburden Thickness (ft)	Total Depth of Hole (ft)	Depth to Groundwater (ft)	Installation Date
B-21 *	644.41	35.0	99.4	35.7	04/19/83
B-22 *	665.09	38.0	90.7	52.0	04/19/83
G-1 +	668.0	39.7	84.0	52.0	01/31/86
G-16 +	656.7	34.0	80.4	28.0	06/05/86
GTS-1	665.35	39.8	39.8	- -	05/12/89
GTS-2	668.17	37.3	37.3	- -	05/09/89
GTS-3	654.97	31.5	31.5	- -	05/08/89
GTS-4	652.20	27.3	27.5	- -	05/10/89
GTS-5	662.64	37.0	37.0	- -	06/06/89
GTS-6	665.28	47.0	47.0		06/07/89
GTS-7	662.07	44.5	44.5		06/08/89

* BNI, 1983
+ BNI, 1987

NOTE: B-21 is presently MW-3009
B-22 is presently MW-3010

TABLE 3-3 Unconsolidated Material Thicknesses

Trench Number	Depth to Topsoil/Fill (ft)	Depth to Loess (ft)	Depth to Ferrelview (ft)	Depth to Clay Till (ft)	Depth to Basal Till (ft)	Total Depth (ft)
TR-4 *	0 - 1	- -	1 - 19.0	19.0 - 22.1	- -	22.1
TR-5 *	0 - 1.5	- -	1.5 - 19.8	19.8 - 22.8	- -	22.8
TR-6 *	0 - 3.75	- -	3.75- 12.8	12.8 - 19.7	19.7 - 21.1	21.1
T-3 +	0 - 1.5	1.5 - 7.9		N/A	N/A	15.0
GT-2T-80	0 - 0.5	- -		N/A	N/A	12.0

* BNI, 1983
\+ BNI, 1987

The loess unit appears isolated due to its absence in the other trenches and borings. As shown in Table 3-3, the T-3 log exhibited loess, but loess was not present in any of the borings or other trenches.

The Ferrelview Formation is a mid-Pleistocene glacial till plain sediment. The unit ranges from 5 ft to 20 ft in thickness and consists of a mottled gray and dark yellowish-orange silty-clay to clayey-silt. The unit is generally stiff and plastic. Iron oxide nodules and manganese oxide (pyrolusite) precipitates are common. The unit commonly displays slickensides as a result of post-depositional compaction and consolidation. Also, irregular blocky fractures are sometimes encountered which continue through the underlying clay till. Block fractures are described as tight dry features which are often coated with calcium or manganese minerals of a powdery or concretionary nature. Laboratory tests for particle size distribution indicate a majority of silt- and clay-sized particles in this unit with minor sand and fine gravel.

The clay till unit underlies the Ferrelview Formation. The clay till ranges in thickness from 10 ft to 20 ft. This unit is a lower Pleistocene glacial till (Kansan) (BNI, 1987) and is composed of yellowish-brown silty-clay and clayey-silt with some sand and rounded pebbles of chert and igneous and metamorphic detritus. Material in this unit is very stiff and moderately to highly plastic. Blocky fractures having manganese oxide precipitates (pyrolusite) as coatings are abundant.

The basal till unit is the lowest member of the Pleistocene glacial till sediments. It underlies the clay till and is found mainly on the western and north central portions of the site. Deposition of the basal till unit is generally thin or absent in areas of higher bedrock elevations, and is thicker where bedrock elevations are lower. The basal till ranges in thickness from

0 ft to 10 ft and can generally be described as a yellowish-brown sandy-, clayey-, silty-gravel having angular chert in a poorly bound matrix.

The residuum unit is located beneath the basal till at the base of the unconsolidated material. The residuum is interpreted to be a pre-Pleistocene weathering product of the underlying cherty argillaceous limestone. The residuum is approximately 5 ft thick and is typically a distinctive red to minor yellow gravelly-clay to gravelly-silt. The gravel fraction is generally weathered chert fragments but contains minor weathered limestone. Interstitial clay is usually quite plastic and tends to form a tight matrix within the gravel fraction.

3.4.2 Bedrock Geology

The uppermost bedrock unit underlying the TSA is the Mississippian Burlington-Keokuk Limestone. Figure 3-6 presents the structural topography of this formation. This formation is composed of fine to coarse grained limestone with abundant chert occurring as nodules and beds. The upper portion of this unit is highly to moderately weathered, highly to moderately fractured, yellowish-brown to white limestone containing 40% to 60% chert. This formation contains solution features in the form of vugs (ranging from pinpoint to 1 in.). The solution features are generally filled with mixtures of silt, clay, and chert gravel. Both the solution features and predominant fractures appear to be oriented parallel to bedding planes in the limestone. Because of the variation in the erosion of the limestone, this unit has variable thickness.

The lower portion of the Burlington-Keokuk Limestone is slightly weathered to fresh, slightly fractured, gray to brownish-gray to gray limestone, and contains approximately 30%

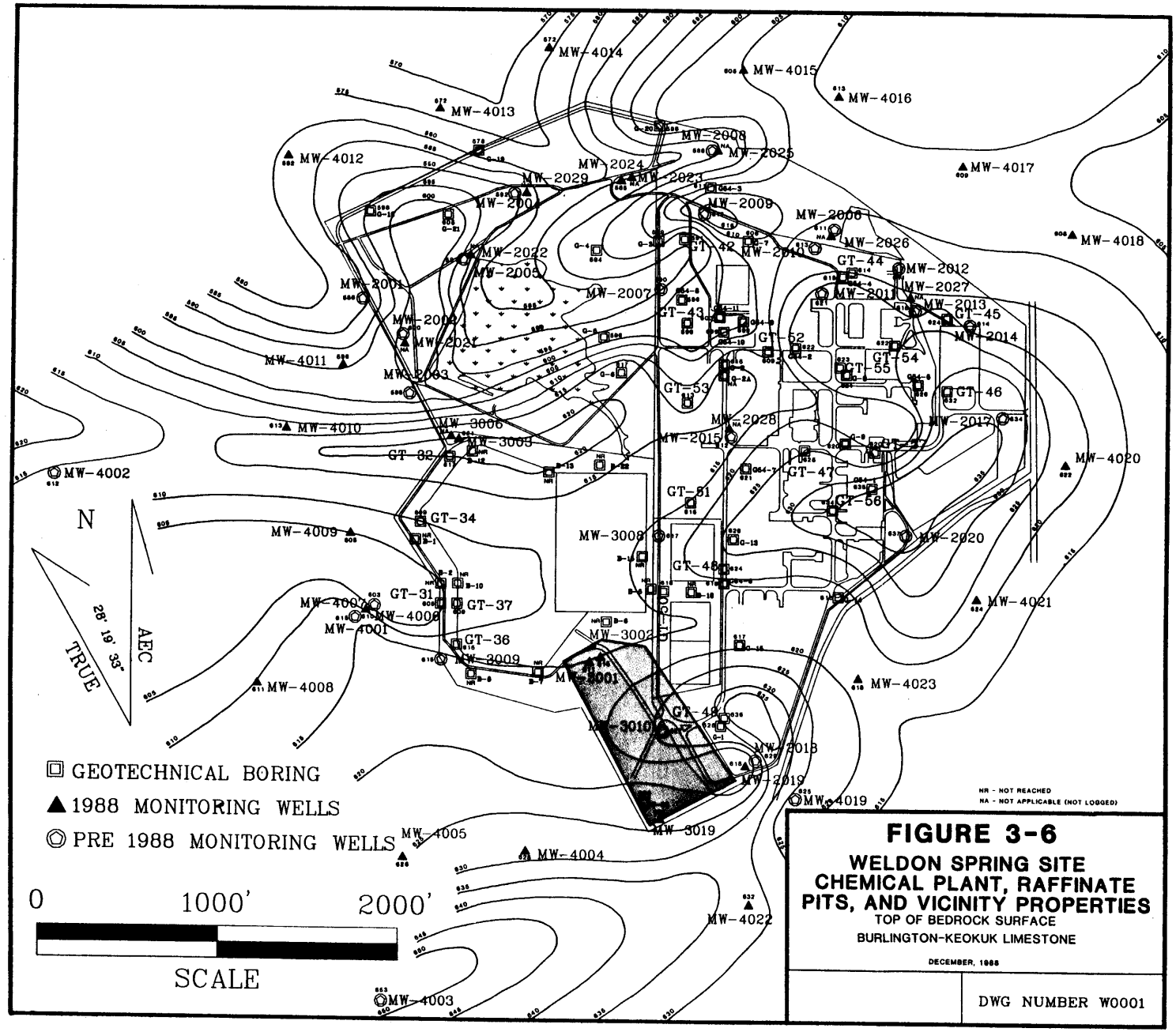


FIGURE 3-6

WELDON SPRING SITE CHEMICAL PLANT, RAFFINATE PITS, AND VICINITY PROPERTIES

TOP OF BEDROCK SURFACE

BURLINGTON-KEOKUK LIMESTONE

DECEMBER, 1988

DWG NUMBER W0001

chert. Solution features are limited to occasional vugs in the upper portion. Stylolites (pressure solution features) and/or shale interbeds are common in this unit.

The formation underlying the Burlington-Keokuk Limestone is the Fern Glen Limestone. This formation is a thin-to-thick bedded, crystalline to argillaceous limestone. Chert is common in this formation with the occurrence of occasional calcareous shale interbeds.

Other bedrock units below the Fern Glen Limestone to the Potosi Dolomite are shown in Figure 3-7. The Salem Formation and the Warsaw Formation are absent in the TSA.

No faults are evident in the exposed bedrock units, but two joint systems have been identified. One set trends N30°E and N72°E, and the other trends N30°W and N65°W. These joint systems are present in the Burlington-Keokuk, the Chouteau Limestone, and the Kimmswick Limestone, and are vertical or near vertical.

3.4.3 Seismicity

The TSA lies within the tectonically quiet Central Stable Region near the Mississippi Embayment boundary. The New Madrid seismic zone within the Mississippi Embayment is currently the most seismically active area and lies approximately 93 miles southwest of the TSA. Published earthquake studies suggest maximum intensities for the area to be between "VII and VIII on the modified Mercalli scale, or a near site magnitude of 5.3 to 5.8" (BNI, 1983). The site meets the seismic criteria for a Resource Conservation and Recovery Act (RCRA) facility since there are no active faults within 200 feet of the TSA.

SYSTEM	SERIES	STRATIGRAPHIC UNIT	TYPICAL THICK (FT)	LITHOLOGY	HYDROSTRATIGRAPHIC UNIT
QUARTERNARY	HOLOCENE	ALLUVIUM	0.5-4		ALLUVIAL AQUIFER
	PLEISTOCENE	LOESS & GLACIAL TILL	15-55		(unsaturated) *
MISSISSIPPIAN	MERAMECIAN	SALEM FORMATION	0-15		(unsaturated) *
		WARSAW FORMATION	60-80		
	OSAGEAN	BURLINGTON-KEOKUK LIMESTONE	100-200		MISSISSIPPIAN-DEVONIAN AQUIFER SYSTEM
		FERN GLEN FORMATION	45-70		
	KINDERHOOKIAN	CHOUTEAU GROUP	20-50		
DEVONIAN	UPPER	BUSHBERG SANDSTONE	40-55		
		LOWER SULPHUR SPRINGS GROUP (UNDIF.)			
ORDOVICIAN	CINCINNATIAN	MAQUOKETA SHALE	10-30		ORDOVICIAN LEAKY CONFINING UNIT
	CHAMPLAINIAN	KIMMSWICK LIMESTONE	70-100		
		DECORAH GROUP	30-60		
		PLATTIN LIMESTONE	100-130		
		JOACHIM DOLOMITE	80-105		
		ST. PETER SANDSTONE	120-150		ORDOVICIAN-CAMBRIAN AQUIFER SYSTEM
	CANADIAN	POWELL DOLOMITE	50-60		
		COTTER DOLOMITE	200-250		
		JEFFERSON CITY DOLOMITE	160-180		
		ROUBIDOUX FORMATION	150-170		
		GASCONADE DOLOMITE	250		
CAMBRIAN	UPPER	EMINENCE DOLOMITE	200		
		POTOSI DOLOMITE	100		

* THESE UNITS ARE BELIEVED TO BE UNSATURATED IN THE WSS VICINITY

MODIFIED FROM : MKF & JEG, 1989; WHITFIELD ET. AL, 1989; KLEESHULTE AND EMMETT, 1987

FIGURE 3-7

GENERAL STRATIGRAPHY AND HYDROSTRATIGRAPHY OF THE WELDON SPRING AREA

Three faults are shown on the Geologic Map of Missouri (Missouri Geologic Survey, 1979) and the U.S. Geologic Survey Map MF 1011, a preliminary Seismotectonic Map of the Central Mississippi Valley. These faults include: (1) a NW-trending fault approximately 5 miles north of the TSA; (2) the north-trending St. Louis Fault approximately 28 miles east of the TSA; and (3) an unnamed east-trending fault approximately 25 miles north of the TSA (Whitfield et al, 1989). None of the above-mentioned faults are considered capable.

3.5 SOIL - PHYSICAL CHARACTERISTICS

An ongoing geotechnical testing program to define specific engineering properties for detailed design and construction specifications is currently taking place. For purposes of this report a comparison was made between the logs from boreholes drilled at the TSA in 1989 and the laboratory testing results from previous drilling operations (Figure 3-1). This proved to be sufficient to ascertain the suitability of the site for construction of the proposed TSA (see Appendix C).

The unconsolidated material thickness underlying the TSA ranges from 27 ft to 50 ft thick. The majority of this material consists of the Ferrelview Formation and the clay till. As shown in Table 3-4, the engineering properties of the Ferrelview Formation and the clay till are consistent with the design requirements for liner permeability as described in Table 3-1. As shown in Table 3-2 the depth to groundwater beneath the TSA ranges from 28 ft to 52 ft. No persistent zones of perched water were identified. In one boring, GTS-2, 2 inches of soft saturated material was observed at about 10.8 ft.

The TSA pad and liner will be of sufficient strength and thickness to prevent failure due to uneven loads, physical contact with the waste or leachate, climatic conditions, stress

TABLE 3-4 Summary of Laboratory Testing of Overburden Soil Samples
(Based on test results from Oct. 88 to May 89)

	Loess	Ferrelview	Clay Till	Basal Till/ Clay Till	Residuum	Raffinate Pit Dike Fill
% of Grain Size						
Gravel	0	0	1	0 *	28	0
Sand	2	5	19	26	24	12
Silt	68	60	40	39	48	48
Clay	30	35	40	35		40
Atterberg Limit						
Liquid Limit	41	48	52	37	72	49
Plastic Index	22	31	36	20	50	31
Unified Soil Classification	CL	CL-CH	CL-CH	CL	GC	CL
Specific Gravity	2.71	2.68	2.71	2.61	2.79	2.63
Unit Weight (lb/ft^3)						
Dry	100	101	108	106	88	102
Wet	113	124	128	125	118	125
Moisture Content (%)	22.5	23.0	19.8	18.3	22.9	20.8
Hydraulic Conductivity ** (Permeability) (cm/sec)	6.2×10^{-6}	8.9×10^{-8}	2.6×10^{-8}	3.8×10^{-8}	5.0×10^{-8}	
Consolidation ***	$C_c = 0.144$ $C_r = 0.022$	$C_c = 0.173$ $C_r = 0.033$	$C_c = 0.153$ $C_r = 0.042$	-- --	$C_c = 0.142$ $C_r = 0.052$	
Coeff. of Consolidation (cm^2/sec)	4.1×10^{-4}	6.0×10^{-4}	1.4×10^{-4}	--	1.0×10^{-4}	
Shear Strength						
Total (from VU test)	c = 1160 psf $\theta = 0$	c = 1380 psf $\theta = 0$	c = 1140 psf $\theta = 0$	c = 1060 psf $\theta = 0$	-- --	
Effective (from CU test)	c = 240 psf $\theta = 35^o$	c = 250 psf $\theta = 19^o$	c = 110 psf $\theta = 26^o$	-- --	c = 260 psf $\theta = 15^o$	

* Gravel portions of the basal till usually not obtainable from conventional sampling methods used. Therefore, gradation values are for the non-gravel size particles only.

** Values averaged using geometric mean method.

*** C_c = virgin compression ratio; C_r = recompression ratio

Notes:
1. Values in table are average values based on available laboratory test results as of May 1989. (--) denotes result not available yet or no test was performed. Results from additional testing subsequent to May 1989 will be published in addendum or separate reports.

2. Average values were calculated using arithmetic mean method unless otherwise noted.

3. All tests are performed on disturbed or undisturbed samples.

of installation, stress of daily operation, or the stress of loading material on and off of the storage area. It will be placed on a foundation capable of providing support to the liner and resistance to uneven loads above and below the liner due to settlement, compression, or uplift. The precise moisture density and compaction requirements for construction of the clay liner and foundation will be determined based on the geotechnical characterization program.

Geotechnical laboratory testing on the samples from the 1989 field program include:

- index properties tests such as gradation, Atterberg limits, natural moisture content, dry unit weight, shrinkage, and specific gravity

- capillary moisture tests for evaluation of long-term moisture content for radon attenuation studies and for correlation of unsaturated hydraulic conductivities with soil saturation

- one-dimensional consolidation tests for compressibility and analysis of time-dependent settlement behavior of fine grained soils

- compaction tests for determination of maximum dry density and optimum water content

- falling head permeability tests for classifying the relative soil permeability

- triaxial shear strength tests (consolidated-undrained or unconsolidated-undrained) for evaluation or total strength parameters of the soils

3.6 GROUNDWATER HYDROLOGY

Three aquifer systems have been identified in the Weldon Spring area. These are the alluvial aquifers, the shallow bedrock aquifer system, and the deep bedrock aquifer system (Kleeschulte and Emmett, 1987). Alluvial aquifers are not present at the TSA site; however, in boring GTS-2, at approximately 10.8 ft, 2 in. of soft saturated material was observed, but this appears to be isolated.

The shallow bedrock aquifer system is composed of saturated Mississippi and Devonian aged rocks which range from 250 ft to 650 ft in thickness and compose the uppermost bedrock unit in the area. At the TSA the Mississippian-Devonian aquifer system includes formations from the Burlington-Keokuk Limestone through the lower part of the Sulfur Spring Group as shown in Figure 3-7.

The deep bedrock aquifer system is composed of saturated Ordovician-Cambrian aged rock which is approximately 1,000 ft thick and consists of Ordovician and Upper Cambrian formations, including the St. Peter Sandstone through the Potosi Dolomite.

The Mississippian-Devonian aquifer system is the uppermost aquifer present beneath the TSA; the upper portion of the system consists of saturated rocks of the Burlington-Keokuk Limestone, which is subdivided on the basis of degree of weathering.

The Burlington-Keokuk Limestone at the TSA is subdivided into shallower and deeper zones. The shallower zone is the weathered and fractured portion of the Burlington-Keokuk Limestone, which is generally characterized by a higher hydraulic conductivity than the thicker deeper zone. The shallower zone within the Burlington-Keokuk Limestone is of

particular concern at the site because it is the zone most likely to permit contaminant migration.

Potentiometric surfaces of the shallower and deeper Burlington-Keokuk are depicted on Figures 3-8 and 3-9. Within the shallow bedrock aquifer under the WSS is a regional groundwater divide which corresponds roughly to the regional surface divide between the Mississippi and Missouri river drainages. The groundwater divide axis of the shallower aquifer transects the TSA. To the north of the divide, groundwater moves to the northeast toward Dardenne Creek. South of the divide, groundwater moves to the southeast toward the Missouri River. The groundwater divide in the deep Burlington-Keokuk is roughly parallel to the shallow bedrock aquifer divide (Figure 3-9).

The location of the divide axis was determined by static water level measurements of the monitoring wells. Monitoring well construction details showing screen location are given in Table 3-5.

In the northern portion of the TSA the upgradient monitoring well in the shallow flow regime is MW-3001; the downgradient well is MW-3009. In the southern portion of the TSA, MW-3010 is the upgradient well, and MW-2018, MW-3019, and MW-4019 are the downgradient wells.

The location of the groundwater divide axis migrates northwest with depth as shown in Figure 3-9. In the deeper portion of the Burlington-Keokuk Limestone, the divide axis is located to the north of the TSA, and consequently the groundwater beneath the TSA flows to the southeast toward the Missouri River Basin.

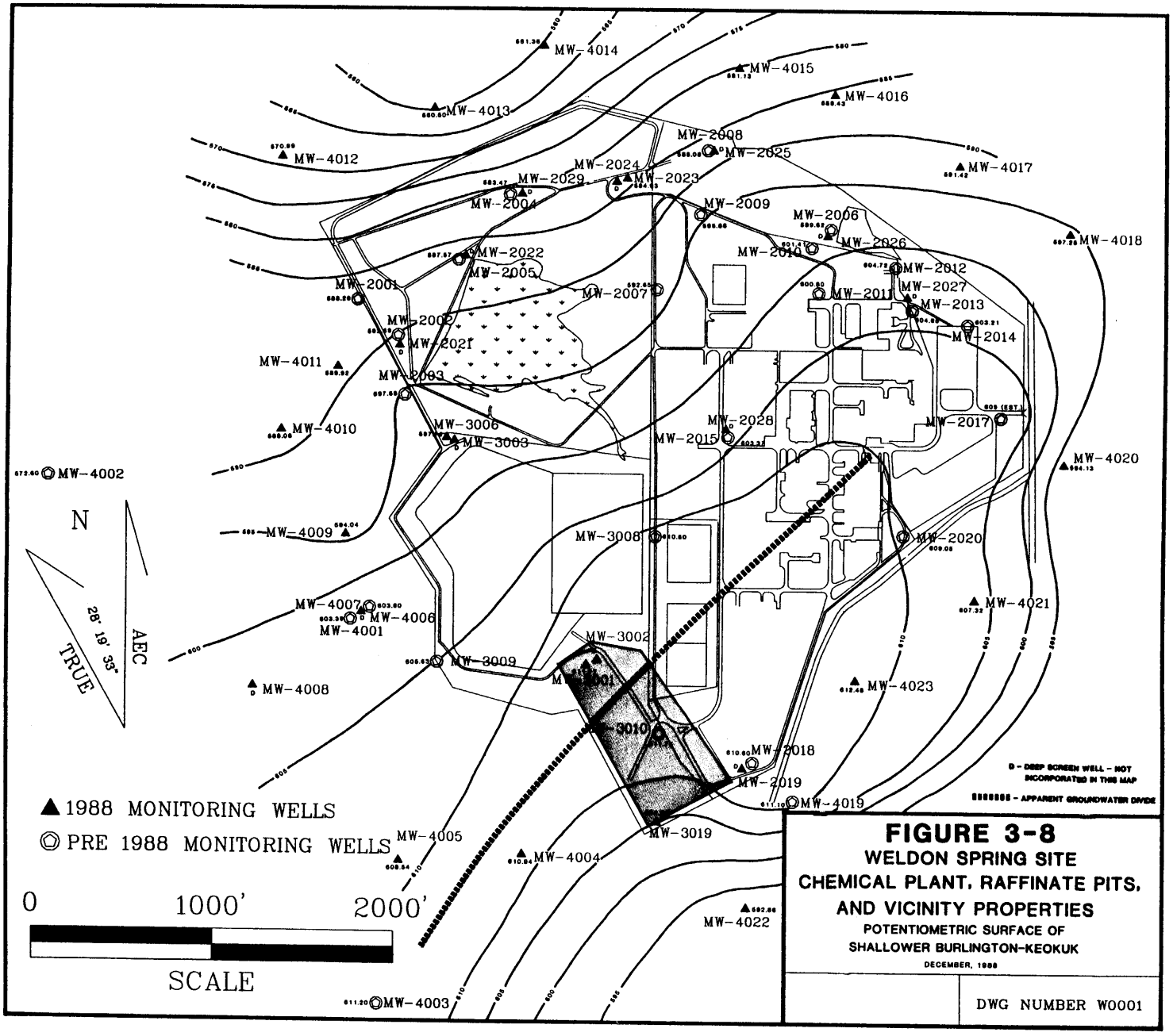


FIGURE 3-8

WELDON SPRING SITE
CHEMICAL PLANT, RAFFINATE PITS, AND VICINITY PROPERTIES
POTENTIOMETRIC SURFACE OF SHALLOWER BURLINGTON-KEOKUK
DECEMBER, 1988

DWG NUMBER W0001

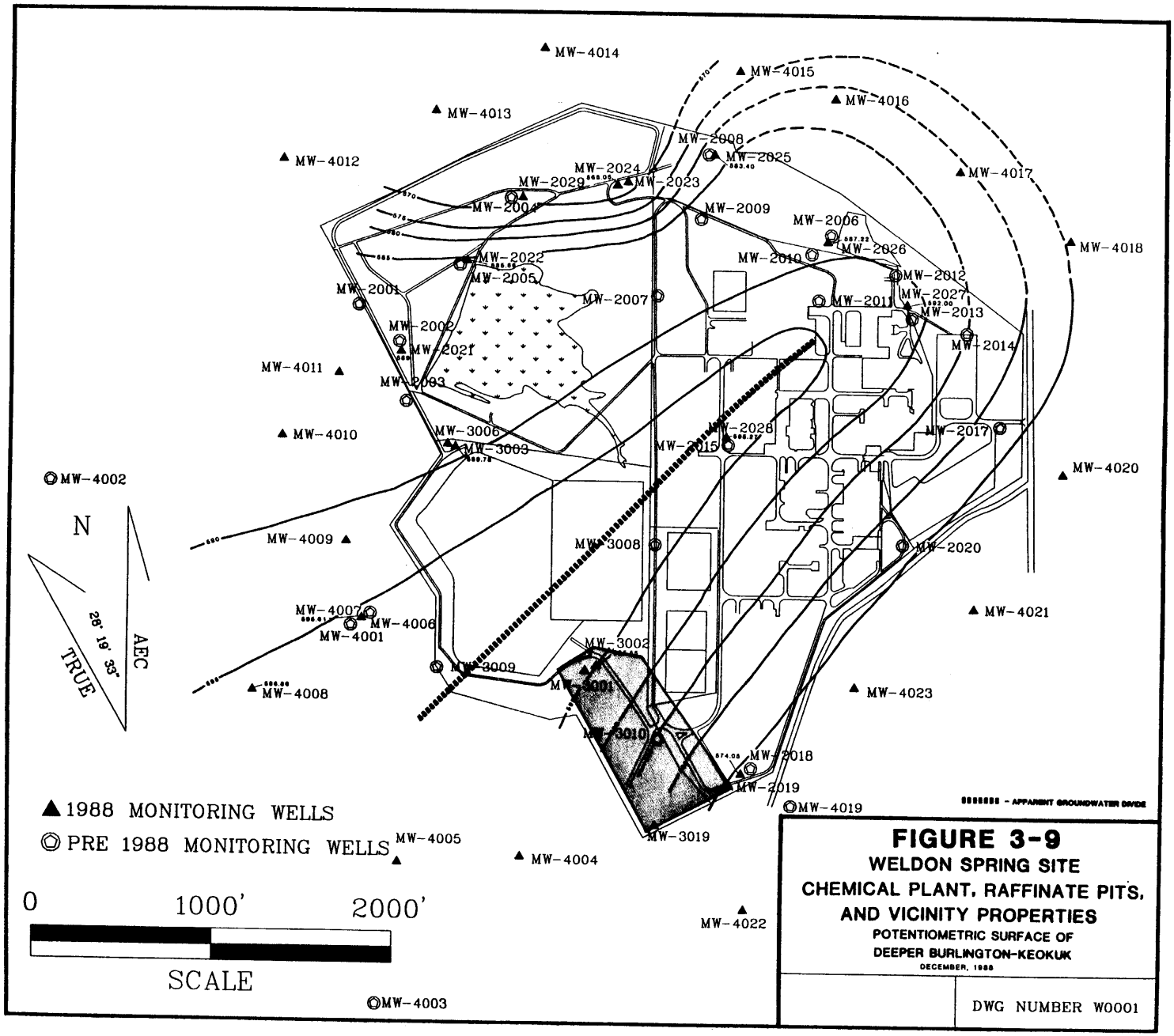


FIGURE 3-9

WELDON SPRING SITE
CHEMICAL PLANT, RAFFINATE PITS, AND VICINITY PROPERTIES
POTENTIOMETRIC SURFACE OF DEEPER BURLINGTON-KEOKUK
DECEMBER, 1988

DWG NUMBER W0001

TABLE 3-5 Monitoring Well Construction Data

Well Number	Ground Elevation (Ft-MSL)	Total Hole Depth (Ft-MSL)	Top of Screen Elevation (Ft-MSL)	Bottom of Screen Elevation (Ft-MSL)	Top of Filter Pack Elevation (Ft-MSL)	Top of Bedrock Elevation (Ft-MSL)	Length of Screen (Ft)
MW-2018	661.49	69.00	608.49	598.49	624.90	628.99	10.00
MW-2019*	661.50	116.40	555.50	545.50	558.50	631.90	10.00
MW-3001	664.25	89.50	609.25	589.25	611.58	610.75	20.00
MW-3002*	664.72	147.60	527.22	518.22	530.72	603.72	9.00
MW-3009+	644.30	99.40	599.30	544.90	599.30	614.80	54.40
MW-3010+	665.02	90.70	612.52	574.32	612.52	627.02	38.20
MW-3019	660.14	83.67	586.44	576.47	590.14	627.00	10.00
MW-4019	645.66	61.00	597.66	587.66	605.66	625.46	10.00

* Deep well
+ Open rock well

Pumping tests, tracer tests, and slug tests were conducted in the spring of 1989 to determine the aquifer characteristics of the Burlington-Keokuk Limestone. Of the seventy-two slug tests performed in the WSS area, three were performed on wells in the TSA. These wells included MW-2018, MW-2019, and MW-3019. The hydraulic conductivity was determined from slug test data using the Hvorslev method and the Bouwer and Rice method. Hydraulic conductivities were found to range from 8.0×10^{-6} ft/sec to 2.7×10^{-7} ft/sec using the Hvorslev Method (1951) and 1.7×10^{-7} ft/sec to 6.0×10^{-8} ft/sec using the Bouwer and Rice Method (1976).

3.7 BUILDINGS

3.7.1 Building 435

Building 435 is a prefabricated steel panel structure. The dimensions of the building are 150 ft x 40 ft x 20 ft. It is divided into five rooms. The building was used for storage and other miscellaneous activities. The room at the north end of the building was the electrical shop. Presently, this room contains numerous cabinets, work benches, and other work tables.

The second room from the north was used to store water-treatment chemicals and miscellaneous mechanical parts. The water-treatment chemicals have recently been removed as part of the interim response action.

The center room contains a large table, several small tables, shelves, file cabinets, pallets, a space heater, and map stand. A small office was also built into this room.

The second room from the south contains four fume hoods, cabinets, and work bench tops from the laboratory building.

There are also various types of ovens, other equipment, and furniture.

The south room contains numerous shelves on which are various pieces of electrical, sampling, and safety equipment.

3.7.2 Building 436

Building 436 is a steel frame Butler building, 180 ft x 40 ft x 20 ft high. It is divided into two sections, north and south. There is an enclosed office area in the southeast corner of the building.

The building at the present time is used for storage. In the southern half of the building there are numerous items, such as sinks, toilets, urinals and different items of furniture. Also stored in this part of the building are freezers and numerous pipe fittings. Between the north and south rooms is a restroom.

The north room, like the south room, also stores various items. These items include firebricks, a chlorine trailer, electric motors, office furniture and cast metal in crates. Initial survey results indicate that the castings are contaminated. Other materials stored include fire extinguishers, furniture, ladders, fixtures and items removed from other buildings.

3.7.3 Building 437

Building 437 is a single-story brick building on a concrete foundation. Dimensions are 70 ft x 33 ft x 15 ft high. This building was part of the previous ordnance works, and was later used as storage space for reports, files, etc. The building is empty except for some file cabinets, office furniture, a furnace

and debris. The building is comprised of seven rooms. All interior walls are brick. The roof is flat with built-up tar and gravel. Small areas of roofing insulation have deteriorated and fallen to the floor. The building is equipped with fluorescent hanging lights and a burglar alarm system.

3.7.4 Building 438

Building 438 is a steel frame Butler building with concrete floor and foundations. Dimensions are 100 ft x 40 ft x 16 ft high. The building was erected during construction of the chemical plant, after which it was used for storage.

The interior walls and roof are all steel I-beam construction with only the exterior steel sheeting exposed. A 10 ft x 30 ft office was built on the south end of Building 438 using drywall construction. The office ceiling is 10 ft high with a storage area above.

Building 438 contains pieces of process equipment and hoppers that are highly contaminated with visible uranium residue. Scale models of different chemical plant and process areas are also stored here.

4 NATURE AND EXTENT OF CONTAMINATION

4.1 SOIL

This section presents the results and interpretations of the chemical soil characterization and the radiological soil characterization programs. Soil concentrations above the determined background or the stated reference criteria are defined, either chemically or radiologically, and possible sources identified. Concentrations are included for each given parameter along with corresponding locations.

4.1.1 Chemical Contamination

The documentation of previous investigations of soil contamination was evaluated during development of the sampling plan for Phase I of the Chemical Soil Investigation for the Chemical Plant/Raffinate Pits. The Phase II Chemical Soil Contamination Report (MKF and JEG, 1989a) was designed to complete characterization for the 217-acre Weldon Spring Chemical Plant/Raffinate Pits (WSCP/WSRP) area. A detailed description of these investigations and discussion of data validity are contained in the sampling plan prepared by MK-Ferguson Company and Jacobs Engineering Group (MKF and JEG, 1988b).

The previous studies provide baseline information regarding chemical soil contamination. The investigations detected elevated concentrations of nitroaromatic compounds, inorganic anions, pesticides, polychlorinated biphenyls (PCBs), metals, and semi-volatile organic compounds. The interpretations in this section take this historical information into account.

Each group of analytical parameters is discussed separately. Figure 4-1 illustrates the sampling locations.

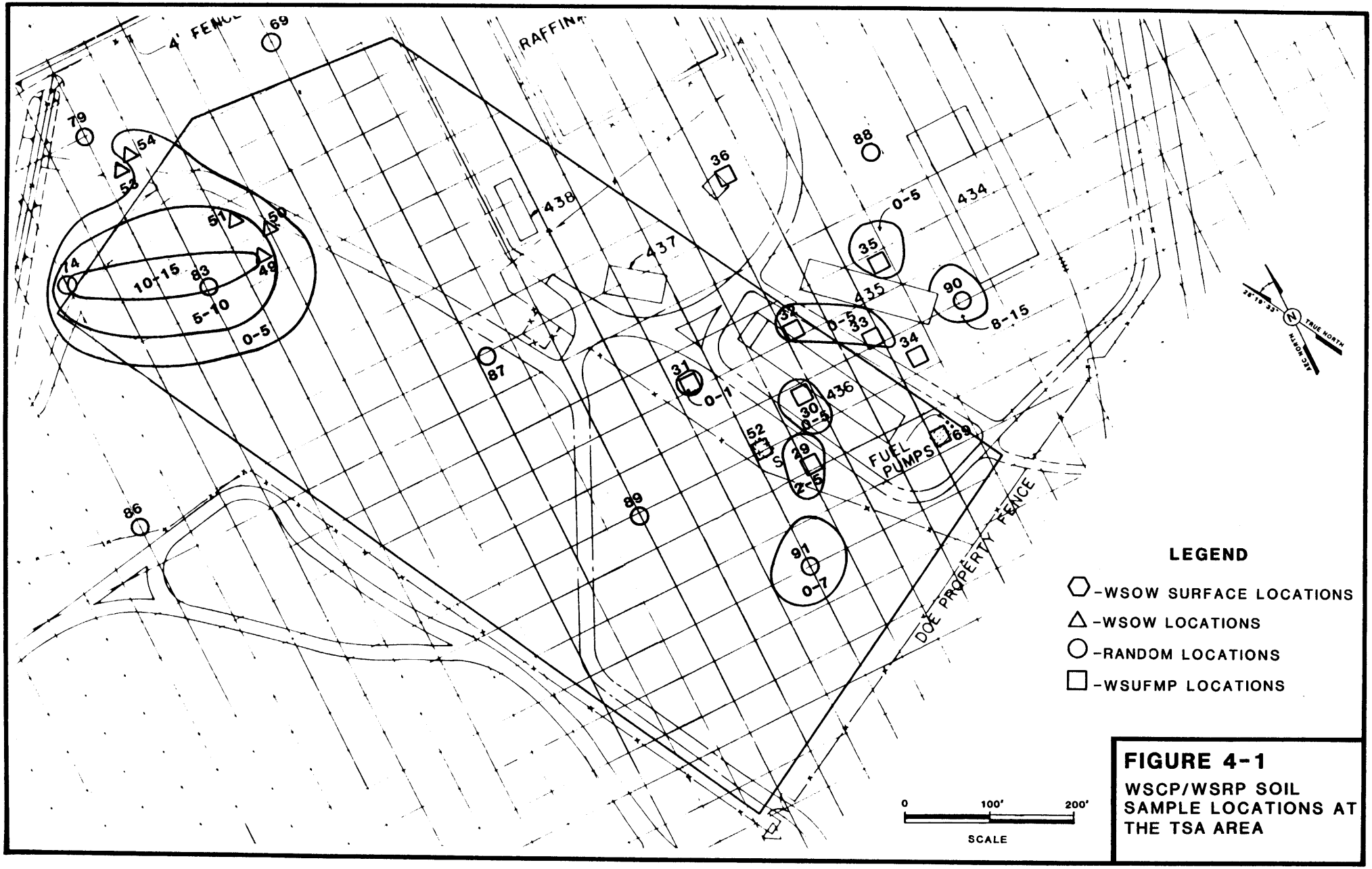


FIGURE 4-1
WSCP/WSRP SOIL SAMPLE LOCATIONS AT THE TSA AREA

These locations consisted of both biased and unbiased sampling programs designed to detect contamination from Weldon Spring Ordnance Works (WSOW) and Weldon Spring Uranium Feed Materials Plant (WSUFMP) processes and sources. The locations of interest are A-29, A-30, A-31, A-32, A-33, A-34, A-35, A-52, A-69, C-49, C-50, C-51, C-53, C-54, D-74, D-79, D-83, D-87, D-89, D-90, and D-91. "A" designates a biased location from WSUFMP processes; "C" designates biased locations from WSOW processes; and "D" designates random locations. Analytical results of the chemical parameters are shown in Appendix D.

Since no cleanup criteria guidelines for chemically contaminated soil have been established, reference-level concentrations have been created for discussion purposes in order to identify chemically contaminated soil. This is not intended to set a precedent but is for presentation purposes only. For each contaminant, data from the previous investigations were used to calculate mean background concentrations. Standard deviations were calculated and upper background limits for each contaminant were established by adding two times the standard deviation to the corresponding mean background concentration. Background limits for some contaminants were established at their analytical detection limits. Since nitroaromatics, PCBs, and some semi-volatile organic compounds do not occur naturally, any concentration above the detection limit was considered. Contaminants and their corresponding reference levels are shown in Table 4-1. The maximum depth of contamination for a particular borehole location is shown in Table 4-2. Figure 4-1 illustrates the areal extent of elevated contaminants.

4.1.1.1 Nitroaromatic Compounds

Nitroaromatic compounds (2,4-DNT and 1,3,5-TNB) were detected at location C-49, which was the site of the

TABLE 4-1 Contaminants and Corresponding Reference Levels

Contaminant	Reference Value[a] (µg/g)	Boreholes Contaminated
Nitroaromatic	0*	C-49
Nitrate	29	D-90
Nitrite	1	C-54
Sulfate	168	A-29, A-33, A-35, C-49 C-50, C-51, C-54, D-74
Fluoride	28.6	C-49
Aluminum	47,800	- -
Arsenic	25	A-30, D-74, D-83
Barium	681.2	C-50, C-51, A-52
Beryllium	4.2	- -
Calcium	9,500	A-30, A-33, D-91
Cadmium	1	A-30, A-33, D-83
Cobalt	71	- -
Chromium	75.2	- -
Copper	50	- -
Iron	58,200	C-49
Mercury	0.2	A-33, D-74, D-83, D-91
Potassium	1,000	A-30, A-33
Lithium	46	- -
Magnesium	6,830	A-30
Manganese	3,020	C-49, D-74
Molybdenum	49	- -
Silver	2	- -
Sodium	1,420	D-83
Nickel	52	- -
Lead	78	C-51
Antimony	12	A-32, C-50
Selenium	1	- -
Vanadium	104	- -
Zinc	116	A-32
Semi-volatile	0*	A-31

* These contaminants are not found in nature; therefore anything detected was considered contamination.
a Reference value = two times upper background

TABLE 4-2 Maximum Depth of Contamination at Sampled Locations

Borehole Contaminated	Contaminant	Depth of Contamination (ft)
A-29*	Sulfate	1 - 5
A-30*	Arsenic, calcium, cadmium, potassium, magnesium	0 - 5
A-31*	Semi-volatile	0 - 1
A-32*	Antimony, zinc	0 - 5
A-33*	Sulfate, calcium, cadmium, mercury, potassium	0 - 5
A-34		- - -
A-35*	Sulfate, arsenic, calcium, cadmium, mercury, potassium	0 - 5
A-69		- - -
C-49	TNT, DNT, sulfate, fluoride, iron, manganese	0 -10
C-50	Sulfate, barium, antimony	0 - 4
C-51	Sulfate, barium, lead	0 - 6
C-53		- - -
C-54	Nitrite, sulfate	0 - 8
D-74	Sulfate, arsenic, mercury, manganese	0 -15
D-79		- - -
D-83	Arsenic, cadmium, mercury, sodium	0 -15
D-87		- - -
D-89		- - -
D-90*	Nitrate	8 -15
D-91*	Calcium, mercury	0 - 7

* Coincides with radiologically contaminated zones.

Trinitrating House of TNT Production Line No. 4 (4-T-9), at maximum concentrations of 6.31 micrograms per gram (µg/g) and 1.88 µg/g, respectively. This contamination was observed four feet below the ground surface, corresponding with the amount of fill at that location (MKF and JEG, 1989a).

Although some nitroaromatic compound contamination was detected in this area, analyses indicate that there is very limited nitroaromatic contamination in the temporary storage area (TSA) soils. Low level contamination is present only in an isolated area.

4.1.1.2 Inorganic Anions

Elevated inorganic anion concentrations were observed in the WSCP/WSRP areas in previous investigations. There are numerous potential sources of this contamination. Nitric and sulfuric acids were used in both the WSOW and the WSUFMP. Spills and routine discharges from these facilities provided mechanisms for soil contamination with inorganic anions. The WSUFMP also used hydrofluoric acid which provided a potential source for fluoride contamination.

An important consideration in evaluating inorganic anion concentrations in soils is the naturally occurring levels present in the soil at the WSCP/WSRP. Previous inorganic anion soil data was statistically evaluated in the Interim Response Action (IRA) Soils Report (MKF and JEG, 1988c) and onsite background concentrations were determined. Offsite samples were taken from areas unaffected by WSOW and WSUFMP processes. These offsite data were used to establish the validity of the earlier statistical background values. Onsite and offsite background levels were approximately the same. The specific procedures and methods used to develop these data can be found in the Phase II Soil Characterization report (MKF and JEG, 1989a).

4.1.1.2.1 **Nitrate**. Elevated nitrate concentrations were observed in the soil near Buildings 435 and 436. Locations A-32 and A-34 exhibited slightly above-background concentrations in surface (0 to 1 ft) samples. This contamination is probably related to WSUFMP usage of these buildings. The 8- to 15-ft interval at Location D-90 contained 427 µg/g nitrate. The source of this contamination is not known.

4.1.1.2.2 **Sulfate**. Sulfate contamination is fairly widespread across the WSS. Elevated sulfate concentrations were detected at locations A-29, A-30, A-31, A-33, A-35, C-49, C-50, C-53, and D-91. Locations C-49, C-50, and C-53 correspond to WSOW building locations. This contamination originated as wastewater from WSOW processes. The contamination appears to be limited in areal extent and restricted to the upper 5 ft of soil. Concentrations range up to 1,407 µg/g. Locations A-29, A-30, A-31, A-33 and D-91 are clustered around several WSUFMP support facilities. Sulfate concentrations are generally less than 200 µg/g. These elevated levels are present in subsurface samples, indicating contamination from WSOW fill sources rather than from the equipment stored there.

4.1.1.2.3 **Fluoride**. Fluoride contamination was detected 4 ft to 6 ft below the surface at location C-49 at a concentration of 112 µg/g. This location also contained elevated sulfate and nitroaromatic concentrations. The source of the fluoride contamination at this location is not known, but the extent appears to be limited, based on other sampled intervals and adjacent borings.

4.1.1.3 Metals

Because acid was used in the processes at the WSOW and the WSUFMP, the soil is likely to be contaminated with metals. The general WSOW process included the use of nitric and sulfuric

acids. Many buildings used lead sheeting to reduce sparking. The nature of the material present in the uranium ore processed at the WSUFMP increased the potential for metal contamination. Samples from the WSOW biased sampling program were analyzed for the following metals: aluminum, antimony, barium, iron, lead, magnesium, and manganese. Samples from the WSUFMP biased sampling program were analyzed for the complete U.S. Environmental Protection Agency's Contract Laboratory Program (CLP) metals list.

Elevated metal concentrations were observed at numerous locations throughout the WSUFMP biased sampling program. Slightly elevated concentrations of calcium and mercury were observed at numerous locations. A general explanation of these elevated concentrations is provided in the following paragraphs.

Slightly elevated calcium concentrations are generally attributable to the use of limestone aggregate in many areas. Limestone was not specifically sampled, but limestone-soil mixtures were. Slightly elevated calcium levels are not of concern, given the high, naturally-occurring background concentrations.

Very low concentrations of mercury were observed at many locations. The background concentration of mercury is below the method detection limit of 0.1 µg/g. The slightly elevated concentrations are generally below 0.3 µg/g. Mercury was probably used in instrumentation throughout the WSCP and may have been present in the processed ore. Low concentrations can be expected, given the operational history of the site.

Limited amounts of metal contamination related to WSOW sources were detected. However, elevated magnesium levels were observed at location C-50. This location is either in or near an area of WSOW wastewater production. The exact source of

contamination is not known, but it is probably related to the dissolution of magnesium fittings and/or equipment by acidic wastewater. This magnesium contamination is not widespread, according to results from adjacent samples and boreholes.

Elevated concentrations of barium were also observed at locations C-49, C-50, C-51, and C-54. These concentrations range from slightly above to three times the upper background limit.

Locations C-49 and C-50 exhibited above-background aluminum levels. These locations are in areas where acidic wastewater was generated or transported. Many of these aluminum concentrations were less than twice background. These slightly elevated levels are not sufficient to affect groundwater or surface water. Background concentrations of aluminum in area soils range up to 27,700 µg/g, which is not unusual given the clay soils present (1989a).

Samples collected from locations A-30, A-32, A-33 , and A-35 contained elevated arsenic, aluminum, magnesium, potassium, selenium, and vanadium concentrations. Magnesium and arsenic were the only metals detected at elevated concentrations in surface soils. The remaining metals are present in subsurface soils. This contamination is related to the miscellaneous uses of the building and/or to the radiologically contaminated debris stored in and around these buildings. The extent of contamination is limited to the area immediately adjacent to these structures.

Two locations, D-74 and D-83, contain elevated concentrations of arsenic, barium, cadmium, cobalt, nickel and sodium. The source of shallow contamination is not known, but deeper contamination may be related to seepage from the WSRP.

4.1.1.4 Pesticides

Pesticides were not manufactured at the Weldon Spring Site, but they may have been used to control insects. No pesticide contamination has been detected in the location of the TSA.

4.1.1.5 Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) were used as a dielectric fluid in oil-cooled transformers. PCBs were also used as lubricating fluids in numerous buildings. Spillage resulting from normal transformer servicing and leakage is the primary mechanism for PCB soil contamination. No PCB contamination has been detected in the TSA.

4.1.1.6 Volatile Organic Compounds

Both the WSOW and WSUFMP processes included the use of volatile organic compounds such as toluene, hexane, and ethyl ether. No volatile organic compounds indicating contamination have been detected in the soils in the TSA. The absence of volatile organic compounds supports the conclusion that uncontrolled waste disposal did not occur and that chemicals stored in the WSCP buildings were not spilled or dumped into the soil.

4.1.1.7 Semi-Volatile Organic Compounds

Semi-volatile organic compounds (SOCs) were detected in previous investigations at the WSCP/WSRP (MKF and JEG, 1988c).

Various compounds associated with coal, petroleum products, and incomplete combustion of organic material were observed in several samples. No semi-volatile organic contamination has been found in the TSA.

4.1.2 Radiological Contamination

Several radiological contamination surveys have been conducted at the WSS since the WSUFMP was shut down in 1966. Data from these studies are used here to identify the areas most likely to contain contaminated soil.

Since there are no guidelines at present, reference-level concentrations were created in order to provide benchmarks from which soils characterization data could be interpreted. Zones were identified by reference levels rather than guidelines. Reference-level concentrations were chosen in the same way for Ra-226, Ra-228, and Th-230, namely 5 picocuries per gram (pCi/g) in soils from ground level to 6 inches in depth and 15 pCi/g in soils lying beyond 6 inches in depth. These concentrations correspond to those stated in 40 CFR 192, which applies to the U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action Project, and to DOE guidelines for surplus facilities. The reference-level U-238 concentration is 15 pCi/g regardless of depth. It must be emphasized that these reference-level concentrations are not site-specific guidelines developed for unrestricted use. These concentrations were developed for presentation purposes only. The estimated zone areas, depths and volumes were based upon these reference-level concentrations and will change if final site-specific guideline concentrations differ from these reference levels.

The reference-level concentrations were used to determine a mixture rule concentration in the following manner. The individual radionuclide concentrations detected in each soil sample were divided by the corresponding reference level and summed. If the sum of these fractions was greater than or equal to one (unity), the sample was considered to contain an above-mixture rule concentration. This determination is

consistent with DOE guidance (DOE, 1988). Analytical results of the radiological contamination are shown in Appendix E.

For presentation purposes the site was divided into eleven regions; Regions 8 and 11 are within the TSA. The interpretation of all soils characterization data resulted in the creation of zones containing above-reference radionuclide concentrations. A portion of Regions 8 and 11 as they pertain to the TSA are shown in Figure 4-2.

4.1.2.1 West Raffinate Pits Area - Region 8

Region 8 is located in the southwest section of the WSS and contains raffinate pits numbers 3 and 4 and an open area to the south. Aerial photographs taken in the mid-1970s show equipment and debris which was removed from Buildings 101, 103, and 105 by the Army during WSCP decontamination operations, and stored on the surface of Zones 2, 3, and 4 of the region. This equipment was removed at some point after the photograph was taken and probably deposited into Raffinate Pit No. 4, where large quantities of equipment are currently visible. Zones 2, 3, and 4 are presently free of equipment.

Extensive walkover scans also were performed by the PMC in some areas where above-reference-level radionuclide concentrations were found. Analysis of these measurements identified four zones of above-reference-level radionuclide concentrations as shown in Figure 4-2.

4.1.2.1.1 Zone 1. The depth of above-reference-level radionuclide concentrations in Zone 1 is estimated at 6 inches based on the near-surface sample results. Boundaries of this zone were determined based on a walkover scan of the area performed by the PMC. This scan identified the areal extent of above-background concentrations of gamma-emitting

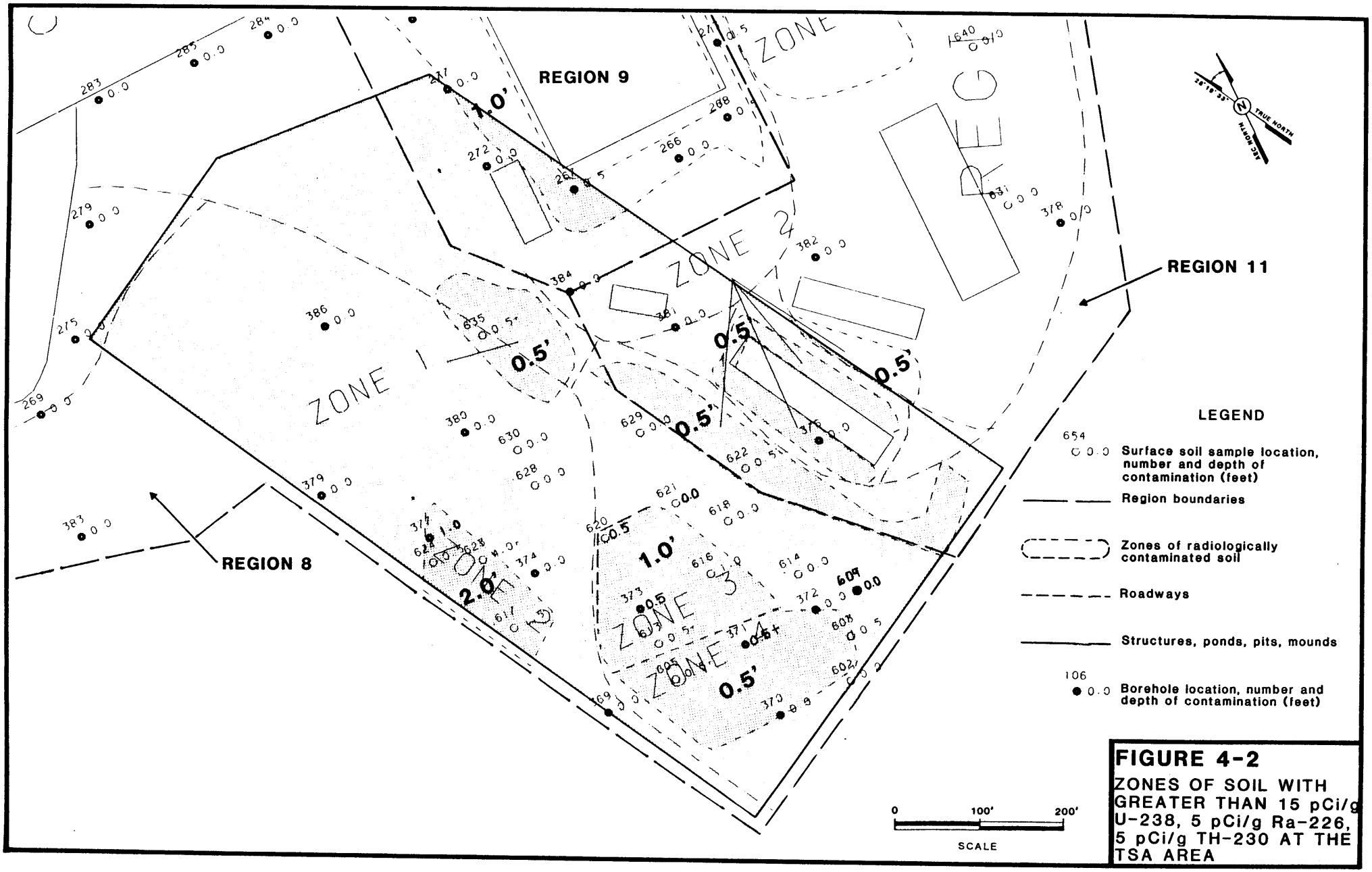


FIGURE 4-2
ZONES OF SOIL WITH GREATER THAN 15 pCi/g U-238, 5 pCi/g Ra-226, 5 pCi/g TH-230 AT THE TSA AREA

radionuclides. Soil sample analyses indicated an above-reference-level U-238 concentration ranging up to 186.0 pCi/g, along with near background Ra-226 and Ra-228 concentrations. The proximity of a site roadway to this sample location suggests the possibility of an inadvertent spill from a vehicle carrying uranium-contaminated material.

4.1.2.1.2 Zone 2. Aerial photographs taken in the mid-1970s show equipment and debris in this zone and also in Zones 3 and 4. This equipment and debris came from Buildings 101, 103, and 105 and were placed in this area by the Department of Army during WSCP decontamination activities. Radionuclide concentration ranges found in Zone 2 were: U-238 from 3.7 to 2,259.3 pCi/g, and Ra-226 and Ra-228 each from 0.4 to 2.0 pCi/g.

One borehole, number 337, and four near-surface sample sites, numbers 617, 623, 624, and 625, are located in Zone 2. All soil samples taken from these locations were analyzed for U-238, Ra-226 and Ra-228 except for samples from borehole 377, which were analyzed for Th-230 only. Sample location 617 was drilled to 2.5 ft and contained a relatively high U-238 concentration of 226.0 pCi/g in the 0-to-0.5-ft sample, followed by a decreasing U-238 concentration gradient to maximum depth with an above-reference-level concentration extending to 1.5 ft. All Ra-226 and Ra-228 concentrations were near-background levels. The high surface concentration and decreasing gradient are probably due to surface deposition from uranium-contaminated equipment previously stored at ground level. Sample location 623 was drilled to 4 ft and contained an erratic U-238 concentration gradient with a high (2,259.3 pCi/g) 0-to-0.5-ft concentration which decreased to 2.5 ft, followed by an increasing concentration with depth. The high surface concentration is probably due to surface storage of contaminated equipment. The erratic concentration gradient with depth may be due to burial of radioactive material, though there is no burial

history in this area. Ra-226 and Ra-228 concentrations were near background levels in all samples here as was the case for all samples in this zone that were analyzed for radium isotopes.

Near-surface sample sites 624 and 625 contained above-reference-level U-238 concentrations to 6 in. and 1 ft respectively. Both locations contained near-reference-level concentrations to these depths, probably due to U-238 transport via sheet water flow from nearby areas of high surface level U-238 concentrations. Borehole 377 was drilled to 5 ft with all associated soil samples indicating background concentrations of Th-230 which, along with the radium data, provides further evidence of uranium being the only radiological contaminant present. Based on the above-reference-level depth of 4 ft in borehole 623 and the above-reference-level depths found at locations 617, 624, and 625, Zone 2 is estimated to average 2 ft in depth.

4.1.2.1.3 Zone 3. Material and debris were previously stored on the ground surface of Zone 3. Four near-surface sample sites, numbers 611, 612, 613 and 615, and two boreholes, numbers 373 and 616, were taken in this zone. Soil samples from locations 611, 612, 613, 615, and 616 were all analyzed for U-238, Ra-226, and Ra-228, while samples from location 373 were analyzed for Th-230. Radionuclide concentration ranges found in Zone 3 were: U-238 from <2.4 to 171.2 pCi/g, Ra-226 from <0.4 to 5.8 pCi/g, Ra-228 from 0.8 to 5.1 pCi/g, and Th-230 from 1.1 to 2.1 pCi/g.

Sample sites 612 and 613 were drilled to 2 ft and to 6 in. respectively and contained relatively high U-238 concentrations of 103.2 and 149.7 pCi/g respectively in the 0-to-0.5-ft samples. Sample site 612 contained above-reference-level U-238 concentrations to 1 ft and a decreasing U-238 concentration gradient from surface to 2 ft deep. The relatively high surface

concentrations in both locations and the decreasing concentration gradient at sample site 612 could be due to surface spills containing high uranium concentrations arising from previous surface storage of equipment and debris. All Ra-226 and Ra-228 concentrations were near background levels in these locations, further suggesting that the main radiological contaminant here is uranium.

Near-surface-sample sites 611 and 615 and borehole 616 were drilled to 0.5, 1 and 5 ft respectively and contained similar surface U-238 concentrations ranging from 11.2 to 43.6 pCi/g. Sample site 615 and borehole 616 contained above-reference-level U-238 concentrations to 6 in. and to 1 ft respectively with below-reference-level U-238 concentrations in all other samples. All samples in these three locations contained near background Ra-226 and Ra-228 concentrations. The U-238 concentrations found at these locations could have been due to spills containing low uranium concentrations or surface water flow from areas of higher surface uranium concentrations. Borehole 373 contained near background Th-230 concentrations in all samples which, along with the near background radium concentrations observed in all other soil samples, indicates uranium to be the primary contaminant in Zone 3.

The depth of above-reference-level radionuclide concentrations in Zone 3 is estimated to be 1 ft based on an average of the depths found in near-surface sites 612, 615, and 616.

4.1.2.1.4 Zone 4. Zone 4 lies immediately south of Zone 3. The mid-1970s aerial photographs show equipment and debris stored on the surface of this zone at that time. Boreholes 370 and 371 and near-surface-sample sites 600, 601, 603, 605, 606, and 607 are located in Zone 4. Soil samples from boreholes 370 and 371 were analyzed for Th-230 and all other

samples were analyzed for U-238, Ra-226 and Ra-228. Radionuclide concentration ranges found in Zone 4 were: U-238 from 2.4 to 231.7 pCi/g, Ra-226 from 0.7 to 3.8 pCi/g, Ra-228 from 0.5 to 2.6 pCi/g, and Th-230 from 0.8 to 2.4 pCi/g.

Sample locations 601 and 607 were both drilled to 5 ft. Location 601 contained an above-reference-level U-238 concentration in the 0-to-0.5-ft sample and below-reference-level U-238 concentrations beyond. Location 607 contained an above-mixture-rule concentration in the 0-to-0.5-ft sample due mainly to U-238 since all Ra-226 and Ra-228 concentrations found in these borehole samples were near background levels.

Boreholes 370 and 371 were also drilled to 5 ft and all associated soil samples from these boreholes contained near-background Th-230 concentrations. The presence of near-background Ra-226, Ra-228 and Th-230 concentrations in the borehole soil samples analyzed for these nuclides, along with the observed U-238 concentrations, indicates uranium to be the primary contaminant here.

Near-surface-sample sites 600, 603, 605 and 606 were all taken to 6 in. and all samples were analyzed for U-238, Ra-226 and Ra-228. Sample sites 600, 603 and 605 contained U-238 concentrations in the narrow range of 13.3 to 26.4 pCi/g while sample site 606 contained a high U-238 concentration of 231.7 pCi/g. Sample site 606 could have been near a concentrated uranium deposition arising from equipment previously stored on the surface, while sites 600, 603, and 605 could have been near spills of lower uranium concentrations or due to surface water flow which could have transferred uranium from areas such as site 606. All near-surface soil samples contained near-background Ra-226 and Ra-228 concentrations, again indicating uranium to be the primary contaminant.

The depth of above-reference-level radionuclide concentrations in Zone 4 is estimated at 6 in. based on boreholes 601 and 607 results. Boundaries of this zone were based on a walkover scan performed by the PMC which identified the areal extent of above-background concentrations of gamma-emitting radionuclides.

4.1.2.2 East Raffinate Pits Area - Region 9, Zone 1

Region 9 is a rectangular-shaped area located directly east of Raffinate Pit No. 3. This region was characterized by 52 boreholes containing a total of 246 borehole soil samples, 10 near-surface-sample sites containing a total of 14 soil samples, 55 surface and one-meter exposure rate measurements, eight spectrometer measurements, and eight FIDLER measurements. Results of soil sample analyses, exposure rate measurements, and spectrometer measurements identified two zones that were found to contain soils with above the reference-level radionuclide concentrations. The region and zone boundaries as well as most sample locations are shown on Figure 4-2. The southern portion of Zone 1 is of interest for purposes of this report.

Radionuclide concentration ranges found in samples from Zone 1 are: U-238 from <0.3 to 12.9 pCi/g, Ra-226 from 0.4 to 7.5 pCi/g, Ra-228 from 0.6 to 8.9 pCi/g and Th-230 from 0.8 to 8.9 pCi/g. Thirty-three boreholes were taken within the zone to depths ranging from 2 to 20 feet. Soil samples from 28 of the 33 boreholes were analyzed for Th-230; samples from seven of the boreholes were analyzed for U-238, and samples from borehole 503 were analyzed for Ra-226 and Ra-228 in addition to U-238. Nineteen of the 33 boreholes taken within Zone 1 contained above-reference-level Th-230 concentrations to 0.5 foot; four other boreholes contained above-reference-level U-238 concentrations to 0.5 foot. Samples from borehole 503 indicated near background concentrations of Ra-226 and Ra-228.

Seven near-surface samples were taken within this zone to depths ranging from 0.5 to 10 feet. All soil samples from these locations were analyzed for U-238, Ra-226, and Ra-228. Near-surface location 664 contained above-reference-level concentrations of Ra-226 and Ra-228 to the maximum sampling depths of 0.5 foot. Near-surface location 665 contained above-reference-level U-238 and Ra-228 concentrations to the maximum sampling depth of 0.5 foot. The five remaining near-surface-sample locations did not contain any above-reference-level concentrations.

A possible mode of contaminant transport in Zone 1 is airborne deposition of raffinate particulates originating from the pits during dry periods. Raffinate Pits 1 and 2 have at times been void of surface water. This would allow for surrounding soils to become contaminated via windblown raffinate sludge. This mode of contaminant transport is consistent with the finding of low radionuclide concentrations confined to the surface soil.

The average depth of above-reference-level radionuclide concentrations in Zone 1 is 0.5 foot based on results from the 23 boreholes and two near-surface locations containing above-reference-level concentrations. Boundaries of Zone 1 were drawn to include the natural drainage between Raffinate Pits 1, 2, and 3 since runoff could have dispersed above-reference-level radionuclide concentrations throughout soils in the drainage.

4.1.2.3 Southeast Area - Region 11, Zone 2

Region 11 includes the southeast section of the WSCP. This region contains non-process buildings 302, 432, 427, 434, 435, and 436. Buildings 434, 435, and 436 were used for storage space. Building 302 was used for magnesium storage. Building 432 was a proof sampler associated with the process sewer system.

For purposes of this report only Zone 2 of Region 11 will be discussed because Zone 2 is the only zone of Region 11 within the TSA footprint.

Zone 2 is located in the southwestern section of Region 11 in the areas surrounding Building 435 and 436 (storage facilities). This area contains equipment and debris that was removed from buildings 101, 103 and 105. These materials are surficially radiologically contaminated and include drinking fountains, stainless steel piping, forklifts, steel tables, 55-gallon drums, wooden pallets and gasoline engines.

Borehole 376 was drilled along the west side of Building 436. This borehole was drilled to 8 ft and was analyzed for Th-230 only. Results indicated near-background concentrations in all samples. Borehole 622 was drilled to 5 ft and was analyzed for U-238, Ra-226, and Ra-228. Results indicated an above-reference-level U-238 concentration to 6 in. and near-background Ra-226 and Ra-228 concentrations.

Surveys performed by the PMC have identified above-background levels of beta-gamma-emitting radionuclides on the equipment and debris stored in this area. Since this equipment originally came from process buildings 101, 103, and 105, loose contamination on the equipment surface could have been removed by precipitation and transported to the ground surface below. The shallow depth of above-reference-level U-238 concentrations found in borehole 622 may be due to surface deposition occurring in this manner.

The depth of above-reference-level concentrations is estimated at 6 in. based on borehole 622 results. The boundaries of Zone 2 include all equipment and debris stored outside of buildings 435 and 436.

4.2 WATER QUALITY DATA

The following results are based on the sampling done in the third quarter of 1988. This information comprises background data for the monitoring wells in the TSA. Each group of analytical parameters will be discussed separately. See Appendix A.

The analytical categories assessed were inorganic anions, nitroaromatic compounds, radiochemical parameters, metals, and total organic carbon (TOC). The inorganic anions include nitrates, sulfates, chlorides, and fluoride. The nitroaromatic compounds include 2,4,6-DNT (dinitrotoluene); 2,6-DNT; 2,4-DNT; nitrobenzene; 1,3,5-trinitrobenzene; and 1,3-dinitrobenzene. The radiochemical parameters include uranium, radium-226, thorium-230, and thorium-232. The metals include all those on the U.S. Environmental Protection Agency Contract Laboratory Program (CLP) list. Lithium and molybdenum were added to the metal parameters. Lithium was used in Building 404, the Metallurgical Pilot Plant; is present in the raffinate pits; and was detected in previous groundwater studies done by the United States Geological Survey (MKF and JEG, 1989b). Molybdenum is often naturally associated with uranium ore.

4.2.1 Nitroaromatic Compounds

Currently, no primary or secondary drinking water standards have been promulgated for any of the six nitroaromatic compounds listed above. The most applicable regulatory guidelines or comparative standards for levels of nitroaromatics in water are the Ambient Water Quality Criteria. For 2,4-DNT, the criterion is 0.11 micrograms per liter (µg/L) (toxicity).

Of the nitrotoluene derivatives analyzed (trinitrotoluene; 2,4-dinitrotoluene; and 2,6-dinitrotoluene), monitoring well

MW-3001 detected a value of 0.81 µg/L 2,4-dinitrotoluene while nothing was detected in the other monitoring wells.

The nitrobenzene derivatives analyzed include nitrobenzene; 1,3,5-trinitrobenzene; and 1,3-dinitrobenzene. The levels ranged from 0.33 µg/L to 2.17 µg/L and from 0.06 µg/L to 0.53 µg/L for nitrobenzene and 1,3,5-trinitrobenzene, respectively. 1,3-dinitrobenzene was not detected in the wells of interest.

The deeper wells, MW-2019 and MW-3002, exhibited higher levels of nitroaromatics than the shallower wells. The source of this contamination is unknown.

The source of nitroaromatic contamination is likely the overflow of disposal lines and/or the discharge of wastewater to surface drainageways.

4.2.2 Inorganic Anions and Groundwater Quality

Nitrate concentrations above the Federal Ambient Water Quality Regulations and Criteria have been detected in three wells. The standard issued in the Safe Drinking Water Act for nitrates as nitrogen (N) is 10 milligrams per liter (mg/L).

The U.S. Environmental Protection Agency (EPA) secondary standard for sulfate in drinking water is 250 mg/L. No monitoring wells have exceeded this value.

The maximum contaminant level for fluoride is 4.0 mg/L (40 CFR 141.11). A secondary maximum contaminant level for fluoride is 2.0 mg/L (40 CFR 141.11). No monitoring wells have exceeded the primary or secondary standard.

The EPA secondary standard for chloride in drinking water is 250 mg/L. No monitoring wells have exceeded this value.

Each of the contaminant types is discussed separately below.

4.2.2.1 Nitrates

Nitric acid was used in the production of trinitrotoluene (TNT) and dinitrotoluene (DNT) at the WSOW.

According to soils data (MKF and JEG, 1989a), nitrate concentrations in the groundwater are not directly attributable to conditions in the soils at the WSOW. Nitrate levels detected in the soils were not in sufficiently high concentrations to be considered as a source of the groundwater concentrations of nitrates. Instead, the primary source appears to be seepage from the raffinate pits. The raffinate pit sludge contains nitrates up to 76,638 mg/g (MKF and JEG, 1989b).

Nitrates were detected at levels below the drinking water standards for nitrogen in one of the deeper screened wells (MW-2019). Two of the shallower wells (MW-2018 and MW-3001) exceed this standard.

4.2.2.2 Sulfates

Sulfate concentrations in the TSA are not above the 250 mg/L water quality standard, but levels range from 19.8 mg/L to 7.0 mg/L. From the chemical soil characterization study, sulfate-contaminated soil was found upgradient of MW-3001 and MW-3002 (located at WSOW building locations) and MW-2018 and MW-2019 (WSUFMP support facilities). Groundwater contamination for MW-3001 and MW-3002 could have originated from wastewater from WSOW processes and for MW-2018 and MW-2019 from WSOW fill sources rather than the equipment stored there.

4.2.3 Radiochemistry

Groundwater samples collected from monitoring wells at the WSCP/WSRP areas were analyzed for total uranium, Ra-226, Th-230, and Th-232. Th-230 was detected in MW-2019 but was below 5 pCi/L. Th-232 and Ra-226 were not detected in any monitoring wells during this phase of sampling.

MW-3009 has consistently exhibited uranium activity above the established background value of 3.4 pCi/L although in the past it has exceeded 40 pCi/L. MW-3019 showed above-background activity of uranium in the third quarter of 1988. It was installed in 1988 and sampled for the first time in that quarter. Additional data from this location are needed before substantive remarks can be made regarding uranium activity.

In many cases, the source of above-background uranium activity in the groundwater can be attributed to the position of the well relative to the raffinate pits. MW-3019 is hydraulically downgradient from the raffinate pits and shows background or slightly elevated uranium activity. This is probably attributable to the raffinate pits.

4.2.4 Metals

Only calcium, magnesium, molybdenum, and sodium were detected in a sufficient number of monitoring wells at the WSCP/WSRP to establish a value for the upper bound of background.

For calcium, the upper bound of background value is 102,195 µg/L. The high value for calcium concentrations results from calcium being a major constituent of limestone, and therefore being ubiquitous to this environment. Certainly the above-background calcium concentration in MW-3001 can be accounted for by the proximity of this well to the raffinate pits. The

surface water in the pits has very high concentrations of calcium, on the order of 900,000 µg/L (MKF and JEG, 1989b).

Magnesium was used as a process material during the operation of the Feed Materials Plant in Building 301 (the metals plant) and Building 302 (the magnesium building). The upper bound of background for magnesium is 60,333 µg/L. This is close to, but does not exactly fit, the calcium distribution. Wells with above-background magnesium are MW-3001 (raffinate area well), and MW-2018. Both of these wells also show above-background calcium.

The upper bound of background for molybdenum is 26.16 µg/L. MW-3001 shows an elevated molybdenum concentration of 57.50 µg/L.

The upper limit of background for sodium is 32,181 µg/L. MW-3001 shows elevated sodium concentrations of 55,130 µg/L.

Ten of the 25 metals (Hazardous Substance List metals plus lithium and molybdenum) -- arsenic, barium, beryllium, cadmium, chromium, lead, nickel, mercury, selenium, and silver -- have been assigned Drinking Water Maximum Contaminant Levels (MCL) by the EPA (40 CFR Part 300).

Arsenic, beryllium, cadmium, chromium, lead, nickel, selenium and silver were not detected in any of the wells concerned. Barium, which has an MCL of 1,000 µg/L, was detected in well MW-3009. This well had a barium level of 1,310 µg/L. Mercury was detected above the MCL of 0.2 µg/L, in MW-3001 and MW-3002, which are located near the raffinate pits. Selenium was not detected in any well nor was silver.

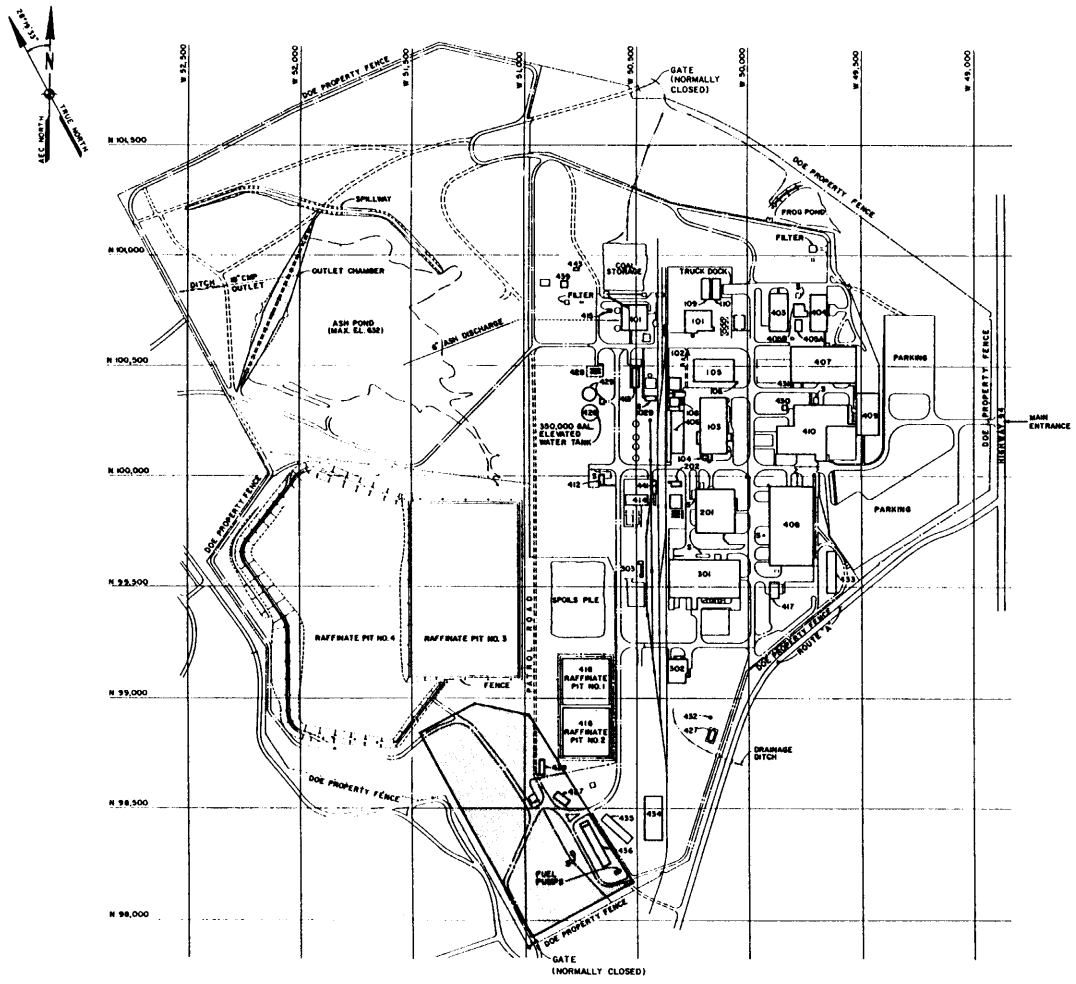
Metals for which MCLs have not been established may nevertheless be of regulatory concern for other reasons. Alternative guidance such as that which may be provided by EPA

research may have to be consulted. There are insufficient data on several metals to permit development of MCLs for drinking water. These metals are aluminum, antimony, cobalt, copper, iron, lithium, manganese, potassium, thallium, vanadium, and zinc.

Aluminum, antimony, copper, cobalt, thallium, and vanadium were not detected in any wells. Lithium was detected in MW-3001; this could be attributed to transport of contaminants from the raffinate pits (a lithium point source). Manganese is a primary metal in pyrolusite which is present naturally in the overburden layers at the WSCP/WSRP. Manganese was detected as follows: MW-2018, 7 µg/L; MW-3001, 96.5 µg/L; MW-3002, 24.30 µg/L; and MW-3010, 5 µg/L. Potassium can be somewhat ubiquitous in limestone and was detected in MW-2019 at 15,740 µg/L.

4.3 BUILDINGS 435, 436, 437, AND 438

As shown in Figure 4-3, Buildings 436, 437 and 438 are located within the footprint of the TSA and therefore will be demolished prior to construction. Building 435 will be demolished prior to construction to provide sufficient maneuverability. At present, no structure or piece of equipment can be released from the WSCP for unrestricted use without further radiation measurements being performed. The characterization information provided in Appendix G separates structural components into two categories: (1) contaminated and not releasable for unrestricted use without some form of decontamination and (2) potentially releasable for unrestricted use without decontamination. If an attempt is made to release items in category 2 for unrestricted use, then at a minimum, spot-check measurements will be required of areas which were inaccessible when the characterization measurements were performed. In many cases, items determined by characterization



BUILDING OR AREA	DESIGNATION
101	FEED PREPARATION AND SAMPLING PLANT
102A	REFINERY TANK FARM
102B	REFINERY TANK FARM
103	DIGESTION AND DENITRATION
104	LIME STORAGE
105	TBP AND ETHER EXTRACTION
106	PROOF SAMPLER
108	NITRIC ACID RECOVERY
109	DRUM STORAGE
110	DRUM STORAGE
201	GREEN SALT PLANT
202	GREEN SALT TANK FARM
301	METALS PLANT
302	MAGNESIUM STORAGE BUILDING
303	CHIP STORAGE
401	STEAM PLANT
403	CHEMICAL PILOT PLANT
404	METALLURGICAL PILOT PLANT
405A	PILOT PLANTS AUXILIARY
405B	PILOT PLANT AUXILIARY
406	WAREHOUSE
407	LABORATORY
408	MAINTENANCE AND STORES
409	ADMINISTRATION
410	SERVICES
412	ELECTRICAL SUBSTATION
413	COOLING TOWER AND PUMP HOUSE
414	SCRAP CLASSIFICATION AND EQUIPMENT STORAGE
415	CLAY BRICK INCINERATOR
416	RAFFINATE PITS 1 & 2
417	PAINT SHOP
426	ELEVATED WATER TANK
427	PRIMARY SEWAGE TREATMENT PLANT
428	PROPANE AND BUTANE GAS PLANT
429	RESERVE WATER FACILITIES
430	AMBULANCE GARAGE
431	PROOF SAMPLER
432	PROOF SAMPLER
433	STORAGE
434	STORAGE
435	STORAGE
436	STORAGE
437	STORAGE
438	STORAGE
439	FIRE TRAINING
441	CYLINDER STORAGE
443	FIRE TRAINING STORAGE

LEGEND:

- PAVED ROAD (ASPHALT OR CONCRETE)
- GRAVELED ROAD
- OLD ROADBED
- FENCE
- S ELECTRICAL SUBSTATION

200 0 200 400
SCALE FEET

MKE DOCUMENT NO. 5121-C-DW-D-01-0278-A

U. S. DEPARTMENT OF ENERGY
OAK RIDGE, TENNESSEE

FIGURE 4-3
WELDON SPRING CHEMICAL PLANT AND RAFFINATE PITS

DESIGNED | DRAWN | CHECKED | INSPECTED | RECOMMENDED | APPROVED

MORRISON-KNUDSEN ENGINEERS, INC.
WSSRA PROJECT

PROJECT NO. DE-AC05-86OR21548
DRAWING NO. 5121E-CP-501 REV.

NO. | DATE | REVISIONS | BY | CK | QA MGR | CHIEF ENG | QA MGR | CHIEF ENG | QA MGR | CHIEF ENG

measurements to be potentially releasable for unrestricted use will require radiation measurements performed on 100 percent of the surface area of the item prior to release from the Weldon Spring Site.

The following sections describe the chemical and radiological contamination of each of these buildings.

4.3.1 Building 435

4.3.1.1 Chemical Contamination

4.3.1.1.1 Asbestos-Containing Material (ACM) - Building 435 was not heated by steam and does not have any insulated pipes. The four fume hoods and a small oven are made of transite siding material. These were not sampled because they are known to contain asbestos. One bulk sample was taken of the fiberboard material from the walls of the small office in the center room (Table F-1 in Appendix F). Asbestos was not detected in this sample. The fume hoods and oven contain an estimated volume of approximately 35 cubic feet of non-friable asbestos-containing material (ACM).

Several other materials such as hard hats and a fire hose which might contain asbestos were found in the building.

4.3.1.1.2 Polychlorinated Biphenyls (PCBs) - A total of eight PCB swipe samples were taken in Building 435. The analytical results of the samples are presented in Appendix F, Table F-2. The analyses indicated concentrations ranging from non-detectable, <1 µg/100 cm^2, to 31 µg/100 cm^2. The second room from the south seems to be the only room with PCB contamination. The PCB waste generated during the cleanup effort in this building cannot be estimated based upon the samples collected and analyzed. All of the samples were taken

on concrete floors which were covered with dust and debris. The floor in the second room from the north was covered with water-treatment chemicals. There are three fluorescent light fixtures in the building which are known to contain PCBs in the ballasts. No other equipment that might have PCB contamination was noted.

4.3.1.2 Radiological Contamination

Building 435 has been surveyed twice: once by Ryckman, Edgerly, Tomlinson and Associates (RETA), and once by the PMC.

RETA performed a radiological survey on this building in 1977. The RETA survey included:

- 21 total alpha measurements
- 14 removable alpha measurements
- 34 total beta-gamma measurements
- 36 total gamma measurements

All measurements on loose surface contamination were at the "releasable" level, but only about 30% of the total surface contamination measurements were at this level. Approximately 17% of the rest were at the "moderately contaminated" level. All other total surface contamination measurements were at the "highly contaminated" level. These estimates were based on the assumption that the only significant activity in this building is due to natural uranium, although RETA performed no radionuclide analyses on loose surface material to confirm this. RETA found that most of the high readings were associated with contaminated equipment stored in this building, and they suggested that the building would probably be releasable if the equipment were moved and the building cleaned (RETA, 1978).

The PMC survey included:

- o 6 bulk samples
- o 300 total beta-gamma measurements
- o 300 removable alpha measurements
- o 1 core sample
- o equipment scans
- o 8 airborne particulate samples
- o 4 radon/thoron gas samples

Six bulk samples were collected in this building. The average activity of each radionuclide found in the samples is given below:

Radionuclide	Activity (pCi/g-dry)
Ra-226	8.5 ± 2.0
U-234	193.7 ± 61.5
U-235	8.8 ± 4.6
U-238	191.7 ± 59.0
Th-230	12.3 ± 3.2
Th-232	1.3 ± 0.8
Th-228	2.4 ± 1.6

Based on these results, the PMC concluded that natural uranium is the predominant radionuclide in this building. Alpha and beta-gamma measurement results as well as determination of releasability based on the PMC key criteria and natural uranium release criteria are summarized in Appendix G, Table G-1.

One core sample was taken on the floor. The total beta-gamma activity at this location was 4,620 disintegrations per minute per 100 square centimeter area (DPA) after dust was removed. After core removal, the total activity was 595 DPA, above the minimum detectable amount (MDA) of the detector. This

suggests that the floor is volumetrically contaminated, so surface release criteria do not apply to it.

An inventory of equipment in Building 435 along with associated scanning results is on file with the PMC. Most equipment either did not meet PMC key criteria and/or natural uranium release criteria, or was determined by the contractor to be not releasable at present.

The results of the air samples collected in this building are presented in Appendix G, Table G-2 . One Type F sample was above the background concentration which, along with the near-background concentration measured by both Type M detectors, suggests the presence of above-background thoron concentrations here. However, the other Type F sample measured a near-background concentration, and Th-228 concentrations measured in the bulk sample results are not high enough to indicate a source of above-background thoron concentrations. All measured radon and thoron concentrations are below DAC guidelines. All eight breathing zone samples were analyzed for long-lived alpha activity and all concentrations were below derived air concentrations (DAC) guidelines for U-238.

4.3.2 Building 436

4.3.2.1 Chemical Contamination

4.3.2.1.1 Asbestos-Containing Material - Building 436 was not heated by steam and does not have any insulated pipes. Eight bulk asbestos samples were taken of suspected ACM throughout the building. All of the results were negative for asbestos (Table F-3 in Appendix F). There are, however, some other asbestos-containing materials: several clutch plates, welding gloves, and some machines with asbestos gaskets. Other asbestos-containing material may be found in the stacks and

crates of equipment that are currently inaccessible. All of the asbestos-containing material found is non-friable. No friable asbestos was noted in this building.

4.3.2.1.2 **Polychlorinated Biphenyls** - A total of eight PCB samples was taken in Building 436: four in the south room and four in the north room. In addition, one soil sample was taken in the road directly west of the building. The analytical results of the samples are presented in Appendix F, Table F-4. The two bulk samples had less than 5 ppm of PCB. The swipe samples ranged from non-detectable to 2 µg/100 cm^2. All samples were taken from concrete floors that displayed some dust and debris on them. There were no visible oil stains. The building contains five fluorescent light fixtures which are known to contain PCBs in the ballasts. Some mechanical equipment in the north room may contain fluids with PCBs.

4.3.2.2 Radiological Contamination

Building 436 has been surveyed twice, once by RETA and once by the PMC. RETA performed a radiological survey on this building in 1977. The RETA survey included:

- 12 total alpha measurements
- 14 removable alpha measurements
- 9 total beta-gamma measurements
- 25 total gamma measurements

All loose surface contamination measurements were at the "releasable" level. However, only about 50% of total surface contamination measurements were at the "releasable" level. Of the rest of the measurements, about 25% were at the "moderately contaminated" level, and 25% were at the "highly contaminated" level. All of the estimates of contamination were based on RETA's assumption that the only significant activity in this

building was due to uranium; however no radionuclide analyses are presented to confirm this.

The PMC surveyed this building in 1988. The PMC survey included:

- o 6 bulk samples
- o 430 total beta-gamma measurements
- o 430 removable alpha measurements
- o 1 core sample
- o equipment scans
- o 5 airborne particulate samples
- o 4 radon/thoron gas samples
- o 1 radon daughter air sample

Six bulk samples were collected. The average activity of each radionuclide found in the samples is given below:

Radionuclide	Activity (pCi/g-dry)
Ra-226	3.5 ± 1.3
U-234	249.5 ± 87.1
U-235	14.2 ± 5.5
U-238	260.2 ± 90.4
Th-230	33.1 ± 10.1
Th-232	1.3 ± 1.6
Th-228	1.8 ± 2.8

Based on these results, the PMC concluded that natural uranium is the predominant radionuclide in Building 436. Alpha and beta-gamma measurement results as well as determination of releasability based on the PMC key criteria and natural uranium release criteria are summarized in Appendix G, Table G-3.

A core sample was taken from the floor. Before core removal, the total beta-gamma activity was 5,355 DPA. After core removal, the total activity was less than the MDA of the detector, indicating that the floor is surficially contaminated only and that surface release criteria are applicable.

An inventory of the equipment in Building 436 along with associated scanning results is on file with the PMC. Most equipment either did not meet PMC key criteria and/or natural uranium release criteria, or was determined by the PMC to not be releasable at present.

Table G-4 in Appendix G presents the results of air samples collected in Building 436. Measured radon and thoron gas concentrations are all near background levels and are below DAC guidelines. The long-lived alpha activity concentrations measured by the five breathing zone samples are all below the DAC guidelines for U-238. The measured radon daughter concentration of 0.001 working level (WL) is near background levels.

4.3.3 Building 437

4.3.3.1 Chemical Contamination

4.3.3.1.1 Asbestos-Containing Material - The transite panels, the roofing material, and the coating of the concrete walls were suspected of containing ACM. No laboratory test was needed to determine that a 107-in. x 3-in. expansion joint gasket on the furnace contains ACM. Six bulk samples were taken of the roofing material, three of the transite paneling, and one of the wall coating.

Asbestos concentrations greater than 1% were found in all three samples of the transite paneling (see Appendix F, Table

F-5). There is an estimated 15 cf of ACM in the transite. Asbestos concentrations were below detection limits (<1%) in the sample of wall coating. Chrysotile asbestos was found in only one sample (BA-2200-042589) of roofing material in trace amounts (<1%). Based on these results, the built-up roof of this building does not contain asbestos in concentrations high enough to be considered ACM according to federal regulations.

4.3.3.1.2 **Polychlorinated Biphenyls** - Eight swipe samples were taken throughout the building. There are no visible oil spills anywhere in this building. One sample (OT-2011-111488) was destroyed in preparation; consequently no data are available for it. The remaining seven samples were below detection limits for PCBs (<.8 µg/100 cm^2). The building is therefore considered free of PCB contamination except for the lighting fixture ballasts (see Appendix F, Table F-6). There are 38 single-bulb and 9 double-bulb fluorescent lights in this building. The ballasts in these light fixtures are estimated to contain approximately 1 cf of PCB waste.

4.3.3.2 Radiological Contamination

Building 437 has been surveyed twice, once by RETA and once by the PMC.

RETA performed a radiological survey on this building in 1977. The RETA survey included:

- 16 total alpha measurements
- 11 removable alpha measurements
- 16 total beta-gamma measurements
- 6 total gamma measurements

RETA found that all the measurements on both loose and total surface contamination were at the "releasable" level based

on the assumption that the only significant activity in this building is due to natural uranium; RETA made no radionuclide analyses on loose surface materials to confirm this assumption.

The PMC surveyed this building in 1988. The PMC survey included:

- o 4 bulk samples
- o 250 total beta-gamma measurements
- o 250 removable alpha measurements
- o equipment scans
- o 2 airborne particulate samples

Four bulk samples were collected. The average activity of each radionuclide found in the samples is given below:

Radionuclide	Activity (pCi/g-dry)
Ra-226	0.98 ± 0.4
U-234	3.8 ± 3.1
U-235	0.3 ± 0.28
U-238	3.7 ± 3.1
Th-230	2.9 ± 1.4
Th-232	5.8 ± 2.4
Th-228	3.8 ± 1.4

Based on these results the PMC concluded that Th-232 is the predominant radionuclide in Building 437. Alpha and beta-gamma measurement results as well as determination of releasability based on the PMC key criteria and Th-232 release criteria are summarized in Appendix G, Table G-5.

An inventory of the equipment remaining in Building 437 as well as associated scanning results is on file with the PMC. None of the equipment in this building is releasable at present.

The results of the airborne particulate samples are presented in Appendix G, Table G-6. Neither of the long-lived alpha air particulate concentrations exceeded the DAC guidelines for Th-232.

4.3.4 Building 438

4.3.4.1 Chemical Contamination

4.3.4.1.1 Asbestos-Containing Material - Building 438 contains no insulated pipe and is built entirely of metal except for two small rooms on the south end which are made from fiberboard and gypsum board paneling. Four samples of gypsum board and three of fiberboard were found to be below detection limits (1%) with respect to ACM (see Appendix F, Table F-7).

Some of the items stored in this building appear to contain ACM. One piece of equipment has a length of insulated pipe attached. Other pieces of equipment have asbestos gaskets or asbestos coated wiring. There is also some loose asbestos-coated wire on a pallet. A wrapping around a blower motor and a gray furnace blanket may contain asbestos. In the northwest corner of the building, there are six boxes of alumi-shield pipe insulation and one box of braided asbestos rope fiberglass insulation.

Building 438 is constructed of materials that are free of asbestos. All of the asbestos-containing material in this building is associated with the items stored in the building. Some of the asbestos materials are listed here. However, more may be uncovered during the removal of the building contents.

4.3.4.1.2 Polychlorinated Biphenyls - In 1987, one swipe test for PCB was taken on an oily spot near the center of

the building. This test measured a PCB concentration of 3 µg/100 cm^2 (see Appendix F, Table F-8).

In 1988, seven swipe samples were taken from the floor throughout the main room on concrete with no visible oil stains. All of the samples tested PCB content at less than 5 µg/100 cm^2. Building 438 is not contaminated with PCBs.

4.3.4.2 Radiological Contamination

Building 438 has been surveyed once by the PMC in 1988. The PMC survey included:

- o 6 bulk samples
- o 300 total beta-gamma measurements
- o 300 removable alpha measurements
- o 1 core sample
- o equipment scans
- o 8 airborne particulate samples
- o 4 radon/thoron gas samples

Six bulk samples were collected. The average activity of each radionuclide in the samples is given below:

Radionuclide	Concentrations (pCi/g-dry)
Ra-226	5.1 ± 1.4
U-234	295.9 ± 92
U-235	13.7 ± 3.6
U-238	314.4 ± 87.2
Th-230	27.7 ± 5.5
Th-232	43.0 ± 10.1
Th-228	3.9 ± 5.1

Since natural uranium and Th-232 are both present at above-background concentrations, release criteria based on a mixture rule concentration of these nuclides was used to determine releasability of the various items in Building 438. Alpha and beta-gamma measurements results as well as determination of releasability based on the PMC release criteria are summarized in Appendix G, Table G-7.

One core sample was taken from the floor. Before core removal, the total activity at this location was 48,708 DPA. After core removal, the total beta-gamma activity on the freshly exposed surface was less than the MDA of the detector, indicating that the contamination is only surficial on the floor.

An inventory of equipment remaining in Building 438 as well as associated scanning results is on file with the PMC. None of the equipment in this building is releasable at present.

The results of the air samples collected in this building are presented in Appendix G, Table G-8.

Two of the eight long-lived alpha air particulate samples exceeded the DAC guideline for Th-232. All of the radon/thoron samples were at approximately background levels.

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LOG OF TEST PIT GT-2T80

- Location: 100 feet plan south of intersection of dike access road and centerline of east side of raffinate pit dike number 4; 40 feet to centerline of road that parallels the pit dike.
- Type of excavator: Cat 416 extendable backhoe (new)
- Start excavation: 2:35 p.m. 07/14/88
- Finish excavation: 3:20 p.m.
- Finish backfilling: 4:15 p.m.
- Finish decontamination: 4:40 p.m.

Corr w/ B-7

Depth, Feet		Description
0-0.5	CL	Fill Silty Clay: Dark yellowish-brown (10YR4/6); moist; medium plasticity; medium stiff. Some organics (possible fill).
0.5-8.0	CL	Silty Clay: Brownish-yellow (10YR6/8) mottled with light brownish-gray (10YR6/2) and yellowish-red (5YR5/8); moist becoming wet at 4.0 feet; medium plasticity; stiff.
8.0-12.0	CH	Silty Clay: Brownish-yellow (10YR6/8) mottled with gray (10YR6/1); wet; high plasticity; stiff.

Samples Collected

GT-2T80: BU-01A, 0.5'-8.0'
GT-2T80: BU-01B, 0.5'-8.0'

GT-2T80: BU-02A, 8.0'-12.0'
GT-2T80: BU-02B, 8.0'-12.0'

Four samples (5-gallon buckets) for Rick Ferguson/Bill Knight (Jacobs) for vitrification tests
2 @ 8-10'
2 @ 10-12'

Logged By. W. A. Gale

APPENDIX A

TABLE A-1
NITROAROMATIC COMPOUNDS
1988 THIRD QUARTER GROUNDWATER DATA

PARAMETER	Trinitrotoluene	2,4-DNT	2,6-DNT	Nitrobenzene	1,3,5-TNB	1,3-DNB
UNITS	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Detection Limit	0.50	0.20	0.60	0.60	0.03	0.40
WELL NUMBER						
MW-2018	ND	ND	ND	ND	0.06	ND
MW-2019‡	ND	ND	ND	0.33	0.15	ND
MW-3001	ND	0.81	ND	ND	0.17	ND
MW-3002‡	ND	ND	ND	2.17	0.53	ND
MW-3009	ND	ND	ND	ND	0.22	ND
MW-3010	ND	ND	ND	ND	ND	ND
MW-3019	ND	ND	ND	0.86	ND	ND
MW-4019	ND	ND	ND	ND	ND	ND

ND=NOT DETECTED AT DETECTION LIMIT ‡=DEEPER SCREENED WELL

TABLE A-2
INORGANIC ANIONS, TOTAL ORGANIC CARBON,TOTAL SUSPENDED SOLIDS
1988 THIRD QUARTER GROUNDWATER DATA

PARAMETER	NITRATES	NITRATES AS N	SULFATES	CHLORIDE	FLUORIDE	TOC
UNITS	(mg/L)		(mg/L)	(mg/L)	(mg/L)	(mg/L)
DETECTION LIMIT	0.10		1.00	0.25	0.25	0.10
WELL NUMBER						
MW-2018	56.10	12.62	10.00	6.00	0.00	1.64
MW-2019‡	1.00	0.23	18.50	1.60	0.00	4.00
MW-3001	1422.00	319.95	19.80	9.70	0.00	2.00
MW-3002‡	0.00	0.00	19.40	1.50	0.00	0.00
MW-3009	345.00	77.63	38.50	3.50	0.40	1.05
MW-3010	5.00	1.13	6.30	1.70	0.30	0.62
MW-3019	0.36	0.08	7.70	1.40	0.00	1.00
MW-4019	1.10	0.25	7.00	1.30	0.00	1.00

0.00 = NOT DETECTED @ DL ; TOC = TOTAL ORGANIC CARBONS ; ‡ = DEEPER SCREEN WELL

NITRATES AS N = NITRATE VALUE x .225

TABLE A-3
RADIOCHEMICAL
1988 THIRD QUARTER GROUNDWATER DATA

PARAMETER	NATURAL URANIUM	RADIUM-226	THORIUM-230	THORIUM-232
UNITS	pCi/L	pCi/L	pCi/L	pCi/L
DETECTION LIMIT	1.00	1.00	1.00	1.00
MW-2018	2.9 +/-0.8	ND	ND	ND
MW-2019*	3.00 +/- 1.0	ND	4.6 +/- 0.6	ND
MW-3001	ND	ND	ND	ND
MW-3002*	1.2 +/- 0.8	ND	ND	ND
MW-3009	3.9 +/- 0.4	ND	ND	ND
MW-3019	8.1 +/- 1.3	ND	ND	ND
MW-4019	2.7 +/- 0.8	ND	ND	ND

ND=NOT DETECTED AT DETECTION LIMIT
*=DEEPER SCREENED WELLS

TABLE A-4
METALS
1988 THIRD QUARTER GROUNDWATER DATA

WSSRAP_ID	DATE_SAM	Aluminum	Arsenic	Barium	Calcium	Chromium	Iron	Lead	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Sodium	Thallium	Zinc
Detection Limit:		200	10	200	5000	10	100	5	50	5000	15	0.2	13	40	5000	5	5000	10	20
Units:		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
MW-2018-Q388	09/02/88	ND	ND	405	70420	ND	ND	ND	ND	31880	ND	ND	ND	ND	ND	ND	45730	ND	20.1
MW-2019-Q388*	11/02/88	ND	ND	ND	5713	ND	ND	ND	ND	5714	ND	ND	12.5	ND	15740	ND	15930	ND	41
MW-3001-Q388	10/31/88	ND	ND	660	184800	ND	ND	ND	64.4	91920	96.5	0.46	57.5	ND	ND	ND	55130	ND	ND
MW-3002-Q388*	10/31/88	ND	ND	ND	41750	ND	ND	ND	ND	35990	24.3	0.35	23.7	ND	ND	ND	12910	ND	ND
MW-3009-Q388	08/19/88	ND	ND	1310	79800	ND	ND	ND	ND	48500	ND	ND	ND	ND	ND	9.86	16800	ND	22
MW-3010-Q388	08/18/88	ND	ND	244	42400	ND	ND	ND	ND	47700	ND	ND	ND	ND	ND	ND	23500	ND	40
MW-3019-Q388	10/20/88	ND	ND	ND	40160	ND	ND	ND	ND	34990	ND	ND	16.4	ND	ND	ND	7204	ND	23.9
MW-4019-Q388	10/12/88	ND	ND	ND	30580	17.7	303	ND	ND	37920	ND	0.25	16.4	ND	ND	ND	8556	ND	ND

* WELL SCREENED IN THE DEEPER INTERVAL ND NOT DETECTED

APPENDIX B

TSA Drainage

Assumptions:

- Impervious soil-clay; therefore, low infiltration
- No evapotranspiration

Data from rain gauge #1
1988 Total Annual Rainfall (in.) = 32.515

Watershed area 12.6 acres

$$(43{,}560\ ft^2/ac)(12.6\ ac)(32.515\ in.)(1\ ft/12\ in.)$$
$$(7.48\ gal/ft^3) = 11{,}124{,}040\ gallons$$

INSTRUMENT LOG BOOK

INSTRUMENT: RAIN GAUGE #1

MANUFACTURER: WEATHER MEASURE (DIVISION OF QUALIMETRICS)
P.O. Box 41039
SACRAMENTO, CALIFORNIA 95841
TELEPHONE: (916) 481-7565

MODEL: NWS

RECEIVED: JANUARY, 1987

Continued on Page

Read and Understood By

Signed	Date	Signed	Date

DATE	SEPT. IN.	SEPT. INITIALS	OCT. IN.	OCT. INITIALS	NOV. IN.	NOV. INITIALS	DEC IN.	DEC INITIALS
1			1.45	MWL			0.03	MWL
2								
3								
4					0.37	MWL		
5								
6								
7					0.09	MWL	0.06	MWL
8								
9								
10					0.66	MWL		
11								
12	0.27	MWL			0.78	MWL		
13								
14					0.04	MWL		
15								
16					1.66	MWL		
17			0.33	MWL				
18			0.51	MWL				
19	0.84	KAB						
20	0.035	MWL						
21			0.33	MWL	2.11	MWL		
22							0.89	MWL
23			0.62	KAB			0.36	MWL
24							*	
25								
26								
27								
28					0.83	MWL		
29								
30								
31								

* = see January 1989
1.90" read on 1/3/89
should be water equivalent of
rain + snowfall from Dec. 24 - Jan 3

Continued on Page

Read and Understood By

Signed Date Signed Date

1988 RAINFALL AT WSCP

JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		DATE
INCHES	INITIALS	INCHES	INITIALS	INCHES	INITIALS	INCHES	INITIALS	INCHES	INITIALS	INCHES	INITIALS	INCHES	INITIALS	INCHES	INITIALS	
		0.92	MWL													1
																2
		T	Snow + ice	ice	ice											3
		0.50	MWL	trace snow	snow			0.54	MWL							4
																5
						0.88*	MWL									6
				0.20	MWL											7
				0.40	GLN											8
								0.39	MWL	1.13	MWL					9
																10
		0.33	MWL									.45	MWL			11
				T	ice + snow											12
																13
				0.12	MWL											14
														0.62	MWL	15
																16
						T										17
.19	MWL			0.17	MWL	0.79*	MWL					1.70	MWL			18
.70	MWL	0.60	MWL											.08	MWL	19
.10	MWL											1.37	MWL			20
T	MWL															21
T	MWL													0.08	MWL	22
								0.32	MWL					1.35	MWL	23
								0.08	MWL			.64	MWL			24
				0.29	MWL											25
												2.4	MWL			26
																27
				0.02	MWL											28
				0.83	MWL					0.62	MWL					29
				0.99	MWL											30
																31
																X

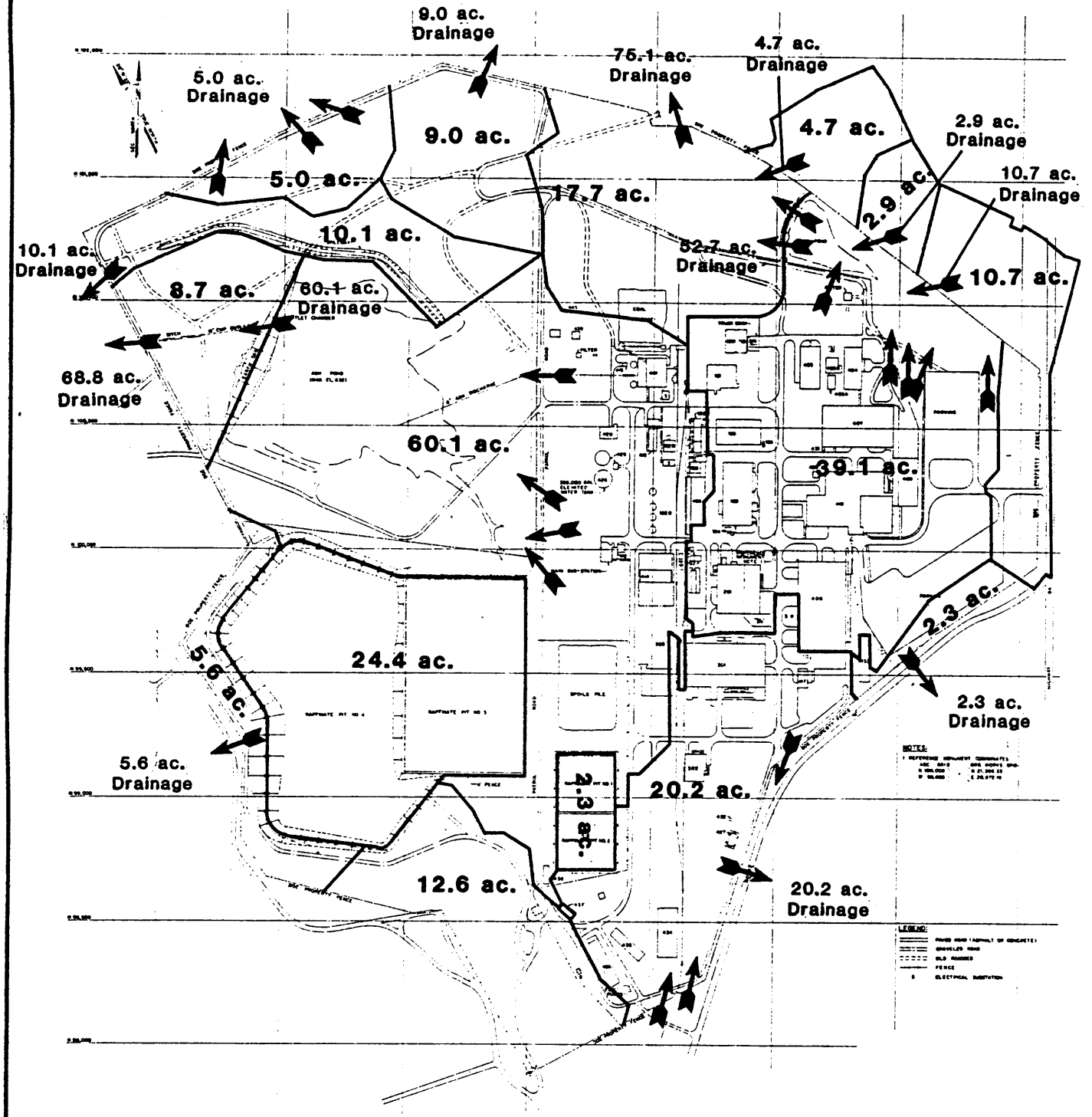
* NOT MEASURED ON THIS DATE; ANY PRECIPITATION INCLUDED ON NEXT DATE

T = TRACE

Continued on Page

Read and Understood By

Signed _____ Date _____ Signed _____ Date _____



WATERSHEDS ON THE WELDON SPRING SITE

APPENDIX C

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO. 14501-201	SHEET NO. 1 of 3	HOLE NO. G-1		
SITE: ADJACENT TO BUILDING 435	COORDINATES: N98,473.2 W50,581.0	ANGLE FROM HORIZ. 90	BEARING -		
BEGUN 1/28/86	COMPLETED 1/31/86	DRILLER TONY CALTRY, BROTCKE ENGINEERING	DRILL MAKE AND MODEL CME-55 ATV	HOLE SIZE 6 1/4"/3"	OVERBURDEN (FT.) 39.7
ROCK (FT.) 44.3	TOTAL DEPTH 84.0 FT				
CORE RECOVERY FT./% 38.5/89	CORE BOXES 4	SAMPLES 9	EL. TOP OF CASING -	GROUND EL. 668.0	DEPTH/EL. GROUND WATER 53.23 FT/614.77
DEPTH/EL. TOP OF ROCK 39.7 FT/628.3					
SAMPLE HAMMER WEIGHT/FALL 140 LBS/30 IN	CASING LEFT IN HOLE: DIA./LENGTH NONE	LOGGED BY: LAWRENCE YOUNG			

SAMPLE TYPE AND NUMBER	SAMPLE ADVANCE: LENGTH CORE RUN	SAMPLE RECOVERY: CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LBS = G.P.M. 1ST 5'	WATER PRESSURE TESTS: PRESSURE P.S.I. 2ND 5'	WATER PRESSURE TESTS: TIME = MINUTES 3RD 5'	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							668.0	0				
							667.0	1			0-1.0 FT GRAVEL, LIGHT GRAY (N7), LIMESTONE, SOME CLAY AND ORGANIC MATERIAL.	0-45.3 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS.
											1.0-4.5 FT CLAYEY SILT, BLACK (N1), SOFT, MOIST, ORGANIC DEBRIS.	
							663.5	4.5				
SS 2"	18"	18"	17	4	7	10		5		1	4.5-39.7 FT CLAYEY SILT, MODERATE YELLOWISH BROWN (10YR 5/4) TO DARK YELLOWISH BROWN (10YR 4/2), STIFF TO HARD, MOIST, WITH MEDIUM GRAY (N5) SILT LENSES, TRACE TO SOME GRAVEL AND COBBLES.	
SS 2"	18"	18"	10	3	4	6		10		2		DRIVING COBBLE.
SS 2"	18"	18"	16	4	6	10		15		3		
SS 2"	18"	18"	26	6	11	15		20		4		
SS 2"	18"	18"	40	9	18	22		25		5		
SS 2"	18"	18"	32	10	14	18		30		6		
							633.0	35				

SS=SPLIT SPOON, ST=SHELBY TUBE, P=PITCHER, O=OTHER

SITE: ADJACENT TO BUILDING 435

HOLE NO. G-1

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE | JOB NO. 14501-201 | SHEET NO. 2 of 3 | HOLE NO. G-1

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN 1ST 6" G.P.M.	WATER PRESSURE TESTS: PRESSURE 2ND 6" P.S.I.	WATER PRESSURE TESTS: TIME IN 3RD 6" MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
2"	18"	18"	24	7	11	13	633.0	35		7		BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION PRIOR TO CORING.
								39.7				
SS 2"	18"	11"	76	27	34	42	628.3	40		8	39.7-45.3 FT LIMESTONE, VERY LIGHT GRAY (N8), VERY SOFT, DECOMPOSED, DRY, CONTAINS CLASTS OF LESS WEATHERED LIMESTONE.	BURLINGTON/KEOKUK FORMATION.
2"	10"	7"	50+	20	50/4"	-	622.7	45		9		SAMPLER REFUSAL.
								45.3			45.3-79.5 FT LIMESTONE, LIGHT GRAY (N7) TO DARK YELLOWISH ORANGE (10YR 6/6), SOFT TO HARD, HIGHLY TO MODERATELY WEATHERED, VUGGY, IRON STAINED, VUGS RANGE IN SIZE FROM 4CM TO LESS THAN 0.5CM. UPPER 2 FT OF CORE CONTAIN HEALED FRACTURES ORIENTED FROM 0-20° RELATIVE TO CORE AXIS. REMAINDER OF UNIT CONTAINS HORIZONTAL FRACTURES, ROUGH PLANAR APERATURE, IRON STAINED, SOME CONTAIN CLAY FILLING. FRACTURE SPACING VARIES FROM 0.1-0.5 FT.	45.3-84.0 FT DRILLED WITH NQ DIAMOND CORE BARREL USING WATER
NQ CORE	8.5	5.0	59%					50		RUN #1		RUN #1 ROD = 66% LP = 0.8 FT AP = 0.5 FT ▽ 1/30/86
NQ CORE	10.0	9.6	96%	17.0 17.5 18.5 19	5 9 13 18	9 4 6 6		55		RUN #2		RUN #2 ROD = 66% LP = 0.8 FT AP = 0.3 FT
								60				
NQ CORE	10.0	9.8	98%	1.5 8	22 29	4 15		65		RUN #3		RUN #3 ROD = 55% LP = 0.8 FT AP = 0.3 FT
								70				
							593.0	75				

SS=SPLIT SPOON; ST=SHELBY TUBE; B=BENISON; P=PITCHER; O=OTHER

SITE: ADJACENT TO BUILDING 435

HOLE NO. G-1

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-1

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							593.0	75				
NO CORE	10.0	10.0	100%							RUN #4		RUN #4 ROD = 75% AP = 0.4 FT LP = 1.5 FT
							588.5	79.5 80			79.5-84.0 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), HARD, MASSIVE, STYLOLITIC, CORE BREAKS ALONG STYLOLITES, THIN (0.2 FT) CHERT LAYERS.	
							584.0	84			BOTTOM OF BORING AT 84.0 FT. BORING GROUTED TO SURFACE ON 1/31/86.	ROD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: ADJACENT TO BUILDING 435

HOLE NO. G-1

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 3	G-16

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
FIELD ADJACENT TO ARMY PROPERTY	N98,051 W51,007	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/3/86	6/5/86	GEOTECHNOLOGY INC KURT JAEGER	CME-45	6-1/4"/3"	34.0	46.4	80.4'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
35.8/77	5	7	-	656.7	30.1'/626.6	34.0'/622.7

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							656.7	0				
							656.2	.5			0 TO 0.5 FT SILTY CLAY, BLACK(N1), ORGANIC DEBRIS, TOPSOIL.	0-34.0 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS.
SS 2"	18"	12"	17	5	6	11		5		1	0.5 TO 12.5 FT SILTY CLAY, MODERATE YELLOWISH BROWN(10YR 5/4), MOIST, VERY STIFF, WITH MEDIUM LIGHT GRAY SILT LENSES, AND LENSES OF BLACK(N1) ORGANIC DEBRIS.	
SS 2"	18"	11"	17	4	7	10		10		2		0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
							644.2	12.5			12.5 TO 21.0 FT SILTY CLAY, BROWNISH GRAY(5YR 4/1), MOIST, VERY STIFF, TRACE TO SOME GRAVEL, TRACE FINE-GRAINED SAND, OXIDIZED NODULES.	
SS 2"	18"	12"	20	5	8	12		15		3		
SS 2"	18"	14"	15	5	6	9		20		4		
							635.7	21			21.0 TO 34.0 FT GRAVELLY CLAY, VERY LIGHT GRAY(N8), STIFF, MOIST, WITH SLIGHTLY WEATHERED, CHERT GRAVEL.	
SS 2"	16"	4"	73+	22	23	50/4"		25		5		29.0 TO 34.0 FT FALLING HEAD PERMEABILITY TEST
SS 2"	18"	10"	34	14	13	21		30		6		▽ 6/5/86
												34.0 FT AUGER REFUSAL
SS 2"	1/2"	0	50+	50/1/2"			622.7	34				BURLINGTON/KEOKUK FM.
							621.7	35			34.0 TO 71.9 FT LIMESTONE, MODERATE YELLOWISH	

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
FIELD ADJACENT TO ARMY PROPERTY	G-16

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE | JOB NO. 14501-201 | SHEET NO. 2 OF 3 | HOLE NO. G-16

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH/ CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS /FT PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION
							624.7	35			
NXB CORE	5.0	1.0	20							RUN #1	BROWN(10YR 5/4) TO MEDIUM GRAY(N5), SEVERELY TO MODERATELY WEATHERED, MEDIUM SOFT TO MEDIUM HARD, VUGGY, HORIZONTALLY FRACTURED WITH IRON STAINING ON FRACTURE SURFACES, CHERT LAYERS AND LENSES RANGING IN THICKNESS FROM 0.5 TO LESS THAN 0.1 FT.
NXB CORE	1.5	0.7	47					40		R#2	
NXB CORE	5.5	5.5	100							RUN #3	
				13.4	5	15		45			46.5 TO 56.5 FT ANGULAR CHERT FRAGMENTS AND INTERBEDS OF GREENISH GRAY(5G 6/1) TO GRAYISH OLIVE GREEN(5GY 3/2) SHALE.
				15.3	10	13					
				16.8	20	7					
NXB CORE	10.0	8.9	89					50		RUN #4	
								55			
NXB CORE	4.1	4.0	98							RUN #5	56.5 TO 60.5 FT MODERATELY WEATHERED, WITH SMALL (<0.1 FT THICK) CHERT NODULES.
NXB CORE	2.0	2.0	100					60		RUN #6	
NXB CORE	8.0	3.4	43					65		RUN #7	
NXB CORE	1.5	1.4	93					70		R#8	
NXB CORE	8.9	8.9	100				584.8	71.9		RUN #9	71.9 TO 80.4 FT LIMESTONE, MEDIUM LIGHT GRAY(N6), SLIGHTLY WEATHERED, HARD, MASSIVE, WITH LIGHT GRAY(N7), CHERT NODULES, BROWNISH GRAY(5YR 4/1) THIN (<.01 FT) SHALE INTERBEDS, AND STYLOLITES.
							581.7	75			

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

34.0 - 34.5 FT DRILLED WITH ROLLER BIT TO START COREHOLE.
34.5 - 80.4 FT DRILLED WITH NXB WIRELINE BIT USING CLEAN WATER.

44.5 FT COMPLETE WATER LOSS.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.1	0.3	0
2	0.1	0.3	0
3	0.3	1.1	74
4	0.3	1.2	43
5	0.4	1.0	86
6	0.3	0.5	60
7	0.3	0.5	52
8	0.4	0.6	70
9	1.0	1.8	87

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: FIELD ADJACENT TO ARMY PROPERTY

HOLE NO. G-16

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-16

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE/ LENGTH CORE RUN	SAMPLE RECOVERY/ CORE RECOVERY	SAMPLE BLOWS/ft PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							580.7	75				
							576.3	80 80.4			BOTTOM OF BORING AT 80.4 FT. BORING GROUTED TO SURFACE ON 6/5/86.	APPROXIMATELY 20FT OF 1-1/4" PVC PIPE GROUTED IN HOLE. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DIVISION; P=PITCHER; O=OTHER

SITE: FIELD ADJACENT TO ARMY PROPERTY

HOLE NO. G-16

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP-WELDON SPRING	14501	1 OF 2	B-21

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
DOE PROPERTY-RAFFINATE PIT AREA	N 98832.52 W 52123.23	90	VERTICAL

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
12 APR.83	18 APR.83	BOYLES BROTHERS	LONGYEAR 44	3 TO 4"	29.5	69.9	99.4'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL.TOP OF CASING	GROUND EL.	DEPTH/EL.GROUND WATER	DEPTH/EL.TOP OF ROCK
54/99	3		2.16/646.57	644.41	35.7/608.71 (4/19/83)	29.5/614.91

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE:DIA/LENGTH	LOGGED BY:
	45' OF 4" PVC	E.M.FANELLI

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION (FT.)	DEPTH (FT.)	GRAPHIC LOGS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURNS CHARACTER OF DRILLING,ETC.
6" ROCKBIT							644.41					Drilled with 6" roller bit and mud, descriptions based on cuttings and TR-14 log.
							643.41				0.0'-1.0': TOPSOIL: BLACKISH-BROWN, ORGANIC-RICH, MOIST TO WET, CLAYEY SILT.	
							639.41	5			1.0'-5.0': CLAYEY SILT: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAYEY SILT; NON PLASTIC TO SEMI PLASTIC, BUT GENERALLY PLASTIC WHEN REWORKED; MODERATELY DENSE WITH DEPTH AND CONTAINS ABUNDANT IRON-OXIDE NODULES.	@ 9'-pulled
							634.41	10				
								15			5.0'-10.0': CLAY: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAY TO SILTY CLAY. THE MATERIAL IS PLASTIC, DENSE, CONTAINS ABUNDANT IRON-OXIDE NODULES, AND HAS SLICKENSIDED SURFACES.	@ 21'-pulled rods.
							621.41	20				
								25			10.0'-23.0': CLAY TILL: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), SILTY, SANDY, DENSE, CLAY THAT CONTAINS A FEW PEBBLES OF SUBROUNDED CHERT, QUARTZITE, AND GRANITIC MATERIAL, WHICH GENERALLY COARSEN TO COBBLE SIZES WITH DEPTH. THE MATERIAL HAS MANGANESE-STAINED SURFACES IRON AND SECONDARY CALCARIOUS FRIABLE CONCRETIONS, AND SHOWS BLOCKY FRACTURING.	
							614.91	30				
								35			@ 15'-17'- VERY DARK GRAY SILTY LAYER LENSE.	
								40			@ 21'-23'- BASAL CHERT TILL: BROWN TO BLACK COBBLE TO BOULDER SIZED, ANGULAR TO SUBANGULAR CHERT CLASTS IN A LOOSE, SANDY, SILTY, CLAYEY MATRIX THE CHERT COMMONLY HAS WHITE WEATHERING RINDS.	@ 40'-drilling hard; 400 psi down pressure.
NX WIRELINE	2.8	45.8-47.8' 2.8	100					45				
	4.4	47.8-52.2' 4.4	100					50			26.0'-29.5': CHERTY CLAY: BRIGHTER YELLOWISH-ORANGE (10YR6/6), TAN AND BROWN CLAY MATRIX CONTAINING SILT AND ABUNDANT CHERT CLASTS. (CONSIDERED A PENSYLVANIAN SOIL BY STATE GEOLOGISTS.	@ 45'-cemented in 4" PVC casing; began NX coring.
	4.6	52.2-56.8' 4.6	100					55				

SS=SPLIT SPOON; ST=SHELBY TUBE; P=PENNSYLVANIAN; P=PITCHER; O=OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA

HOLE NO. B-21

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP-WELDON SPRING	14501	2 OF 2	BH-21

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION (FT.)	DEPTH (FT.)	GRAPHIC LOGS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURNS CHARACTER OF DRILLING,ETC.
NX WIRELINE	4.6	52.2-56.8' 4.6	100					55			29.5-35': RESIDUAL LIMESTONE: WEATHERED, ALTERATING LAYERS OF CHERT, LIMESTONE (WEATHERED) AND SILTY CLAY.	
	5.1	56.8-61.9' 5.1	100					60				
	4.2	61.9-66.1' 4.2	100					65			35-99.4'(BOH): LIMESTONE: FORMATION NAME: BURLINGTON/ KEOBUK AGE: MISSISSIPPIAN GRAY (N7), FOSSILIFEROUS, FINE TO COARSE GRAINED, OFTEN SHOWS VERY SMALL SCALE GRADED BEDDING, LIMESTONE IS INTERBEDDED WITH LENSES AND NODULES OF CHERT.	
	4.7	66.1-70.8' 4.7	100					70				
	4.8	70-.8-75.6' 4.8	100					75				
	4.7	75.6-80.3' 4.7	100					80			FORMATION IS WEATHERED DARK YELLOWISH ORANGE (10YR6/6) TO MODERATE YELLOWISH BROWN (10YR5/4) TO APPROXIMATELY 54', AND IS GENERALLY SOFT WHERE WEATHERED.	
	4.7	80.3-85.0' 4.7	100					85				
	5.0	85.0-90.0' 5.0	100					90			LIMESTONE CONTAINS ABUNDANT STYOLITES (PRESSURE SOLUTION FEATURES) ASSOCIATED WITH BLACK ORGANIC CLAY SEAMS AT SUTURES. STYOLITES INTERSECT FOSSILS, FOSSILS ARE PREMARILY BRACIPOODS, BUROZOA AND CRINOIDS, LIMESTONE ALSO CONTAINS PYRITE, IRON, AND MANGANESE.	
	4.8	90.0-94.8' 4.8	100					95				
	4.6	94.8-99.4' 4.2	91				522.01	100			@54'-LIMESTONE IS GENERALLY FRESH AND UNWEATERED_COLOR CHANGE TO GRAY (N4).	@ 95'-drilling very soft.
								105			@56.-56.9' CORE BECOMES SHALEY CONTAINS ABUNDANT PYRITE AND SOME GLAUCOMITE AND/OR CHLORITE.	@ 99.4'-bailed well recovered @ .44 gpm.
								110			@ 56.-56.9' CORE BECOMES SHALEY COTAINS ABUNDANT PYRITE AND SOME GLAUCOMITE AND/OR CHLORITE.	
								115			@ 93' ROCK APPEARS SATURATED AND POROUS.	
								120			BOH @ 99.4' HOLE COMPLETED AS A ROCK OBSERVATION WELL.	

NOTE: ROCK AND SOIL COLORS ARE INDEXED ON THE ROCK-COLOR CHART PUBLISHED BY THE GEOLOGICAL SOCIETY OF AMERICA.

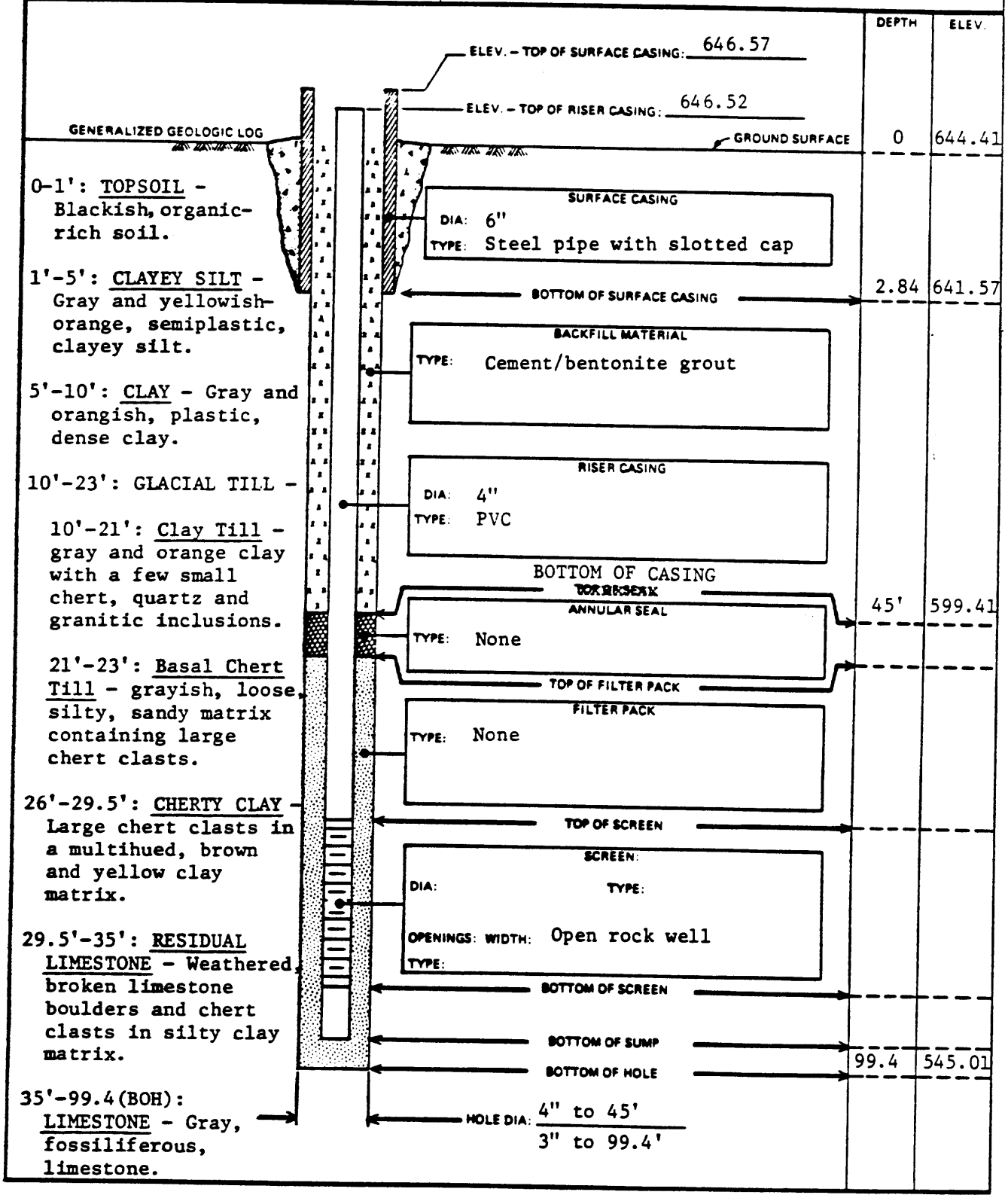
SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: DOE PROPERTY- RAFFINATE PIT AREA

HOLE NO. B-21

OBSERVATION WELL

PROJECT: FUSRAP - Weldon Spring			WELL NO: B-21
JOB NO: 14501	SITE: DOE PROPERTY - RAFFINATE PIT AREA	COORDINATES: 98832.52 N 52123.23 W	
BEGUN: 4/12/83	COMPLETED: 4/18/83	PREPARED BY: E.M. FANELLI	REFERENCE POINT FOR MEASUREMENTS: Top of Surface Casing



GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP-WELDON SPRING	14581	1 OF 2	B-23

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
DOE PROPERTY-RAFFINATE PIT AREA	N 98471.52 W 50936.42	90	VERTICAL

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
13 APR.83	19 APR.83	BOYLES BROTHERS	LONGYEAR 44	3 TO 4"	38.0	52.7	90.7

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL.TOP OF CASING	GROUND EL.	DEPTH/EL.GROUND WATER	DEPTH/EL.TOP OF ROCK
37.9'/99	2	8	2/667.09	665.09	52/613.1(4/19/83)	38'/627.09

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE:DIA/LENGTH	LOGGED BY:
150 LBS/30 IN.	4"/52.5	E.M.FANELLI

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS W/ PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION (FT.)	DEPTH (FT.)	GRAPHIC LOGS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURNS CHARACTER OF DRILLING,ETC.
6" ROLLER BIT							665.09					Drilled with 6" roller bit and mud to 52.5'.
							664.09				0.0'-1.0': TOPSOIL: BLACKISH-BROWN, ORGANIC-RICH, MOIST TO WET, CLAYEY SILT.	
							659.09	5			1.0'-6.0': CLAYEY SILT: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAYEY SILT; NON PLASTIC TO SEMI PLASTIC, BUT GENERALLY PLASTIC WHEN REWORKED; MODERATELY DENSE WITH DEPTH AND CONTAINS ABUNDANT IRON-OXIDE NODULES.	
							655.09	10				
								15			6.0'-10.0': CLAY: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAY TO SILTY CLAY. THE MATERIAL IS PLASTIC, DENSE, CONTAINS ABUNDANT IRON-OXIDE NODULES, AND HAS SLICKENSIDED SURFACES.	
								20				
								25			10.0'-38.0': CLAY TILL: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), SILTY, SANDY, DENSE, CLAY THAT CONTAINS A FEW PEBBLES OF SUBROUNDED CHERT, QUARTZITE, AND GRANITIC MATERIAL, WHICH GENERALLY COARSEN TO COBBLE SIZES WITH DEPTH. THE MATERIAL HAS MANGANESE-STAINED SURFACES IRON AND SECONDARY CALCARIOUS FRIABLE CONCRETIONS, AND SHOWS BLOCKY FRACTURING.	@ 36.5'-drilling harder.
								30				
								35				
							628.59				@ 36.5'-38': BASAL CHERT TILL: MOTTLED, GRAY AND BROWN SILTY CLAY MATRIX CONTAINING LAYER COBBLE SIZED CLASTS OF CHERT.	@ 38'-drilling harder and steady 500 psi down pressure; first limey return.
								40				
								45				
								50			38'-90.7'(BOH): LIMESTONE	
								55			(SEE NEXT PAGE FOR DESCRIPTION).	@ 52.2'-cemented in 4" PVC, began NX coring.
	52.5-57.6'											
	5.1	5.0	98									

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA

HOLE NO. B-23

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP-WELDON SPRING	14501	2 OF 2	B-23

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION (FT.)	DEPTH (FT.)	GRAPHIC LOGS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURNS CHARACTER OF DRILLING,ETC.
NX WIRELINE	5.1	52.5-57.6' 5.0	98					55			38'-90.7'(BOH): LIMESTONE: FORMATION NAME: BURLINGTON/ KEOKUK: AGE: MISSISSIPPIAN; A LIGHT GRAY (N7) TO VERY LIGHT GRAY (N8), FINE- TO COARSE-GRAINED, FOSSILIFEROUS LIMESTONE INTERBEDDED WITH LENSES AND NODULES OF SPECKLED, BANDED, AND MOTTLED LIGHT-BLUISH-GRAY (5B7/1) AND BLUISH-WHITE (5B9/1), FOSSILIFEROUS CHERT. THE FORMATION IS IRON-OXIDE STAINED, MODERATE YELLOWISH ORANGE (10YR6/6) WHERE WEATHERED, AND BECOMES LESS WEATHERED WITH DEPTH. IT IS MANGANESED STAINED AND GENERALLY HARD AND MASSIVE, BUT SHOWS SMALL-SCALE GRADED BEDDING LOCALLY. THE FOSSILS ARE PREDOMINANTLY CRINOIDS, BRYOZOA AND BRACIOPODS, WHICH ARE LOCALLY REPLACED BY PYRITE. A FEW CALCITE AND QUARTZ CRYSTALS ARE ASSOCIATED WITH VUGS, ESPECIALLY AT LIMESTONE-CHERT CONTACTS. THE FORMATION CONTAINS ABUNDANT STYOLITES (PRESSURE SOLUTION FEATURES), WHICH ARE SECONDARY FEATURES THAT ARE PERPENDICULAR TO BEDDING AND INTERSECT FOSSILS. STYOLITE SUTURES ARE ASSOCIATED WITH A THIN (1/4") BLACKISH-GRAY, CARBONACEOUS, SILTY CLAY, THAT CONTAINS IRON.	
	4.9	57.6-62.5' 4.9	100					60				
	5.2	62.5-67.7' 5.0	96					65				
	4.0	67.7-71.7' 4.0	100					70				
	4.6	71.7-76.3' 4.6	100					75				@ 77'-white return.
	4.8	76.3-81.1' 4.8	100					80				
	4.9	81.1-86.0' 4.9	100					85				
	4.7	86.0-90.7' 4.7	100					90				@ 90.7'-Bailed hole to 70' recovered to 52' @ .16 gpm.
								95				
								100				
								105				
								110				
								115				
								120				

LIMESTONE IS WEATHERED DARK YELLOWISH-BROWN (10YR5/4) TO 75.5'.

@ 75 SMALL SHALEY LENSE CONTAINING SOME GLAUCONITE AND/ OR CHLORITES.

BOH @ 90.7'- HOLE COMPLETED AS A ROCK OBSERVATION WELL.

NOTE: ROCK AND SOIL SOLORS ARE INDEXED ON THE ROCK-COLOR CHART PUBLISHED BY THE GEOLOGICAL SOCIETY OF AMERICA.

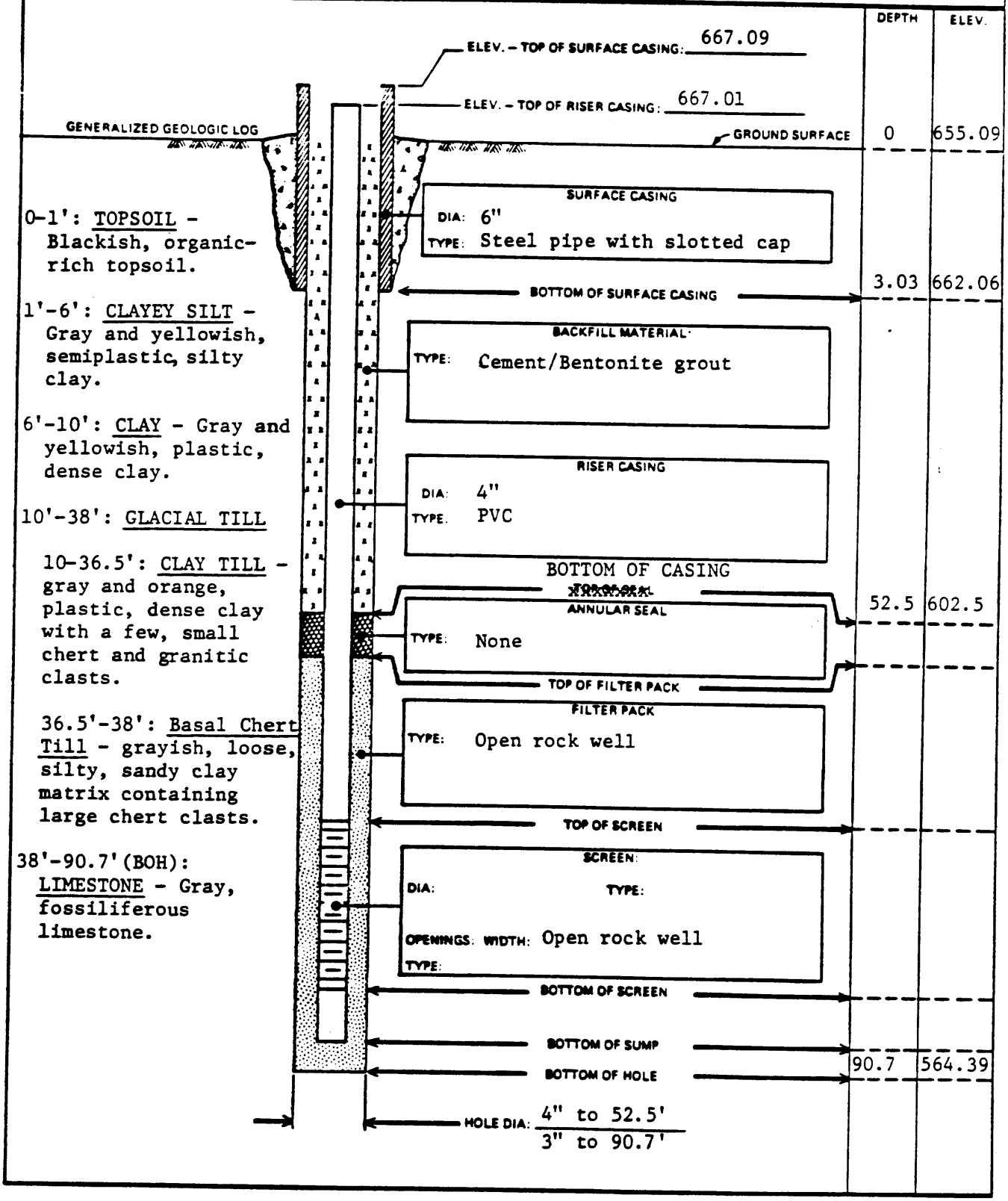
S=SPLIT SPOON; ST=SHELBY TUBE; P=PISTON; O=OTHER	SITE: DOE PROPERTY-RAFFINATE PIT AREA	HOLE NO. B-23

OBSERVATION WELL

PROJECT	WELL NO
FUSRAP - Weldon Spring	B-23

JOB NO	SITE	COORDINATES
14501	DOE PROPERTY- RAFFINATE PIT AREA	98471.52 N 50936.42 W

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
4/13/83	4/19/83	E.M. FANELLI	Top of Surface Casing



WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 2

Project Number: 5121

Hole Number: GTS-1

Project: Geotechnical Investigation - Phase II	Location: Temporary Storage Area
Coordinates: (AEC) N. 98657.1 W. 50964.4	Drilling Contractor: Hannibal Testing Labs.
Drill Make and Model: CME 55: 6 7/8" Hollow Stem Auger, 3¼", I.D.	Depth Top of Rock: 39.8'
Depth Casing & Size: none	Hole Size: 6 7/8"
Elevation: 665.35 ft. G.S.	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 39.8'	
Water Level: none	Fluid & Additives: none
Date Start: 5/11/89	Date Finish: 5/12/89
Logger: P. Patchin	

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
0	1.0 2.5	SS 01	7"	2-3-4 7		CLAYEY SILT, nonplastic, brown (10YR 4/3) w/roots, organics, FeOx nodules, v. stiff (2.75) last 1"
	2.5 4.0	SS 02	11"	2-4-5 9		1.8 mottled lt. yellowish brown (2.5Y 6/4) and yellowish brown (10Y 5/8), damp to dry. ML. CLAYEY SILT (40% clay) slightly plastic, mottled lt. brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/8) FeOx) damp to dry, MnOx blebs, FeOx stain, ML-CL
5	5.0 7.5	ST 03	12"			as above, damp, pp=2.5, non-plastic, ML FERRELVIEW
	7.5 9.0	SS 04	18"	2-3-5 8		7.8 SILTY CLAY, mottled as above, damp FeOx nodules (20% silt), slight to mod. plasticity. V. stiff 2.25 CL
10	10.0 12.5	ST 05	20"			CLAY med. to high plasticity, mottled lt. yellowish brown (2.5Y 6/4) and yellowish brown (10Y 5/8), damp, v. little silt, FeOx nodules, no MnOx, v. stiff (2.5) CL-CH.
	12.5 14.0	SS 06	18"	2-3-4 7		CLAY as above, with white non-calcareous soft inclusions, pp=3.0 CH FERRELVIEW
15	15.0 17.5	ST 07	28"			CLAY, gravelly (10%) mod. plasticity, mottled as above, slightly damp, abundant MnOx streaks,
	17.5 19.0	SS 08	17"	2-8-9 17		16.3 FeOx nodules. Gravel is subrounded igneous and metamorphics, very stiff (3.25) CL-CH CLAY TILL Clay gravelly as above, increased MnOx stringers and FeOx blebs to 7mm, igneous gravel to 2cm (15%) damp to dry. Sandy (5%) coarse, very stiff (3.75) CL
20	20.0 21.5	ST 09	29"			CLAY as above, sandy, predominantly yellowish brown (10YR 5/8) moist, pp=2.75 CL CLAY TILL
	22.5 24.0	SS 10	18"	3-9-10 19		CLAY as above, no mottling; with hard L.S. gravel, vert. fractures w/MnOx, pp=3.75, sandy, dry to damp, CL
25						See next page for sample ST11

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 2

Project Number: 5121

Hole Number: GTS-1

Project: Geotechnical Investigation - Phase II

Location: Temporary Storage Area

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25	25.0	ST 11	16"			Sampler drove rock & caved last 8" of Shelby tube. Cut offtube 8" from bottom. Rock was calcareous. Gravelly CLAY as above, dry pp=3.5 CL
		27.2					Sampler refusal
		27.5	SS 12	18"	4-10-11 21		CLAY as above, abundant MnOx & fractures with leaching pp=4.5 dry
		29.0					CLAY TILL
	30	30.0	SB 13	5"	8-19-20 39		Pushed a large (7cm) rock at end of sampler. CLAY as above, damp pp=3.
		31.5					31.8
		32.5	SS 14	17"	6-14-17 31		CLAYEY SAND to SILT (v. fine)(20% clay)lt.gray (10YR 7/2) nonplastic, dry to damp, abundant FeOx nodules to 3mm. Hard (> 4.0) no gravel mottled with lt.yellowish brn. (10YR 6/4) SC-ML
		34.0					BASAL TILL? 34.9
	35	35.0	SB 15	12"	6-12-13 25		GRAVELLY CLAY, slight plasticity, yellowish red, no silt (5YR 5/6) mottled with pinkish gray (5YR 6/2) 5% chert gravel to 12mm, minor finely xln L.S. (dark); damp, blocky, w/minor MnOx; FeOx blebs, hard (4.5) CL
		36.5					Residuum
		37.5	SS 16	3"	7-11-20 31		Pushed rock, lithographic limestone, gray 10YR 6/1) GRAVELLY CLAY, as above, pp=4.5, dry
		39.0					39.8
	40						Auger refusal @39.8' @8:40a.m. 5/12/89
							Note: In end of clean-out tube before grouting was large chert gravel (7cm) with weathering rinds and pyrite (fresh) inclusions. Also more leached looking clay.
							Collected bulk sample from 0-5.0' from auger cuttings.
							Grouted hole to surface with Volclay grout.
							Performed a constant head test at 36.5'. No take.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 2

Project Number: 5121

Hole Number: GTS-2

Project: Geotechnical Investigation - Phase II	Location: Temporary Storage Area
Coordinates: N.98100.4 W.50751.9 (AEC)	Drilling Contractor: Hannibal Testing Labs
Drill Make and Model: CME-55, 6 7/8" Hollow Stem Auger; 3¼" I.D.	Depth Top of Rock: 37.3' / Depth Casing & Size: none / Hole Size: 6 7/8"
Elevation: 668.17 ft. G.S.	Angle from Vert. and Bearing: Vertical / Depth Bottom of Hole: 37.3'
Water Level: None	Fluid & Additives: None / Date Start: 5/9/89 / Date Finish: 5/10/89 / Logger: P. Patchin

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
0	0 – 1.5	SS 01	12"	2-6-7 / 13		SILTY CLAY, mod. plasticity, mottled light gray (10YR 7/1) and yellow (10YR 7/6), moist, roots, organics. CL. Bottom 6" is clayey silt, dk grayish brown (10YR 4/2) non-plastic, v. stiff (2.25) ML
	2.5 – 5.0	ST 02	18"			SILTY CLAY, low plasticity, mottled light brownish gray (2.5Y 6/2) and brownish yellow (10YR 6/6) very stiff (2.25) damp, CL. FeOx blebs, MnOx stringers. Silt ~30-40%.
5	5.0 – 6.5	SS 03	18"	3-5-8 / 13		As above pp=2.0 CL FERRELVIEW
	7.5 – 10.0	ST 04	28"			As above, pp=2.25 minor fine gravel, CL
10	10.0 – 11.5	SS 05	18"	7-9-10 / 19		As above, pp=2.0 2" soft saturated zone at 10.8', overall moist CL.
	12.5 – 15.0	ST 06				CLAY, as above, less silty (10%) high plasticity, moist, CH pp=2.5
15	15.0 – 16.5	SS 07	18"	2-5-10 / 15		CLAY as above, pp=2.75, high plasticity, damp, with slickensides, CL-CH FERRELVIEW
	17.5 – 20.0	ST 08	0"	Sample fell out no recovery		Shelby tube sampler empty. Drove split barrel sampler to pick up sample. At end of split barrel was SILTY CLAY as above, dry, increase MnOx streaks, minor fine gravel, CL
20	20.0 – 21.5	SS 09	18"	2-4-6 / 10		CLAY, as above, dry, pp=3.25, minor gravel, CL-CH 22.0
	22.5 – 25.0	ST 10	26"			CLAY, as above but with increased (10%) fine gravel/ coarse sand, dry, low plasticity, hard (3.75) CL CLAY TILL
25						

See next page for SS11 sample description

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 2

Project Number: 5121

Hole Number: GTS-2

Project: Geotechnical Investigation - Phase II

Location: Temporary Storage Area

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25	25.0 26.5	SS 11	18"	3-7-8 15		SILTY CLAY, gravelly (15%) low plasticity, dry, hard (4.25), gravel fraction subround igneous, mafic, possible metamorphic rock, sandy (10%), predominantly yellowish brown (10YR 5/8) CL
		27.5 29.0	SB 12	12"	4-7-14 21		as above pp=4.5 dry CLAY TILL
	30	30.0 31.5	SS 13	18"	5-7-12		as above, less sand and silt, more plastic pp=4.0 gravel up to 3cm (chert).
		32.5 34.0	SB 14	0"	4-11-12		No sample, pushed rock. At end of split barrel is white (5Y 8/1) clay with decomposed L.S. CL 34.2 RESIDUUM?
	35	35.0 36.5	SB 15	12"	13-39-30 >50		CLAYEY GRAVEL, nonplastic, dry, gravel up to 5cm, white (5Y 8/1), weathered limestone and chert (90%) minor clay, white (5Y 8/2) and MnOx and FeOx staining; last 4" is light gray (5Y 7/2) clay, "soapy", dry.
					37.3'		Auger Refusal at 37.3' at 3:40pm 5/9/89
	40						Note: Constant head tests at 10.0' and 25.0'. No take on both. Attempted test at 36.5' but could not seat NW drill rod due to rock. Took bulk sample from 0-5' from auger cuttings. Grouted hole to surface with Volclay grout.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 2

Project Number: 5121

Hole Number: GTS-3

Project: Geotechnical Investigation - Phase II	Location: Temporary Storage Area
Coordinates: N.93118.6 W.51076.9 (AEC)	Drilling Contractor: Hannibal Testing Labs
Drill Make and Model: CME-55, 6 7/8" Hollow Stem Auger with 3¼" I.D.	Depth Top of Rock: 31.5'
Depth Casing & Size: none	Hole Size: 6 7/8"
Elevation: 654.97 ft. G.S.	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 31.5'	
Water Level: None	Fluid & Additives: None
Date Start: 5/5/89	Date Finish: 5/8/89
Logger: P. Patchin	

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	0						Augered to 2.5'
							FERRELVIEW
		2.5 4.0	SS 01	5"	2-1-1 2		SILTY CLAY, low plasticity, dark yllwsh brn(10YR 3/4) mottled with yellowish red (10YR 4/6), moist, soft (.75) CL
	5						
		5.0 7.5	ST 02	17"			CLAY, high plasticity, mottled red (2.5YR 4/8) and brn (10YR 5/3), minor black (MnOx) streaks, moist, med. stiff (1.0) CH
		8.0 9.5	SS 03	11"	2-7-8 15		CLAY, as above, light gray (10YR 7/1), slightly silty, no mottling, moist, stiff (1.5), CH
	10						
		10.0 12.5	ST 04	28"			SILTY CLAY, 15% silt, low to med plasticity, mottled yellowish brown (10YR 5/6) and light gray (10YR 7/1) with abundant FeOx nodules and MnOx streaks, damp, very stiff (4.0), CL
		12.5 14.0	SS 05	18"	1-8-9 17		FERRELVIEW As above, grading to siltier (~30%) minor fine sand and gravel at bottom, v. stiff (3.0) CL 13.5
	15						CLAY TILL
		15.0 17.5	ST 06	29"			SILTY CLAY, low plasticity, yellowish brown (10YR 5/6) mottled with light gray (5Y 7/2), damp very stiff (4.0) approx. 15% fine gravel (igneous & metamorphic) subrnd abundant FeOx blebs & MnOx stringers. CH
		17.5 19.0	SS 07	10"	3-12-18 30		SANDY GRAVEL, nonplastic, white (10YR 8/1) 60% large angular chert gravel, (gray 10YR 6/1) up to 2cm, minor clay (5%), minor FeOx stain; dry. GM 18.5
	20						BASAL TILL
		20.0 22.5	ST 08	16"			CLAY, low to med plasticity, white, (5Y 8/1), damp, blocky, stiff, (2.0) with FeOx and MnOx stringers, "soapy", with approx. 25% decomposed limestone? (high reaction to HCL) CL. 21.3
		22.5 24.0	SS 09	12"	9-10-15 25		As above, increase in FeOx stain, with very angular pale blue chert, pp=2.0
	25						RESIDUUM?

rilling

See next page for SB11 Sample description.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 2

Project Number: 5121

Hole Number: GTS-3

Project: Geotechnical Investigation - Phase II

Location: Temporary Storage Area

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25	25.0	SB	6"	13-14-15		CLAY, gravelly, light brownish gray (2.5Y 6/2), mod. to high plasticity, with FeOx staining (10YR 6/6) & MnOx stringers; stiff (1.23) 25% subangular chert gravel to 4cm, no limestone, CL RESIDUUM?
		26.5	10		29		
		27.5	SS		10-22-23		GRAVEL, with minor clay, nonplastic, dry 10% clay, gravel is cherty limestone to 3cm, also sand size decomposed rock, all stained with FeOx, GC.
5/5		29.0	11	10"	45		
5/8		30.0					As above w/50% clay to 30.2', gravel (cont'd below)
	30		SB12	6"	50 - > 50		
		30.5			refusal		AUGER REFUSAL RESIDUUM? 31.5
							@8:50 am 5/8/89
							is predominantly chert gravel. At 30.2 is weathered bedrock with mainly chert and clay (brownish yellow 10YR 6/6), chert pieces to 4cm. Also white clay (5Y 8/1) with MnOx stringers. FeOx stain throughout with minor weathered limestone and limey clay.
							Grouted hole to surface with Volclay grout.
							Note: Performed constant head test at 7.5', 17.5', and 22.5'. No take on all tests.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 2

Project Number: 5121

Hole Number: GTS-4

Project: Geotechnical Investigation - Phase II	Location: Temporary Storage Area
Coordinates: N.98448.6 W.51237.2 (AEC)	Drilling Contractor: Hannibal Testing Labs
Drill Make and Model: CME 55, 6 7/8" Hollow Stem Auger: 3¼" I.D.	Depth Top of Rock: 27.3
Depth Casing & Size: none	Hole Size: 6 7/8"
Elevation: 652.20 ft. G.S.	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 27.5	
Water Level: None	Fluid & Additives: None
Date Start: 5/10/89	Date Finish: 5/11/89
Logger: P. Patchin	

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	0	QO 1.5	SS 01	9"	3-7-6 13		CLAYEY SILT, non-plastic, dark brn (10YR 3/3) abund. roots & organics, moist. Last 3" brn (10Y 5/3) w/med. gravel & dry ML. TOPSOIL/FILL 2.0
		2.5 5.0	ST 02	27"			SILTY CLAY, slight plasticity, mottled brn (10YR 5/3) & strong brn (7.5YR 5/6), dry to damp, abund. FeOx stn, 25% silt, occasional blkorganic? blebs, v. stiff (2.25) CL
	5	5.0 6.5	SS 03	16"	2-3-6 9		CLAYEY SILT (~30% clay) non-plastic, mottled lt. grnsh gray (10YR 6/2) & brnsh yellow (10YR 6/8), dry to damp, w/bl organic? blebs (prob. FeOx), v. stiff (2.25) ML FERRELVIEW
		7.5 10.0	ST 04	30"			As above, increased SILT (80-90%) w/FeOx blebs, more lt. brnsh gray (10YR 6/2), damp, stiff (1.75) ML 10.3
	10	10.0 11.5	SS 05	18"	2-5-7 12		CLAY, gravelly, mod. plasticity, mottled yellowish brn (10YR 6/8) and lt. gray (minor) (10YR 7/1), chert gravel (subrnd) fine to 1cm (10%) minor sand, abund FeOx nods & MnOx stringers, v/stiff (2.25). CL-CH
		12.5 15.0	ST 06	30"			As above, sandier, less mottling, pp=3.25, w/vert & horiz. fractures w/MnOx staining and leaching, dry-damp CL.
	15	15.0 16.5	SS 07	16"			As above, pp=3.5, no mottling; slight to mod. plasticity. CL-CH CLAY TILL
Gravel 6"		17.5 20.0	ST 08	26"			CLAY, mod. plasticity, lt. yellowish brn (10YR 6/4), hard (4.25) abund FeOx blebs 5% rounded gravel, v. little sand, dry to damp, no fractures, CL-CH
	20	20.0 21.5	SS 09	15"	4-8-7 15		As above, pp=3.75, abund angular chert gravel @20.5 for 4" yellowish brown (10YR 5/7) abund. MnOx streaks; damp, no L.S. CL-CH
		22.5 24.0	SB 10	6"	8-15-5 20		22.8 CLAYEY GRAVEL, w/angular chert gravel up to 6cm in diam. (possible silicified L.S.) BASAL TILL? 23.7
	25						GRAVELLY CLAY, slt. plasticity, wh. (5Y 8/2) mottled w/brnsh ylw (10YR 6/8) mottling, 20% chert RESIDUUM (ang) gravel (pieces) up to 5cm long, vuggy w/wthring rinds, clay is moist and talc-like, no L.S., CL-CH

See next page for sample SB11

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 2

Project Number: 5121

Hole Number: GTS-4

Project: Geotechnical Investigation - Phase II

Location: Temporary Storage Area

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION: Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol
	25	25.0 26.5	SB 11	6"	17-19-12		CLAYEY GRAVEL, nonplastic 20% clay is "talc like", lt olive yellow (10YR 6/6), damp, w/ abund. FeOx, also decomposed L.S (HCL reaction), angular chert gravel loose silty matrix, GC — RESIDUUM? 27.5
							Auger refusal @ 27.5'
							@ 3:50pm 5/10/89
	30						Note: GTS-4 Bulk Sample taken from 0-5.0' from auger cuttings.
							Grouted hole to surface with Volclay grout.
							Constant head test at 5.0' and 24.0'. No take on both.

WELDON SPRING REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 2
Project Number: 5121
Contract WP117
Hole Number: GTS-5

Project: Geotechnical Investigation Phase II			Location: Temporary Storage Area	
Coordinates: N.98607.7 W.51245.8 (AEC)			Drilling Contractor: Hannibal Testing Laboratories	
Drill Make and Model: CME-55 H.S. Augers 6-7/8", 3 1/4"	Depth Top of Rock: 37.0	Depth Casing & Size: None	Hole Size: 6-7/8"	
Elevation: G.S. 662.64 ft.	Angle from Vert. and Bearing: Vertical		Depth Bottom of Hole: 37.0	
Water Level: Dry	Fluid & Additives: None	Date Start: 12:50 6/5/89	Date Finish: 11:10 6/6/89	Logger: A. Benfer

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	GTS-5 Bulk	2.5					(Bulk sample of cuttings, GTS-5, collected from 0 to 5.0 feet).
	5	5.0	ST 01	29"			CLAY, highly plastic, mottled brownish yellow (10YR 6/6) and dark gray (10YR 4/1), moist, minor black, stiff to very stiff (2.0), CH, contains minor rounded limestone gravel (¼"), possible fill.
		6.5	SS 02	13"	2.2.2 4		As above, bottom 2" mottled blue and olive gray (5Y 5/2) with decomposed grass.
							FILL 7.5
		7.5	ST 03				SILTY CLAY, low plasticity, mottled yellowish brown (10YR 5/6) and light gray (10YR 7/1), moist very
	10	10.0		19"			stiff (2.25), CL, minor FeOx.
		10.0	SS 04	17"	2.4.4 8		As above, mostly light yellowish brown (10YR 6/4), with ~20% black FeOx, pp=2.2
		11.5					
							FERRELVIEW 12.5
		12.5	ST 05				CLAY, highly plastic, mottled yellowish brown (10YR 5/6) and gray (10YR 6/1), moist, stiff (1.5), CH.
	15	15.0		20"			Contains ~10% FeOx and <5% spherical nodules (1/8"), trace limestone sand.
		15.0	SS 06	18"	2.1.3 4		As above, pp=2.2, 16.0-16.5, 5% sand.
		16.5					
		17.5	ST 07				Disturbed
	20	20.0		23"			
		20.0	SS 08	18"	2.2.5 7		FERRELVIEW 20.5
		21.5					SILTY CLAY, medium plasticity, 10% sand, 10% fine subrounded gravel, brownish yellow (10YR 6/6) with
		22.5	ST 09	32"	Pushed 24"		black MnOx stringers, moist, very stiff (3.0), CH.
/5/89 /6/89	25	24.5					As above, mottled with light gray (10YR 7/1), less sand and gravel, pp=3.0. CLAY TILL

WELDON SPRING REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 2
Project Number: 5121
Contract WP117
Hole Number
GTS-5

Project: Geotechnical Investigation Phase II
Location: Temporary Storage Area

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25	25.0 26.5	SS 10	18"	2.6.3 19		26.0-28.0 as above, increase in gravel >50%, predominantly chert, up to 2", subrounded, pp(clay)=3.5.
5/5/89 5/6/89		27.5 29.0	SB 11	12"	7.12.16 28		As above, pp=4.5+, hard, 15% fine to coarse sand, trace gravel (1/4"), MnOx stringers.
	30	30.0 31.5	SS 12	18"	4.7.11 18		CLAY TILL SILTY CLAY, medium plasticity, ~15% sand, mottled brownish yellow (10YR 6/6) and light gray (10YR 7/1), damp, hard, (>4.5), CL-CH, spherical FeOx, MnOx stringers and blebs.
		32.5 35.0	ST 13	34			As above, pp=3.0, very stiff, CH.
	35	35.0 36.5	SS 14	18"	3.9.50 59		36.0 GRAVEL fragments, chert, 10% clay, chert-yellowish brown (10YR 5/6), also clay with black MnOx, clay moist, hard, GC. RESIDUUM
							Auger refusal at 37.0, T.D. 11:10 6/6/89 Apparent bedrock Grouted hole with 2 bags of Volclay Constant head test at 15.0'. Take = .25 oz. in 10 minutes.

WELDON SPRING REMEDIAL ACTION PROJECT

Sheet 1 of 2

BOREHOLE LOG

Project Number: 5121
Contract WP117

Hole Number: GTS-6

Project: Geotechnical Investigation Phase II			Location: Temporary Storage Area	
Coordinates: N.98933.0 W.51035.7 (AEC)			Drilling Contractor: Hannibal Testing Laboratories	
Drill Make and Model: CME-55 H.S. Auger 6 7/8", 3 1/4"	Depth Top of Rock: 47.0	Depth Casing & Size: None	Hole Size: 6 - 7/8"	
Elevation: G.S. 665.28 ft.	Angle from Vert. and Bearing: Vertical	Depth Bottom of Hole: 47.0		
Water Level: Dry	Fluid & Additives: None	Date Start: 3:00 6/6/89	Date Finish: 1:25 6/7/89	Logger: A. Benfer

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	GTS-6 Bulk						(Bulk sample of cuttings, GTS-6, collected from 0 to 5.0 feet).
		2.5 4.0	SS 01	9"	3.6.8		SILT, nonplastic, mottled yellowish brown (10YR 5/6) and light gray (10YR 7/2), damp, hard (4.5+), ML.
	5						
		5.0 7.5	ST 02	24"			FERRELVIEW As above, pp=4.5+, hard, light yellowish brown (10YR 6/4)
		7.5 9.0	SS 03	18"	3.5.7 12		SILTY CLAY, low to medium plasticity, mostly light yellowish brown (10YR 6/4) with yellowish brown (10YR 5/6), moist, very stiff to hard (4.0), CL. Up to 1/8" blebs MnOx.
	10						
		10.0 12.5	ST 04				FERRELVIEW As above, pp=4.1, hard, mottled yellowish brown (10YR 5/6) and lt. gray (10YR 7/1), abundant FeOx. 12.5
		12.5 14.0	SS 05	12"	2.3.5 8		CLAY, highly plastic, mottled yellowish brown (10YR 5/6) and light gray (10YR 7/1), moist, very stiff (2.5), CH. Slickensided, contains MnOx and FeOx.
/6/89 /7/89	15						
		15.0 17.5	ST 06	26"			As above, pp=3.1 FERRELVIEW
		17.5 19.0	SS 07	18	3.4.6 10		As above, pp=2.5, very stiff, slickensided with stringers and blebs of MnOx and spherical FeOx nodules.
	20						
		20.0 22.5	ST 08	30"			As above, pp=3.75, 5% white angular sand 22.5
		22.5 24.0	SS 09	18"	4.6.10 16		SILTY CLAY, highly plastic, 15% sand, 10% subrounded fine gravel, spherical FeOx, reddish yellow (7.5YR 6/6) with light gray (10YR 7/1), damp, hard (4.5+) CL-CH. Minor MnOx. CLAY TILL

WELDON SPRING REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 2

Project Number: 5121
Contract WP117

Hole Number: GTS-6

Project: Geotechnical Investigation Phase II

Location: Temporary Storage Area

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25	25.0 27.5	ST 10	28"			As above, pp=4.5+, increase in MnOx
		27.5 29.0	SS 11	18"	4.6.8 14		As above, pp=3.0, very stiff, less sand and gravel
	30	30.0 31.5	SB 12	12"	3 8.10.13 23		SILTY CLAY, medium plasticity, 10% sand, 10% fine gravel, brownish yellow (10YR 6/6) with minor light gray (10YR 7/1), damp, very stiff (3.25), CL. FeOx and MnOx stringers.
		32.5 34.0	SS 13	15"	5.7.10 17		As above, pp=4.5+, hard, slickensided with MnOx
	35	35.0 36.5	SB 14	12"	9.18.24 42		As above, pp=4.3 CLAY TILL
		37.5 39.0	SS 15	18"	5.7.10 17		Hard drilling As above, pp=3.75, spherical FeOx, granitic rock fragments, some well rounded fine gravel.
	40	40.0 41.5	SB 16	12"	11.22.35 57		As above, at 40.5', mottled red (2.5YR 5/8) and light gray (10YR 7/1), moist, hard (4.5+).
	45	45.0 46.5	SS 17	— 18"	5.15.43 58		GRAVEL, 30% clay, predominantly chert, brownish yellow (10YR 6/6) and black (MnOx), damp, hard (4.5) GC, bottom 2" chert, highly fractured. RESIDUUM
							Auger refusal 47.', T.D. 1:25 6/7/89 Probably bedrock Grouted hole with 2 bags Volclay

WELDON SPRING REMEDIAL ACTION PROJECT

Sheet 1 of 2

BOREHOLE LOG

Project Number: 5121
Contract WP117

Hole Number: GTS-7

Project: Geotechnical Investigation Phase II			Location: Temporary Storage Area	
Coordinates: N.98771.0 W.51381.8 (AEC)			Drilling Contractor: Hannibal Testing Laboratories	
Drill Make and Model: CME-55 H.S Auger 6-7/8", 3-1/4"	Depth Top of Rock: 44.5	Depth Casing & Size: None	Hole Size: 6-7/8"	
Elevation: G.S. 662.07 ft.	Angle from Vert. and Bearing: Vertical	Depth Bottom of Hole: 44.5		
Water Level: Dry	Fluid & Additives: None	Date Start: 8:45 6/8/89	Date Finish: 2:00 6/8/89	Logger: A. Benfer

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		GTS-Bulk					(Bulk sample of cuttings GTS-7 Bulk, collected from 0 to 5.0 feet).
							FILL
		2.5 4.0	SS 01	4"	3.3.5 8		SILTY CLAY, low plasticity, dk yellowish brn (10YR 4/2) dry, hard (4.5+), CL, localized angular gravel. 3.5
	5						SILTY CLAY, medium plasticity, mottled strong brown (7.5YR 5/6) and yellow (10 YR 7/3), moist, stiff to very stiff (2.0), CL. Contains black MnOx. FERRELVIEW
		5.0 7.5	ST 02	32"			
		7.5 9.0	SS 03	14"	1.3.5 8		CLAY, low plasticity, very silty, yellow (10YR 7/4) very stiff (3.0), CL. MnOx and FeOx blebs. 9.0
	10						
		10.0 12.5	ST 04	20"			CLAY, highly plastic, mottled yellowish red (5YR 6/6) and light gray (7.5YR 7/0). moist, very stiff (2.25), CH.
		12.5 14.0	SS 05	18"	3.4.5 9		As above, mostly light gray (10YR 7/1) with strong brown (7.5 YR 5/6) (FeOx), pp=2.75.
							As above, minor MnOx, spherical FeOx, pp=3.5.
	15						
		15.0 17.5	ST 06	22"			FERRELVIEW
							As above, trace sand and fine gravel, pp=2.75. 17.5
		17.5 19.0	SS 07	18"	3.5.10		SILTY CLAY, 20% sand, mottled brownish yellow (10YR 6/6) and light gray (10YR 7/1), damp, hard (4.5+), CL-CH. Slickensided, MnOx blebs.
	20						CLAY TILL
		20.0 22.5	ST 08	20"			
		22.5 24.0	SS 09	16"	3.5.6 11		As above, 15% sand, 5% subrounded gravel, pp=3.7, CH.
							As Above, pp=4.5+, MnOx stringers. trace gravel up to ½".

WELDON SPRING REMEDIAL ACTION PROJECT

Sheet 2 of 2

BOREHOLE LOG

Project Number: 5121
Contract WP117
Hole Number
GTS-7

Project: Geotechnical Investigation Phase II

Location: Temporary Storage Area

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		25.0 26.5	SB 10	18"	7.15.27 42		As above, stiff (1.5), moist, CL, stringers of CaCO3 and MnOx, some well rounded coarse sand.
		27.5 29.0	SS 11	18"	4.7.9 16		As above, pp=4.5+, 10% fine gravel, vertical light gray clay stringers. CLAY TILL
		30.0 31.5	SB 12	12"	17.38.28 66		CLAY, silty, 10% sand, 10% gravel up to 1", brownish yellow (10YR 6/6) with light gray (10YR 6/6) stringers, spherical FeOx, damp hard (4.5), CL.
		32.5 34.0	SS 13	18"	4.7.11 18		As above, reddiwh yellow (7.5YR 6/8) at 33.5, pp=4.5, slickensided some with MnOx film.
35		35.0 36.5	SB 14	12"	11.15.26 41		As above, yellowish brown (10YR 6/6) 37.0
		37.5 39.0	SS 15	18"	7.11.8 19		37.5-38.0 SAND, fine to coarse, 20% clay, strong brown (7.5YR 5/6), damp, medium dense, SC. 38.0-39.0 CLAY, medium plasticity, light gray (10YR 7/1) moist, medium stiff to stiff (1.0), CL-CH, with white lithographic limestone fragments.
40		40.0 41.5	SB 16	12"	5.9.2 11		40.0-41.5 CLAY, low plasticity, speckled yellowish brown (10YR 7/1), moist, very stiff (2.5), CL, minor MnOx, abundant FeOx up to 1/4" nodules. CLAY TILL
							Auger refusal 44.5', T.D., 2:00 6/8/89 Probable bedrock Hole grouted with 2 bags Volclay.

MW-2018

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-18

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
SE OF BLDG. 434	N98,297 W50,382	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/28/86	7/8/86	GEOTECHNOLOGY INC.	MOBIL B57/CME 750	6"/3"	32.5	32.5	65.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
18.5/59	4	7	-	661.4	39.4'/622.0	32.5/628.9

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/64.0'	A.ATKINSON/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE/ LENGTH CORE RUN	SAMPLE RECOVERY/ CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN 1ST 5' G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I. 2ND 5'	WATER PRESSURE TESTS: TIME IN MINUTES 3RD 5'	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							661.4	0				
6" HSA							660.4	1			0 TO 1.0 FT GRAVEL, LIGHT GRAY(N7), CRUSHED LIMESTONE, IN MODERATE BROWN (5YR 3/4) SILTY MATRIX.	0-32.5 FT DRILLED WITH 6 IN OD HOLLOW STEM AUGERS
SS 2"	18"	15"	13	3	5	8				SS-1	1.0 TO 7.0 FT SILTY CLAY/CLAYEY SILT, MOTTLED TAN-BROWN-GRAY(10YR 5/4), STIFF CONTAINS SOFT, BLACK(N1), WEATHERED NODULES.	
6" HSA								5				
							654.4	7			7.0 TO 11.0 FT SILTY CLAY, GREENISH GRAY(5GY 7/1) AND DARK YELLOWISH ORANGE (10YR 6/6), MEDIUM STIFF.	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	16.5'	10	3	4	6				SS-2		
								10				
6" HSA							650.4	11			11.0 TO 27.0 FT SILTY CLAY, MOTTLED ORANGE-YELLOW-BROWN(10YR 5/5), VERY STIFF, OCCASIONAL ROUNDED PEBBLES AND SAND SIZE MATERIAL, MANGANESE OXIDE STAINING AND FILLINGS COMMON.	
ST 3"	24"	26"								ST-1		
SS 2"	18"	17"	26	6	11	15				SS-3		
6" HSA								15				
SS 2"	18"	19"	18	5	8	10				SS-4		
								20				
6" HSA												
SS 2"	18"	27"	28	11	14	14				SS-5		32.5 FT AUGER REFUSAL, PERFORMED PERMEABILITY TEST
								25				
6" HSA							634.4	27			27.0 TO 32.5 FT GRAVELLY CLAY, MODERATE YELLOWISH BROWN(10YR 5.5/6), WITH ANGULAR CHERT GRAVEL. CHERT IS DARK YELLOWISH BROWN(10YR4.5/2) IN THE CENTER GRADING TO DARK YELLOWISH ORANGE (10YR 5.5/6) STAINED, EXTREMELY WEATHERED WITH WHITE(N9) RINDS ON GRAVEL.	BURLINGTON/KEOKUK FM.
SS 2"	18"	5"	41	8	18	23				SS-6		32.0 TO 65.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED CORE BIT, USING FRESH WATER.
								30				
6" HSA							628.9	32.5				
NXB 3"	3'	2.2'	73%	0 0.08	10 20	5 5	626.4	35		RUN #1	32.5 TO 38.5 FT LIMESTONE, LIGHT GRAY (N7), SLIGHTLY WEATHERED, MEDIUM HARD, MODERATELY HORIZONTALLY FRACTURED, TWO FRACTURES 1/4 AND 1/2 INCH THICK FILLED.	

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DICKINSON; P=PITCHER; O=OTHER

SITE	HOLE NO.
SOUTHEAST OF BLDG. 434	GMW-18

MW-2018

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE | JOB NO. 14501-201 | SHEET NO. 2 of 2 | HOLE NO. GMW-18

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION
							626.4	35			
NXB 3"	5'	3.5'	70%				0%	2		RUN #2	WITH VERY LIGHT GRAY(N8) CLAY AND ANGULAR CHERT FRAGMENTS, MANGANESE OXIDE DEPOSITS ON FRACTURE SURFACES. 35.0 TO 37.3 FT LIGHT GRAY(N7) CLAY, EXTREMELY WEATHERED LIMESTONE, AND ANGULAR CHERT FRAGMENT.
							622.9	38.5			
								40			38.5 TO 57.5 FT LIMESTONE, YELLOWISH BROWN(10YR 5/4), EXTREMELY WEATHERED TO DECOMPOSED, MEDIUM HARD WITH CLAY SEAMS AND HORIZONTAL FRACTURES, CHERT INTERBEDS AND FILLED VOIDS.
NXB 3"	5'	0.8'	16%				0%	3		RUN #3	
				0.7	10	5					
				1.3	20	5		45			
NXB 3"	5'	1.4'	28%	0.9	10	5	0%	4		RUN #4	
								50			
NXB 3"	2'	.5'	25%				0%	5		RUN #5	
								52			
NXB 3"	3'	1.1'	37%				12%	6		RUN #6	
								55			
NXB 3"	5'	5.0'	100%				7%	7		RUN #7	
							603.9	57.5			57.5 TO 65.0 FT LIMESTONE MODERATE YELLOWISH BROWN(10YR 5/4), EXTREMELY WEATHERED, MODERATELY HORIZONTALLY FRACTURED, WITH HARD, LIGHT GRAY(N7) CHERT FILLED VOIDS, SOME OF WHICH ARE INCOMPLETELY FILLED.
								60			
NXB 3"	5'	5.0'	100%				22%	8		RUN #8	All weathered
							596.4	65			BOTTOM OF BORING AT 65.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 53.0 TO 63.0 FT.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

7/8/86

RUN	AP (FT)	LP (FT)	ROD (%)
1	0.2	0.35	16
2	0.1	0.2	0
3	0.1	0.2	0
4	0.25	0.3	0
5	<0.1	0.1	0
6	0.2	0.35	32
7	0.15	0.35	7
8	0.2	0.35	22

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.

LP=LONGEST PIECE OF CORE FROM EACH RUN

ROD= ROCK QUALITY DESIGNATION FOR EACH RUN.

SOIL AND ROCK COLOR DESCRIPTION FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON ST=SHELBY TUBE D=DENISON P=PITCHER O=OTHER

SITE: SOUTHEAST OF BLDG 434

HOLE NO. GMW-18

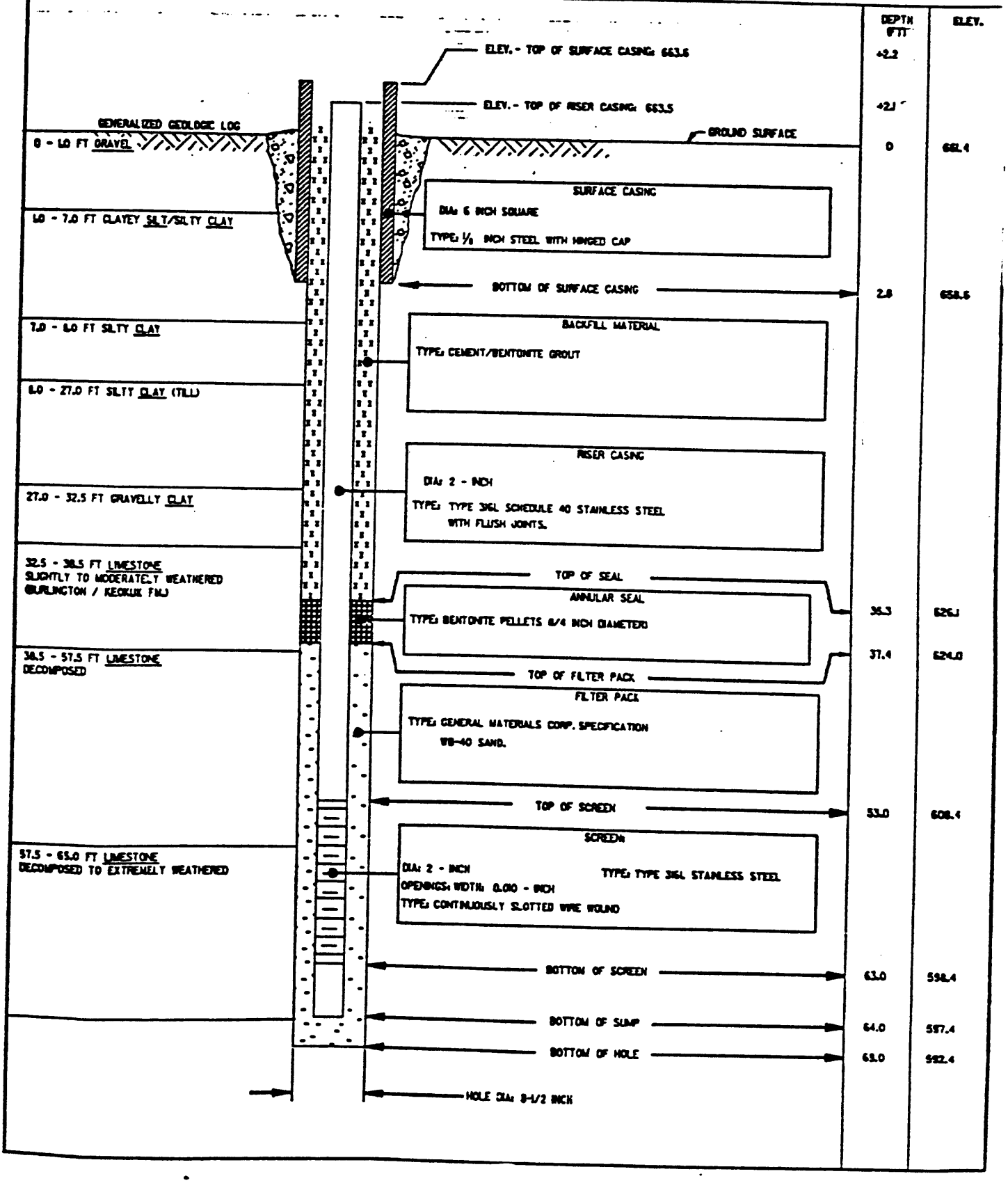
MW-2018

OBSERVATION WELL

PROJECT	WELL NO.
FUSRAP-WELDON SPRING CHEMICAL PLANT	GMW-18

JOB NO.	SITE	COORDINATES
14501	SOUTHEAST OF BLDG. 434	N98,297 W50,382

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
6/28/86	7/16/86	A.ATKINSON	GROUND SURFACE



WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 6

Project Number:

Hole Number: MW-2019

Project: WSSRAP Monitor Well Drilling	Location: South edge of Chemical Plant next to RR gate
Coordinates: N.98287.4 W.50391.3 (AEC)	Drilling Contractor: Layne-Western
Drill Make and Model: CME 55/75, NQ Wireline	Depth Top of Rock:
Depth Casing & Size: 80'; 10"	Hole Size: 12" to 80' then 8.5"
Elevation: 661.5, 663.2 TOC	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 116.0'; reamed to 116.3'	
Water Level:	Fluid & Additives: Water
Date Start: 05/24/88	Date Finish: 05/25/88
Logger: Original* K. Erickson	

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION, CORING RATE AND SMOOTHNESS, CORING FLUID LOSS, CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS, PLANARITY, SMOOTHNESS, FILLING, STAINING, ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY, CLASSIFICATION, COLOR, GRAIN SIZE, ALTERATION; CEMENTATION, HARDNESS, WEATHERED STATE
									For description of soils and upper bedrock, see log of MW-2018 (Bechtel GMW-18, 1986)
81									Begin Core 81.0'
82	Competent Limestone ↓	RUN1 9.0/9.0 100%		1	6.3 / 9.0 / 70%	1	Open, rough		81.0-84.7 LIMESTONE light gray to very light gray (N7-N8) mealy texture, hard, fresh crystalline, microfossils and fossil fragments, horn coral, crinoids, styolitic with black organics? on styolite surfaces, hairline fracture-open-dipping 86°, chert 83.3-83.6 white with light blue specks, no visible porosity in limestone
83	↓				LP = 1.3' / 9	3	Tight, rough Tight, rough Tight,rough,MnOx		
84					4"	3	Open, rough Open, rough Open,rough,MnOx Stylolite		

*Geotechnical Information by: P. Patchin/ D. Reynolds

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 6

Project Number:

Hole Number MW-2019

Project: WSSRAP MW DRILLING

Location: N.98287 W.50391

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
84		RUN1 con't		1			Open,rough, stylolitic,MnOx?		Limestone, as above
						4	Open,rough,MnOx		
85							Open,rough,MnOx Tight,rough		84.7-85.6 CHERT light bluish gray (5B 7/1) very hard, fresh, nodular
							Tight,rough		
						3	Tight,rough Open,rough		85.6-88.1 LIMESTONE light gray (N7) microcrystalline, dense, interbedded chert and chert nodules at 86.1-86.2, 86.7, 87.3-87.4, very thin stylolites, hairline fractures, hard, fresh
86									
							Tight,rough		
						3	Tight,rough		
87							Tight,rough		
						1	Open,rough, stylolitic,MnOx?		
88									88.1-89.0 CHERT mottled light bluish gray to white, very hard, fresh
							Tight,rough,MnOx stylolite		
89						3	Tight,rough		
							Tight,rough stylolite		89.0-93.7 LIMESTONE light gray (N7) finely crystalline, fossil fragments, crinoids, stylolitic, dense, hard, fresh, chert nodule 92.6-93.1 light bluish gray (5B 7/1), fracture from 91.8-92.9 86° dip, healed with calcite
90						0			
		RUN2 3.7/3.7		2	3.7/3.7		stylolite (5)		
91		100%			100%	0			

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 3 of 6

Project Number:

Hole Number MW 2019

Project: WSSRAP MW DRILLING

Location: N.98287 W.50391

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
91		RUN2 con't		2	LP = 1.1'		Tight, rough, stylolitic, MnOx		Limestone, as above
92					4 > 4"	1	Stylolites		
93						1	Stylolite		
							Open, rough		
		93.7		93.7		1	Mechanical		93.7-94.4 CHERT light bluish gray (5B 7/1) crinoidal, very hard and dense, fresh
94		RUN3		.8 6.3			Tight, smooth		94.4-97.6 LIMESTONE light gray (N7) flaggy, broken into wafers "poker chips" along bedding planes ¼" to 2" fossiliferous, stylolitic, weathering along wafer planes, crinoidal moderately wthrd 94.4-95.2; severely wthrd 96.0-97.3, visible porosity along solutioned bedding planes
		6.3/6.3		13%			Tight, smooth		
		100%		LP = 0.4'		8	Rubblized wafered section		
95							Open, rough		
							Open, rough		
					2 > 4"	10	Open, rough		
96							Open, rough		
97						> 30	Multiple laminar fractures, rock wafers w/re-crystallization, very weathered		
98						> 6	Rubble		97.6-108.7 LIMESTONE light gray (N7) massive, finely crystalline, crinoidal, (con't)

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 4 of 6

Project Number:

Hole Number MW-2019

Project: WSSRAP MW DRILLING

Location: N. 98287 W.50391 (AEC)

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
98		RUN 3 con't		2		4	Open, rough Open, rough Tight, smooth		bryozoans, large stylolites chert nodules at 98.5-99.0, 99.5-99.8, 102.2-102.9, 107.7-108.3, very hard and dense, fresh, no visible porosity.
99							Tight, smooth 20°		
						4	Open, rough Open, rough Open, rough Rubble		
100		100.0					Open, rough		
		RUN4 10.0 / 10.0		3	7.0 / 10.0	2	Tight, rough Stylolite Tight, rough		
101		100%			70%		Stylolite		
					LP = 1.7' 9¾"	6	Open, rough		
102							Open, rough Rubble		
						3	Open, rough		
103							Tight, rough 15°		
						0	Stylolites		
104									
						1	Stylolite, weak Tight, rough		
105									

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 5 of 6

Project Number:

Hole Number MW 2019

Project: WSSRAP MW DRILLING

Location: N.92827 W.50391 (AEC)

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
105		RUN4 con't.		3			Stylolite Stylolite		Limestone, as above
106						1	Tight, rough, stylolitic, MnOx		
107						0			
108						3	Open, rough Stylolite Stylolite Open, smooth, 10° Open, smooth, 30° MnOx		
109						7	Open, smooth 10°		
110		110.0				6	Open, rough Open, rough Rubble Open, rough		108.7-109.7 LIMESTONE light gray (N7) flaggy, broken into ¼" to 1½" wafers along bedding planes, finely crystalline, crinoidal, sub-chalky, breaks easily along bedding planes-poorly cemented, slightly wthrd.
111		RUN5 6.0/6.0 100%		4	2.9 6.0 = 48%	3	Open, rough Open, rough Stylolite		109.7-110.8 LIMESTONE very light gray (N8), micro-crystalline, dense, very thin stylolites, hard, fresh
112					LP = 0.85 > 4"	2	Open, rough Rubble Open, rough		110.8-112.1 LIMESTONE medium light gray (N6) crinoid fragments 1m to 25mm, fine to coarse crystalline, stylolitic, hard, fresh, visible vuggy porosity 1-3mm.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 6 of 6

Project Number:

Hole Number MW 2019

Project: WSSRAP MW DRILLING

Location: (AEC) N. 98287 W.50391

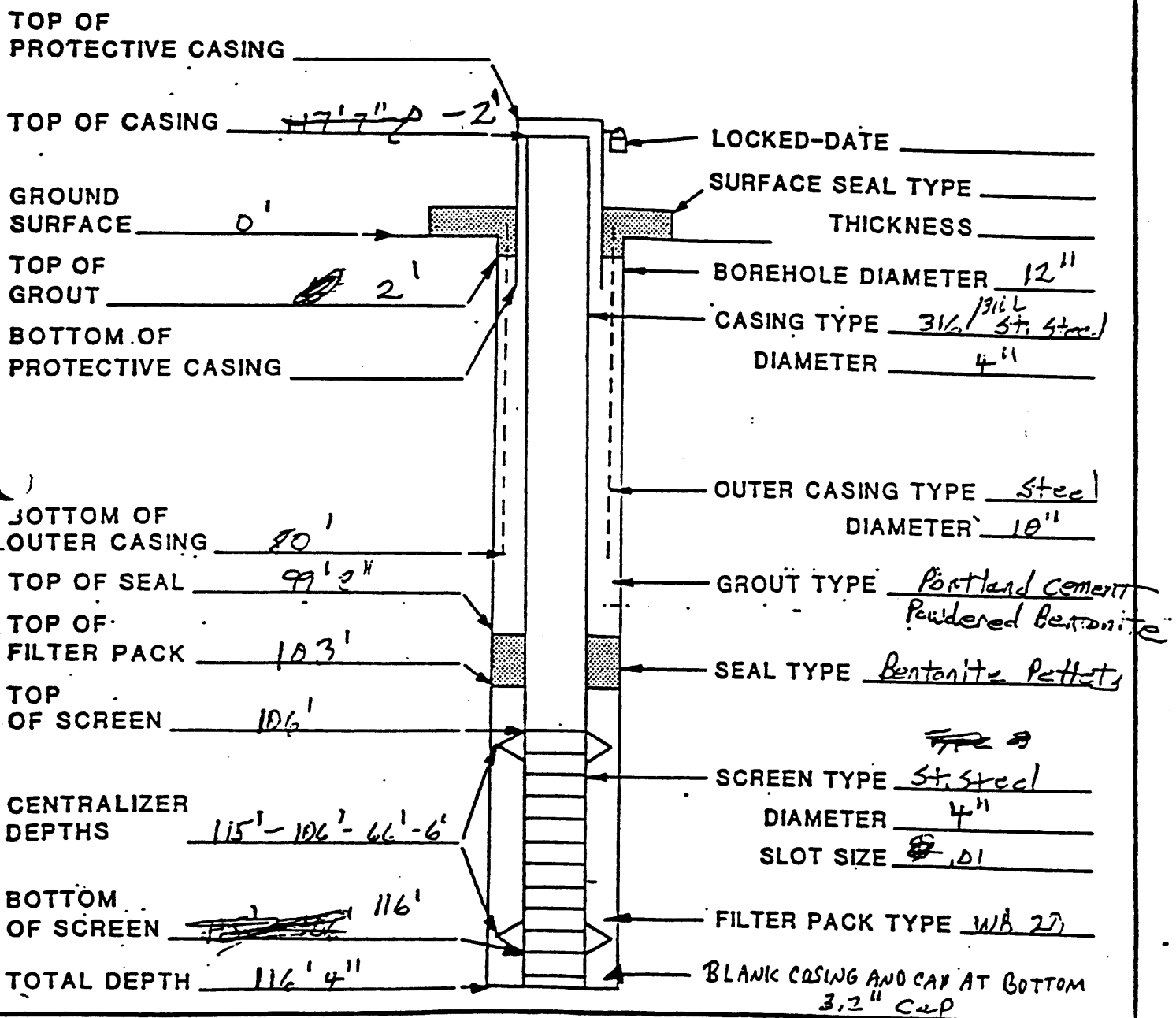
DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
112		RUN5 con't		4			Stylolite Tight, rough		112.1-113.2 LIMESTONE very light gray (N8) coarse crystalline with large crinoid and bryozoan fragments, more porous. Good visable porosity 15 to 20% inter-crystalline and vuggy porosity moderately hard, slightly weathered.
						5	Open, rough		
113									
						2	Tight, rough		
114									113.2-115.6 LIMESTONE light gray (N7) medium to fine crystalline, scattered vugs, est.5-10% porosity Chert nodules at 113.5-113.6, 114.1-114.4, 114.5-114.8, 115.1-115.2, 115.4,115.7 to 116.0. Chert is very light blue (5B 7/1) modular to chicken wire hard, fresh, fracture from 115.7'-116.0' dipping 70°±3°, cemented with calcite.
							Open, rough Open, rough(2) Tight,smooth,MnOx 15°		
						5	Open, rough		
115							Rubble		
							Open, rough		
							Open, rough Tight, rough		
						4	Tight, rough		
116							Tight, smooth		
									T.D. 116.0'
									Reamed to 116.3'. Installed well consisting of 4" dia. stainless steel. Screen 116.0' to 106.0', 0.010" slots. Sand pack to 103.0'.

ELDON SPRING SITE REMEDIAL ACTION PROJECT

WELL COMPLETION RECORD

WELL NUMBER 2019 DATE INSTALLED 6-1-88

PMC REPRESENTATIVE Neal Allday DRILLER Wayne Johnsen



COMMENTS Add 1ft for bottom cap.
Hydrated bentonite pellets with 5 gal. water

PMC REPRESENTATIVE SIGNATURE Neal Allday DATE 6-16-88

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 6

Project Number:

Hole Number MW 3001

Project: WSSRAP Monitoring Well Drilling	Location: 200' South of Raffinate Pit 3
Coordinates: N.98852.6W.51262.4(AEC)	Drilling Contractor: Layne-Western
Drill Make and Model: CME-55/75, NQ wireline	Depth Top of Rock:
Depth Casing & Size:	Hole Size: Reamed 8.5"
Elevation: 664.3',666.45 TOC	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 90.0'	
Water Level:	Fluid & Additives: Water
Date Start: 06/14/88	Date Finish: 06/15/88
Logger: Original* N. Bingert	

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION, CORING RATE AND SMOOTHNESS, CORING FLUID LOSS, CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS, PLANARITY, SMOOTHNESS, FILLING, STAINING, ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY, CLASSIFICATION, COLOR, GRAIN SIZE, ALTERATION; CEMENTATION, HARDNESS, WEATHERED STATE
									For soils descriptions and upper bedrock, see log of MW 3002. Augered to 51.5'.
51.5	Split Spoon	10%		1					51.5-51.7' Split Spoon 40 blows to go 2" Chert Breccia and clay, chert is white (N9) to iron stained light brown (5YR 5/6) angular coarse sand to fine gravel; clay is very pale brown (8/4)
52									
53							Residuum?		51.7 to 53.5? No sample available
	53.5	Run1							53.5' Begin Core
54	Top of bedrock?	.45/.50 90%		0/.5=0 0%	L.P 0>4"	4	Open, rough Open, rough		53.5-54.0' Chert very light gray (N3) to iron-stained dark ylwish orange (10YR 6/6) hairline fractures, vugs pinpoint to 0.5', druzy quartz in larger vugs, fossiliferous including solution cavity or crinoid stem.
55	Split Spoon 54.8								54.0-54.8' Split Spoon 100 blows to go 0.8' Chert Breccia and clay, same as 51.5-51.7', unconsolidated, water bearing according to driller
56	Split Spoon								54.8-56.0' No sample available

*Geotechnical Information by: P. Patchin/
D. Reynolds

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 6

Project Number:

Hole Number MW-3001

Project: WSSRAP MW Drilling

Location: (AEC) N.98853 W.51262

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	DISCONTINUITIES: FRACTURES PER FOOT	DISCONTINUITIES: DESCRIPTION (TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION)	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
56		RUN2 2.0/2.5		1	1.5		Open, rough — Healed —		56.0-58.5 Chert Breccia, rehealed with sparry calcite and clay; chert is mostly light gray (N7) to iron-stained dark yellowish orange (10YR 6/6); one large (1") oxidized pyrite nodule in vug at 56.7', moderately weathered bedded chert from 57.8-58.0.
					2.5	1			
					60%				
57		80%			LP=.8'		Open, rough brecciated, recemented		
					2 > 4"	4	Open, rough(4)		
58									
							Open, rough		
		58.5							
		RUN3 1.1/4.5			0				58.5-63.0 Chert Breccia unconsolidated. Same as 54.0-54.8. Bottom 0.2' of interval may be back into weathered bedded chert. Only 1.1' of sample recovered.
59					4.5				
					=0%				
		25%			LP=0'		Core loss 3.4'		
					0 > 4"		Location Unknown		
60									
									Location of core loss on RUN3 is unknown.
61									
62									
		61.9							
						3	Rubble or unconsolidated		
63							All open, rough		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 3 of 6

Project Number:

Hole Number MW-3001

Project: WSSRAP MW Drilling

Location: (AEC) N.98853 W.51262

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
63		RUN4 .45/3.0 15%	63.2	1	0 / 3.0 =0% LP =0		Open, rough Open, rough		63.0-66.0 Chert Only 0.5' of fractured rock recovered, similar to 53.5-54.0 but less weathered
64									
65							Core Loss 2.5' Location unknown		
66		66.0	65.7				Rubble Zone		66.0-73.8 LIMESTONE Dark yellowish orange (10YR 6/6) thick bedded to massive with chert nodules and beds to 1.5' thick. Limestone contains trace pyrite, oxidized, in medium sand sized grains. MnOx? specks throughout, moderate to moderately severely weathered, chert is mottled, light olive gray (5Y 6/1) to grayish orange (10YR 7/4); contains some vugs, chert from 68.0' to 69.5' and contains vugs pinpoint to 1.3' partially filled with quartz and drusy quartz.
67		RUN5 7.0/7.8 90%			0.9/7.8 = 12%	>3	Open, rough Open, rough Open, rough		
68					LP = 0.5 2 > 4"	5	Open, rough Open, rough Open, rough Open, rough Open, rough MnOx		
69						3	Open, rough Tight, rough		
70						6	Open, rough		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 4 of 6

Project Number:

Hole Number MW-3001

Project: WSSRAP MW Drilling

Location: (AEC) N.98853 W.51262

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
70		RUN5 con't		2					Limestone, as above
						5	Open, rough		
71									
							Rubble Zone		
							Open, rough		
							Open, rough		
72									
							Rubble Zone		
							Open, rough		
							Open, rough		
73							Rubble Zone		
							CORE LOSS 0.8' location unknown		
		73.8							
74		RUN6							
		6.16 / 7.7					CORE LOSS 1.2' location unknown		73.8-81.5 LIMESTONE mottled light gray (N7) to grayish orange (10YR 7/4), thick bedded to massive with nodules and interbeds of chert to .7' thick, vugs pinpoint to .1", 10% at most, trace pyrite. Chert is light gray (N7) to medium gray (N5) with some silicified fossils (shell frags). Severely weathered to 77.0', remainder slightly to moderately weathered, trace stylolites.
		80%							
75									
							Rubble Zone		
76									
77									

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 5 of 6

Project Number:

Hole Number MW-3001

Project: WSSRAP MW Drilling

Location: (AEC) N. 98853 W.51262

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
77		RUN6 con't		2		5			Limestone, as above
78							Open, rough		
79			79.0			> 6	Rubble Zone		78.4-79.0 Chert
80			79.3			> 6	Rubble Zone		79.1-79.3 Chert
81						3	Tight, rough Tight, rough Stylolite, open rough MnOx		
82		81.5 RUN7		3		4	Tight, rough Tight, rough Open, rough Open, rough		81.5-83.5 LIMESTONE same slightly weathered limestone and chert interval as 73.8-81.5
83		8.1/8.5 95%				3	Stylolite, open rough MnOx Tight, rough Tight, rough		
84						1	Tight, rough		83.5-90.0 LIMESTONE light gray (N7); massive, course grained to medium grained, chert mostly very light gray (N8) in nodules

(con't)

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 6 of 6

Project Number:

Hole Number MW-3001

Project: WSSRAP MW Drilling

Location: (AEC) N.98853 W.51262

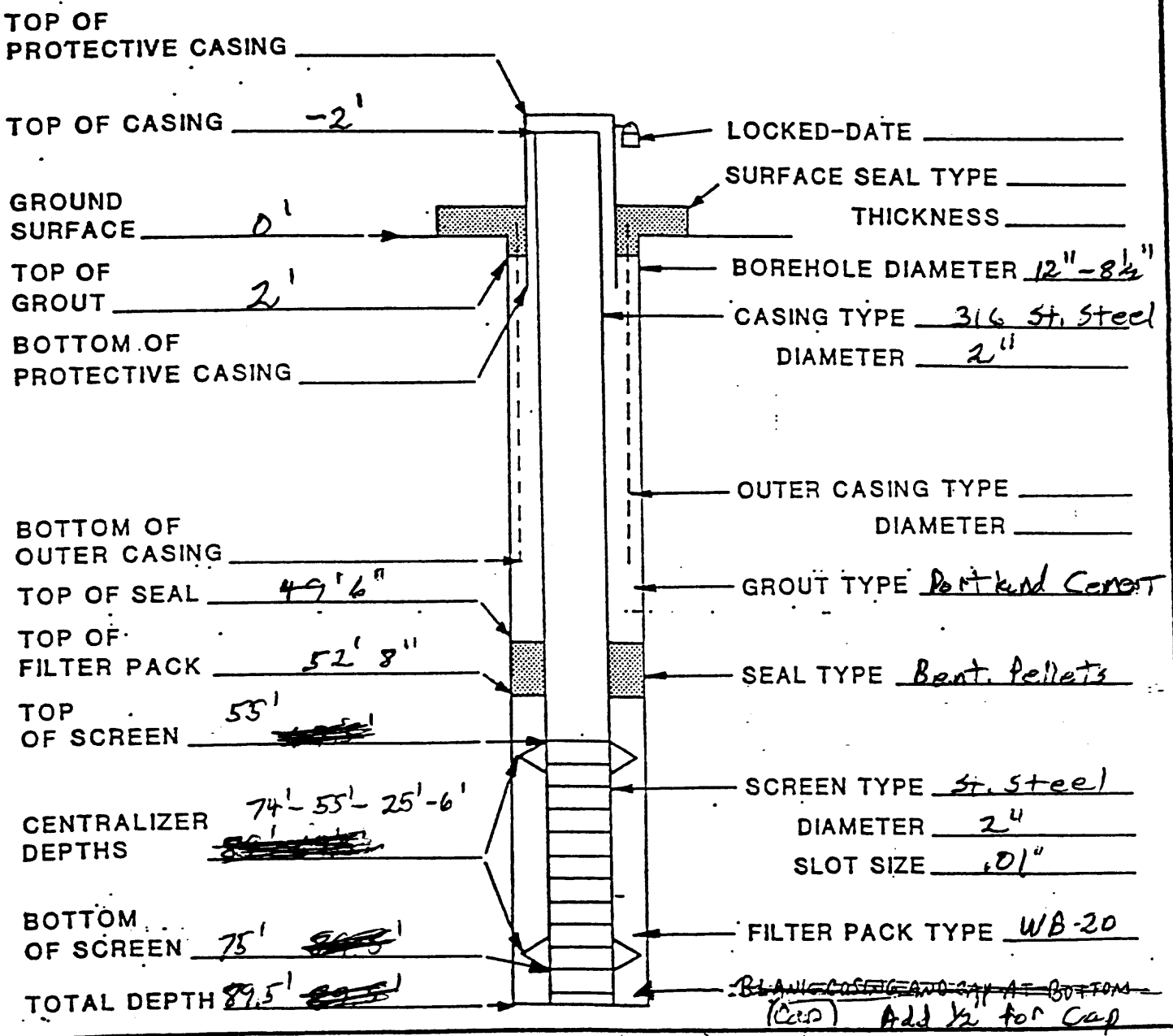
DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
84	↑ Weathered Limestone	RUN7 con't.			3		Tight, rough Open, rough		and beds to 0.3' thick, trace styolites, fossils are shell frags, crinoid pieces and brachiopods, fresh, hard.
85						5	Tight, rough Open, rough Open, rough, MnOx		
86	Competent Limestone ↓					1	Tight, rough		
87			86.7			1	Open, rough		Core Loss 0.4' Location unknown
88			87.1			3	Tight, rough Open, rough Open, rough		
89						3	Tight, rough Tight, rough Tight, rough		
90						5	Open, rough		
									T.D. 90.0' Installed well consisting of 2" diameter stainless steel. Screen 75.0' to 50.0', 0.010" slots. Sand pack to 52.7'.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

WELL COMPLETION RECORD

WELL NUMBER 3005 DATE INSTALLED 6-23-88

PMC REPRESENTATIVE Neal Allday DRILLER Wayne Johnson



COMMENTS We filled hole with (3 bags) sand to 80.5', poured bentonite pellets to 73', put 3' more of sand to bottom of casing.

PMC REPRESENTATIVE SIGNATURE Neal Allday DATE 6-23-88

SCI FIELD BOOK

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 16

Project Number:

Hole Number: MW-3002 B

Project: WSSRAP - Monitor Well Drilling	Location: 150' S of SW corner Raffinate Pit 3
Coordinates: N.98856.6 W.51245.6 (AEC)	Drilling Contractor: Layne Western
Drill Make and Model: CME 55/75, 7" Hollow Stem Auger, NQ Wireline Core	Depth Top of Rock: 65.0
Depth Casing & Size: 100'; 10"	Hole Size: 12" to 100" then 8.5"
Elevation: 664.7; 666.7 TOC	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 150'	Water Level:
Fluid & Additives: Water	Date Start: 06/03/88
Date Finish: 06/06/88	Logger: * Original Erickson

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	0					XXX	LOESS
		3.5 5.0	SS 01	2"	11-19-18 37		SILTY CLAY-CLAYEY SILT, low plasticity, yellowish brown (10YR 5/4), very dry, very stiff, crumbly, CL to ML.
	5						6.8
		8.5 10.0	SS 02	18"	2-6-8 14		SILTY CLAY, mottled, low plasticity, dark brown (10YR 4/3) to grey, slightly damp, stiff, limonite staining, CL.
	10						
		13.5 15.0	SS 03	18"	2-4-6 10		SILTY CLAY, as above, medium plasticity, olive brown (2.5Y 4/4), moist, Mn, CL.
	15						FERRELVIEW
		18.5 20.0	SS 04	18"	3-7-8 15		SILTY CLAY, as above, trace of medium sand, very stiff, Mn specks and streaks, Fe nodules, CL.
	20						
		12.5 25.0	SS 05	18"	5-8-10 18		SILTY CLAY, as above, trace medium to coarse sand and gravel, yellowish brown (10YR 5/8), slightly moist, CL.
	25						

* Geotechnical Information by: R. Parsons
M. Schauer

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25						
							27.0
		28.5 30.0	SS 06	18"	5-10-11 21		SILTY CLAY, as above, light olive brown (2.5Y 5/4), occasional limonite and Fe, Mn bands (fracture-like crosscut), CL.
	30						
		33.5 35.0	SS 07	18"	5-8-10 18		SILTY CLAY, as above, very slight to low plasticity, vertical fracture with Mn surfaces, CL.
	35						CLAY TILL
		38.5 40.0	SS 08	18"	7-10-11 21		SILTY CLAY, as above.
	40						
		43.5 45.0	SS 09	18"	2-4-6 10		SILTY CLAY, slight to low plasticity, trace fine gravel, light yellowish brown (2.5Y 6/2), slightly moist, stiff, limonite stain, Mn, CL.
	45						
							46.8
		48.5 50.0	SS 10	6"	17-21-46 67		CLAYEY GRAVEL, low to medium plasticity, fine to coarse gravel, yellow (2.5Y 8/6), slightly moist, stiff, angular to subangular chert and LS gravel, some weathered chert, clay has limonite stain, Mn, GC.
	50						BASAL TILL
							Begin Core (53.5-57.5)
			Run1				53.5 53.5-57.5 CHERT, light bluish gray (5B 5/1) microcrystalline, mostly core loss
	55						RESIDUUM

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 3 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	55			RUN 1 cont'd .2 / 4.0	RQD: 0 / 4.0		Core loss - As Above RESIDUUM
				5%	0% LP=0.2' 0> 4"		Auger? 57.5-65.0
	60	60.0 / 60.9	SS II	2"	3/18"/0 / 5 / 0		SILTY SAND to CLAYEY SAND, non-plastic to low plasticity, reddish yellow (7.5YR 6/8), wet, loose, coarse, angular chert fragments 1 to 7 mm, SM to SC 61. ? ? ? Top of Bedrock?
	65						Sampler refusal at 60.9' Cored from 53.5-57.5' 65.0-100.0' Core descriptions on pages 4 through 10.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 4 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
									Resume NQ Coring 65.0
65		Run2 9.5 / 9.5 100%		2	6.1 / 9.5 64% LP = 1.2'	2	Open, rough Open, rough		65.0-74.5 LIMESTONE; argillaceous; dark yellowish orange (10YR 6/6); med. bedded with chert; lt. grey (N7); thin interbeds and rubble zones to .5' thick; vugs in chert interbeds; irregular shape to .8" in length; druzy quartz in vugs; pinpoint Fe stains in LS to 10%; limestone mod. weathered and mod. hard.
66					12 > 4	1	Open, rough		
67						3	Open, rough Open, rough		
68						4	Open, rough (4)		
69						2	Open, rough Open, rough		
70						3	Open, rough (2)		
71			2				Open, rough		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 5 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
71		Run2 Cont.		2		4	Open, rough Open, smooth, MnOx Open, rough, MnOx		As Above	
72							Open, rough, MnOx			
						1				
73							Open, smooth, MnOx			
						0				
74										
		74.5		2		6	Open, rough (6)		74.5-80.5 LIMESTONE; cherty, dusky yellow (5Y 6/4) to lt. grey (N7); med. bedded, chert nodules in brecciated zones and thin beds; chert very lt. grey (N8) to med. grey (N5); irregular vugs 20% in cherty zone to 1.0"; lined w/druzy quartz; trace of pyrite; mod. to slight weathering and mod. hard. Argillaceous 74.5 to 78.2.	
75		Run3 5.4/6.0 90%		3	1.4/6.0 = 23% LP = 0.4' 4 > 4"	4	Open, rough (4)			
76						4	Open, rough (4)			
77						4	Open, rough Open, rough Open, rough Open, rough			
78										

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 6 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
78		Run3 Cont.	78.3				Rubblized zone		As Above
79			78.9				Open, rough		
						4	Open, rough (2)		
							Open, rough		
80	Upper weathered limestone						Open, rough		
		80.5				3	Open, rough		80.5-90.0 LIMESTONE; fossiliferous; yellowish gray (5Y 7/2) to lt. gray (N7); thick bedded to massive; med. to coarse xtln; some chert lt. grey (N7) to med. grey (N5) in nodules and beds to 0.5' thick; fossils are shell fragments and crinoids; trace stylolites; fresh to slightly weathered and hard.
	Lower competent limestone	Run4 9.5/9.5 100%			6.0/9.5 = 63% LP = 0.9'		Open, rough		
81						2	Open, rough		
					10 > 4"		Open, rough, MnOx		
82						2	Open, rough		
							Open, rough, MnOx		
83									
						2	Open, rough		
				3			Open, rough		
84				4			Open, rough		
						2	Open, rough		
85				4			Rubblized zone		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 7 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
85		Run4 Cont.		4		2	Open, rough		As Above
							Open, smooth		
86						2			
							Open, rough, MnOx		
87						1	Tight, MnOx Open, rough		
88						7	Open, rough, MnOx Open, rough (2)		
							Open, rough (4)		
89						2	Open, rough		
							Open, rough		
90		90.0					Open, rough		90.0-100.0 LIMESTONE; fossiliferous and interbedded chert; yellowish grey (5Y 7/2) to lt. grey (N7); thick bedded to mass; med. to coarse xtln; chert lt. grey (N7) to med. (N5) grey; nodules and beds to 0.5'; fossils are shell fragments and crinoids; trace stylolites fresh to slightly weathered and hard.
		Run5 10.0/10.0 100%		7.9/10.0 = 79% LP = 1.1'		2	Rubblized zone Open, rough		
91						2	Open, rough		
				12 > 4"					
92			4				Tight, stylolite		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 8 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
92		Run5 Cont.		4		1	Open, rough		As Above
93						2	Open, rough, MnOx Tight, MnOx		
94				4 5		4	Open, rough Open, rough (3)		
95						2	Rubblized zone Open, rough Open, rough		
96						3	Tight,stylolite Open, rough Open, rough		
97						2	Tight,stylolite		
98						1	Open, rough		
99				5			Open,stylolite		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 9 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
99		Run5 Cont.		5		4	Open, smooth Tight, stylolite Open, smooth Open, smooth		As Above
100				5					100.0-101.4 Rotary drilled
101									
		101.4							
		Run6 7.8/7.8 100%		1*	5.4/7.8 69% LP = 1.0' 9/>4"	6	Rubblized zone		101.4-150.0 LIMESTONE; lt. grey (N7); thick bedded; fine to med. xtln; occ. chert nodules; occ. fossils; fresh and hard.
102						5	Open, rough (5)		
103						1	Rubblized zone		
							Open, rough		
104						2	Tight		
							Open, smooth		
105						3	Open, rough		
							Open, rough (2)		
106				1					

*Box numbers correspond to additional core boxes for interval from 101.4' to 150.0'.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 10 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
106		Run6 Cont.		1		4	Open, stylolite MnOx		As Above
							Open, ro gh		
							Open, rough, MnOx		
107						1	Open, rough		
108						1	Open, rough		
109							Open, rough, MnOx		
		109.2							
		Run7 5.5 / 5.5 100%		4.7 / 5.5 85% LP = 0.9'		3	Open, rough, MnOx (2)		
110						2	Open, rough, MnOx		
				1 9 > 4"			Open, rough		
111				2		3	Open, rough, MnOx		
							Open, rough (2)		
112						2	Open, rough, MnOx		
							Open, rough		
113									

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 11 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
113		Run7 Cont.		2		1	Open, stylolite, MnOx		As Above
114		114.7				3	Open, rough, MnOx		
		Run8			5.3		Open, rough		
115		6.3 / 6.3			6.3	3	Open, stylolite MnOx		
		100%			84% LP = 1.2'		Open, rough, MnOx		
							Open, rough, MnOx		
116					9 > 4"	1	Open, rough		
117						2	Open, rough (2)		
118						2	Open, rough, MnOx		
							Open, rough		
119			2						
			3			3	Open, smooth(3)		
120			3						

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 12 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
120		Run8 Cont.		3		2	Open, rough, MnOx Open, smooth		As Above
121		121.0 Run9 8.0 8.0 100%			7.0 8.0 88% LP = 1.5'	5	Open, smooth (4)		
122					9 > 4"	1	Open, rough Open, rough, MnOx		
123						0			
124						2	Open, rough Open, smooth		
125						3	Open, rough Tight Open, rough		
126						0			
127			3						

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 13 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	LITHOLOGY: CEMENTATION HARDNESS WEATHERED STATE
127		Run9 Cont.		3		2	Tight		As Above	
							Tight, stylolite (2)			
128				3		3	Open, rough (2)			
				4						
		129.0					Open, stylolite			
129		Run10 10.0/10.0 100%			6.0/10.0 60% LP = 0.8'	3	Open, smooth (3)			
130				11 > 4"		3	Open, stylolite MnOx			
							Open, spun			
131							Open, rough (3)			
						3	Rubblized zone			
132						1	Open, rough			
133							Open, rough			
						3	Tight, stylolite (2)			
134			4							

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 14 of 16

Project Number:

Hole Number 3002 B

Project: MZZRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
134		Run10 Cont.		4			Open rough (5)		As Above
135							Tight, stylolite Open, rough (3) Tight, stylolite Open, rough		
136							Tight Tight, stylolite Open, rough, MnOx		
137							Open, smooth (2) Open, smooth Tight, stylolite		
				4			Open, smooth (3)		
138				5			Open, rough		
139		139.0							
		Run11 10.0 10.0 100%		6.3 10.0 63% LP = 1.5'			Open, rough (2)		
140									
141			5	10 > 4"			Open, rough, MnOx		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 15 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
141		Run11 Cont.		5		4	Open, rough (4)		As Above	
142						0				
143						3	Open, smooth			
144						1	Tight, stylolite MnOx			
145						2				
146						6	Open, rough (6)			
147						2	Open, rough (3)			
			5	6			Tight,stylolite			
148			6							

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 16 of 16

Project Number:

Hole Number 3002 B

Project: WSSRAP - Monitor Well Drilling

Location: 150' S of SW corner Raffinate Pit 3

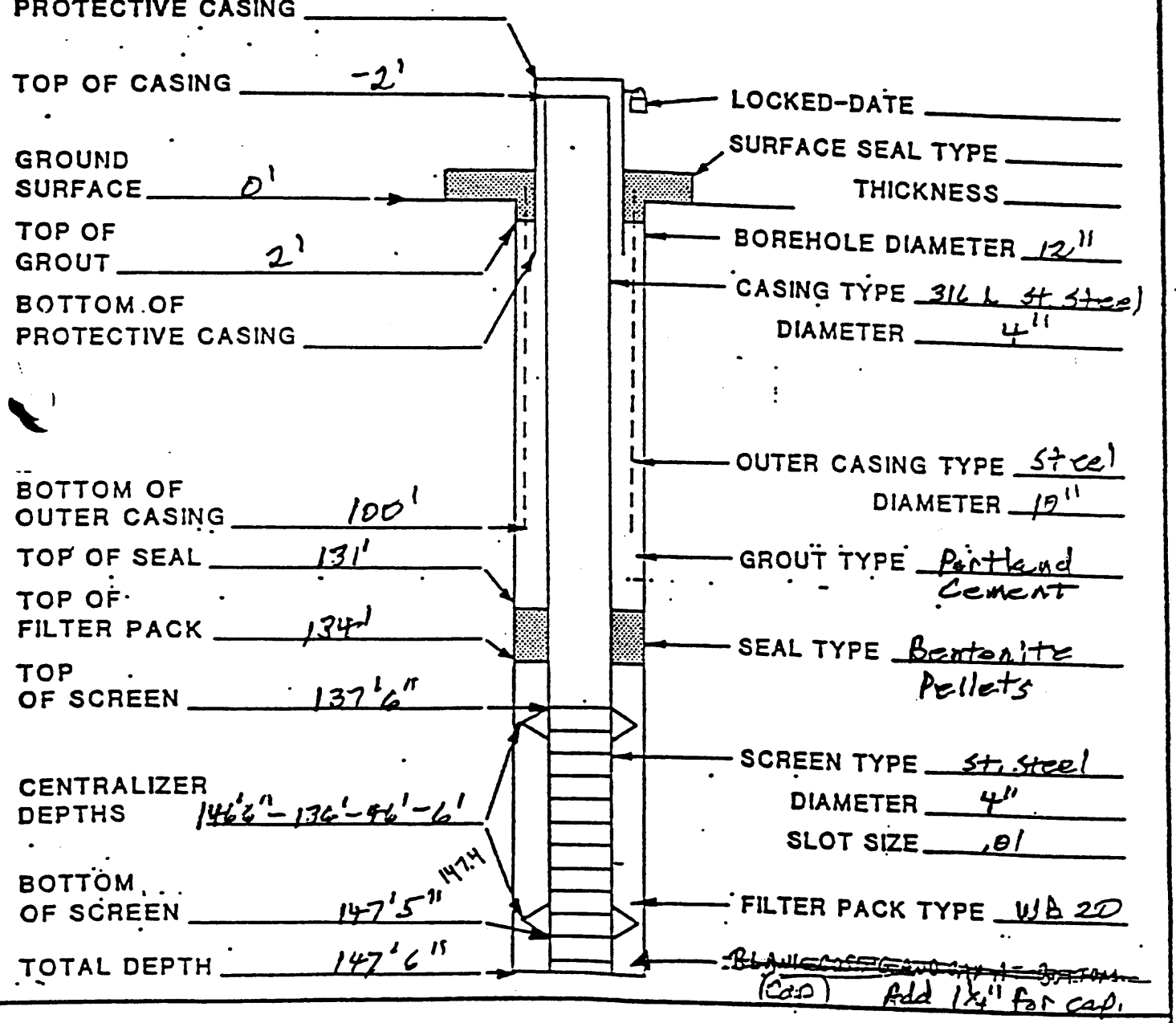
DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
148		Run11 Cont.				6	Open, rough (3) Open, rough, MnOx Open, rough Open, rough		As Above
		149.0							
149		Run12 0.5/1.9 50%			0/1.0 0% LP= 0.2' 0 > 4"		Rubblized zone		
150									Total Depth 150' Installed well consisting of 4" diameter stainless steel. Screen 147.5 to 137.5', 0.010" slots. Sand pack to 134.0'.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

WELL COMPLETION RECORD

WELL NUMBER 3002B DATE INSTALLED 6-22-88

PMC REPRESENTATIVE Neal Allday DRILLER Wayne Johnson



COMMENTS

PMC REPRESENTATIVE SIGNATURE Neal Allday

MW-3010

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP-WELDON SPRING	14501	3 OF 3	~~B-23~~

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE/ LENGTH CORE RUN	SAMPLE RECOVERY/ CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
NX Wireline												
	4.8	4.8	76.3-81.1' / 100					80			LIMESTONE IS WEATHERED DARK YELLOWISH-BROWN (10YR5/4) TO 75.5' bottom of weathered @ 75 SHALE SEALEY LENSES CONTAINING SOME GLAUCONITE AND/OR CHLORITE.	@ 77' -white return.
	4.9	4.9	81.1-86.0' / 100'					85				
	4.7	4.7	86.0-90.7' / 100				574.39	90			BOH @ 90.7'- HOLE COMPLETED AS A ROCK OBSERVATION WELL. NOTE: ROCK AND SOIL COLORS ARE INDEXED ON THE ROCK-COLOR CHART PUBLISHED BY THE GEOLOGICAL SOCIETY OF AMERICA.	@ 90.7' -bailed hole to 70' recovered to 52' @ .16 gpm.
								95				

SS = SPLIT SPOON; ST = SHELBY TUBE; B = BENNISON; P = PITCHER; O = OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA

HOLE NO. B-23

MACF 19-2

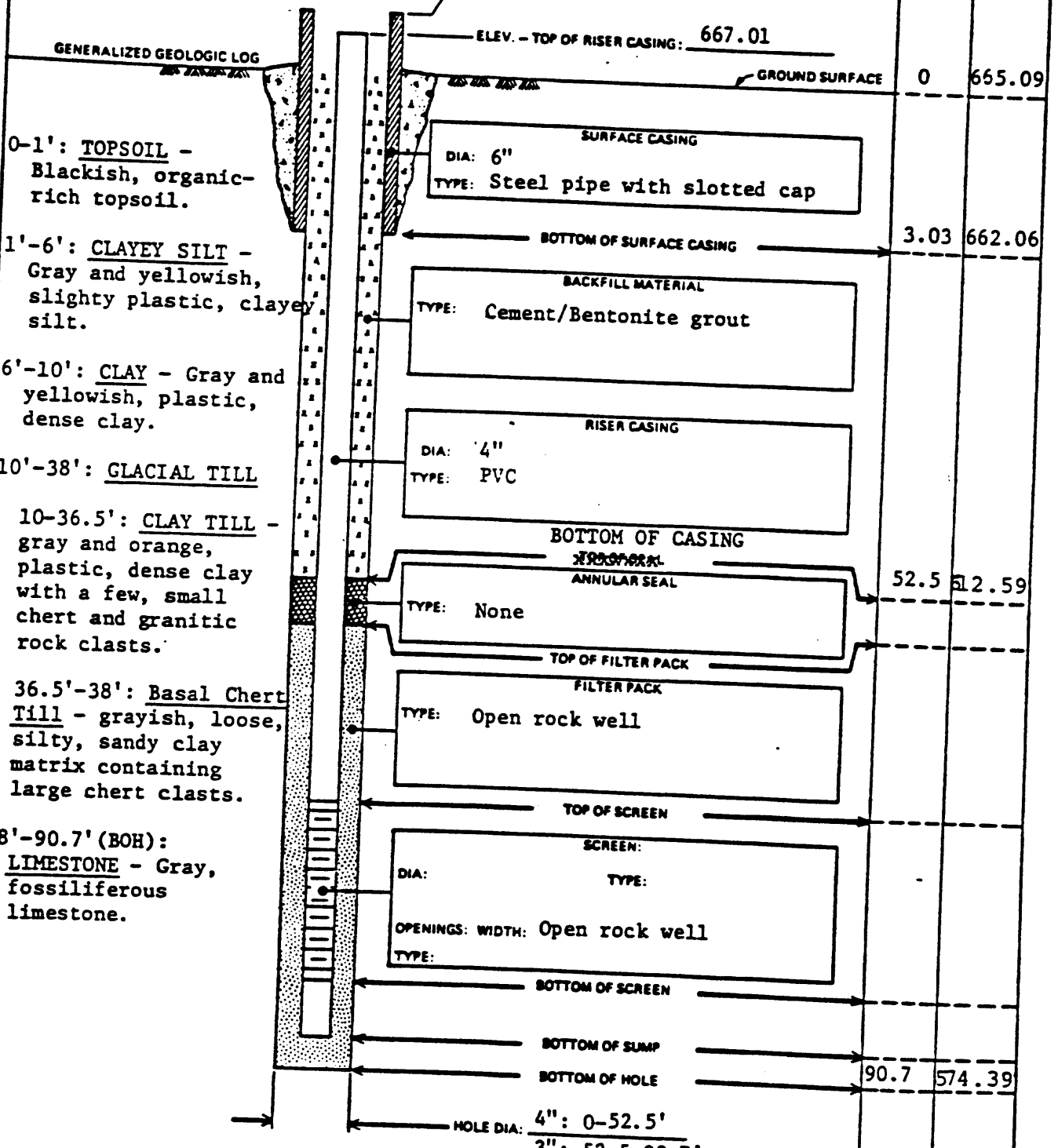
MW-3010

OBSERVATION WELL

JOB NO.	SITE	PROJECT	WELL NO
14501	DOE PROPERTY- RAFFINATE PIT AREA	FUSRAP - Weldon Spring	~~B-23~~

COORDINATES	
98471.52 N	50936.42 W

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
4/13/83	4/19/83	E.M. FANELLI	Top of Surface Casing



	DEPTH	ELEV.
GROUND SURFACE	0	665.09
BOTTOM OF SURFACE CASING	3.03	662.06
BOTTOM OF CASING / TOP OF ANNULAR SEAL	52.5	612.59
BOTTOM OF HOLE	90.7	574.39

0-1': TOPSOIL - Blackish, organic-rich topsoil.

1'-6': CLAYEY SILT - Gray and yellowish, slighty plastic, clayey silt.

6'-10': CLAY - Gray and yellowish, plastic, dense clay.

10'-38': GLACIAL TILL

10-36.5': CLAY TILL - gray and orange, plastic, dense clay with a few, small chert and granitic rock clasts.

36.5'-38': Basal Chert Till - grayish, loose, silty, sandy clay matrix containing large chert clasts.

38'-90.7'(BOH): LIMESTONE - Gray, fossiliferous limestone.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 8

Project Number:

Hole Number: MW-3019 B

Project: WSSRAP - Monitor well drilling	Location: 5' South of 3019 A
Coordinates: N.97932.6 W.50945.5	Drilling Contractor: Layne Western
Drill Make and Model: CME 55/75; 7" Hollow Stem Auger; NQ Wireline Core	Depth Top of Rock: 35.0
Depth Casing & Size:	Hole Size: Reamed 8"
Elevation: 660.14'G.S.; 661.9'TOC	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 84.3'	
Water Level:	Fluid & Additives: Water
Date Start: 03/17/88	Date Finish: 03/21/88
Logger: Original* N. Bingert	

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION
	30						For description of soils, see log 3019A
		34.5	SS 01	5"	40/5"		34.5-34.9 CLAYEY GRAVEL, low plasticity, silty greenish gray (5Y 7/3), moist, dense, fine to coarse subangular chert gravel lt. blue grey (5B 7/1) to light brown (5YR 5/6), Fe staining and Mn, GC.
	35	34.9					Top of bedrock @ 35.0'
							Cored from 35.5 to 84.3
							Core descriptions on pages 2 through 8

Geotechnical information by: M. Schauer
R. Parsons

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 8

Project Number:

Hole Number 3019 B

Project: WSSRAP - Monitor Well Drilling

Location: 5' South of 3019 A

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
35		35.5							35.0-35.5 No log available Begin coring 35.5'
36		Run1 3.8 8.5 45%		1	0.5 8.5 6% LP = 0.5' 1 > 4"				4.7' core loss exact location unknown 35.5-52.0 CHERT RUBBLE lt. grey (N7) to lt. brown (5Y 5/6), gravel to cobble size, clay filling in fracs and vugs, mod. brown (5YR 4/4) to very pale orange (10YR 8/2), vugs in chert, pinpoint to .5", druzy quartz lining; fossil frags (crinoids) in chert; mod. severe weathering and soft overall (chert hard)
37									
38									
39									
40									
41				1					

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 3 of 8

Project Number:

Hole Number 3019 B

Project: WSSRAP - Monitor Well Drilling

Location: 5' South of 3019 A

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
41		Run1 Cont.		1					As Above
42									
43									
44		44.0							
		Run2 4.0/8.0 50%			1.2/8.0 15% LP = 0.4'				4.0' core loss exact location unknown
45					3 > 4"				
46									
47									
48				1					

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 4 of 8

Project Number:

Hole Number 3019 B

Project: WSSRAP - Monitor Well Drilling

Location: 5' South of 3019 A

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
49		Run2 Cont.		1					Chert rubble, as above
50									
51									
52		52.0		1					
		Run3 1.5/2.0 75%		2	0.5/2.0 25% LP = 0.5'				0.5' core loss exact location unknown
53					1 > 4"				52.0-63.7 ARGILLACEOUS LIMESTONE; grey orange (10YR 7/4) to mod. yellow brown (10YR 5/4), finely xtln, cherty, numerous vugs pinpoint to .5", secondary calcite filling vugs and fractures, mod. weathered and soft to med. hard.
54		54.0							
		Run4 10.0/10.0 100%		2	4.8/10.0 48% LP = 1.1'	0	fracs.		
55					10 > 4"	3	Open, rough (3)		
56									

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 5 of 8

Project Number:

Hole Number 3019 B

Project: WSSRAP - Monitor Well Drilling

Location: 5' South of 3019 A

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
56		Run4 Cont.		3		7	Open, rough (7)		As Above	
57						4	Open, rough (4)			
58						4	Open, rough (4)			
59						2	Open, rough			
60							Open, rough (2)			
61						3	Open, rough (3)			
62				2		4	Open, rough (3)			
63				3		2	Open, rough (2)			

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 6 of 8

Project Number:

Hole Number 3019 B

Project: WSSRAP - Monitor Well Drilling

Location: 5' South of 3019 A

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
63		Run4 Cont.		3		4	Open, rough (4)		63.7-64.0 LIMESTONE; lt. grey (N7); fossiliferous; med. xtln; abundant crinoid frags; fresh and hard.
64		64.0					Open, rough, MnOx		
		Run5 .8/.8 100%			0.3 0.8 38% LP= 0.3 1>4"	2	Open, rough (2)		64.0-64.8 LIMESTONE; lt. olive grey (5Y 6/1); med. bedded; fine to med. xtln; trace fossils; fresh and hard. 64.5-64.7 chert nodule, lt. grey (N7), rounded, surrounded by dark yellowish orange (10YR 6/6) clay.
	64.8								
65		Run6 9.5/9.5 100%			6.8 9.5 72% LP = 1.4"	1	Open, smooth		64.8-67.6 LIMESTONE; fossiliferous; lt. grey (N7) to yellowish grey (5Y 7/2); massive; med. to coarse xtln; no vugs; fossils; crinoids; brachiopods; bryzoans; fresh and hard, trace glauconite.
66					11 > 4"		Open, smooth, MnOx		
						2	Tight, stylolite		
67							Open, smooth		
						2			67.6-70.6 CHERT and LIMESTONE INTERMIXED; chert; very lt. grey (N8) to med. grey (N5); micro xtln; vugs pinpoint to .2" x 1", some druzy quartz in vugs; trace pyrite in fractures; trace fossil fragments; limestone; same as above 64.8 to 67.6 except occ. Fe staining; fresh to slightly weathered and hard.
68							Open, rough		
						3	Open, rough (3)		
69							Open, rough, MnOx		
						3	Open, rough, MnOx		
70				3			Open, rough		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 7 of 8

Project Number:

Hole Number 3019 B

Project: WSSRAP - Monitor Well Drilling

Location: 5' South of 3019 A

DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: ROD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
70		Run6 Cont.		3		3	Open, rough (3)		As Above
71				3 4		1	Open, rough		70.6-72.4 LIMESTONE; lt. grey (N7) to yellowish grey (5Y 7/2); massive; med. to coarse xtln; no vugs; Fe staining; slightly weathered and mod. hard to hard.
72						4	Tight Open, rough, FeOx Rubblized zone Open, smooth (2)		72.4-74.3 CHERT and LIMESTONE INTERMIXED; same as section 67.6-70.6.
73						3	Open, rough (3)		
74		74.3					Rubblized zone		
75		Run7 10.0 / 10.0 100%		5.9 / 10.0 59% LP 1.0'		2	Open, rough (2) Open, smooth		74.3-77.0 LIMESTONE; fossiliferous; lt. grey (N7); massive; med. to coarse xtln; chert nodules; fossils are crinoids; slightly weathered and mod. hard to hard.
76				10 > 4"		4	Open, rough (2) Open, rough (2)		
77				4		3	Open, stylolite MnOx Open, rough chlorite lined Open, rough, MnOx		

WELDON SPRING SITE REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 8 of 8

Project Number:

Hole Number 3019 B

Project: WSSRAP - Monitor Well Drilling

Location: 5' South of 3019 A

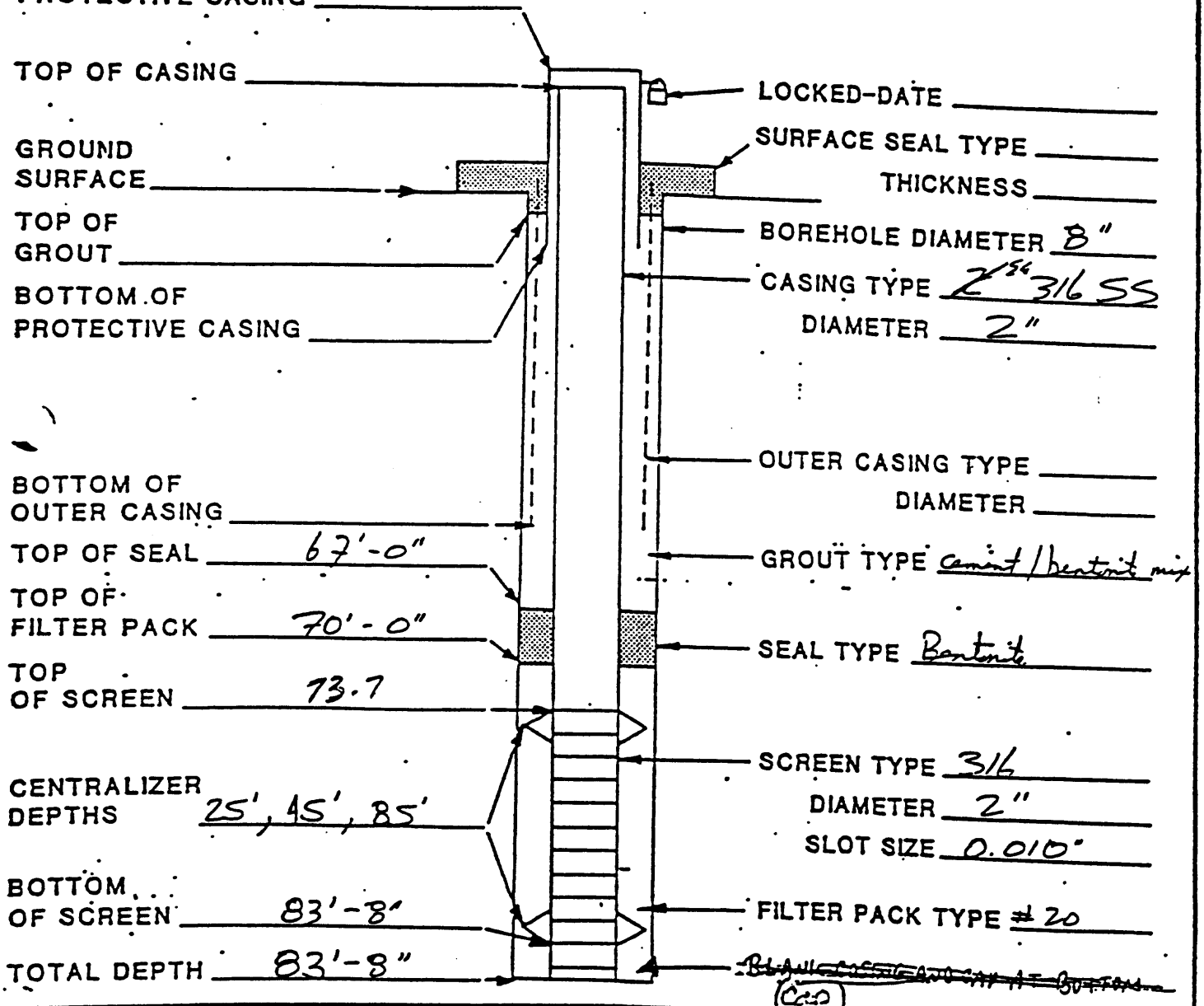
DEPTH	COMMENTS: TESTS/MONITORING INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS CONTAMINATION	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES: RQD	FRACTURES PER FOOT	DESCRIPTION: TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	GRAPHIC LOG	LITHOLOGY: MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION / CEMENTATION HARDNESS WEATHERED STATE
77		Run7 Cont.		4		4	Open, rough (4)		77.0-78.3 CHERT and LIMESTONE INTERMIXED; same as section 67.6 to 70.6.
78	78.3 lower competent bedrock					1	Open, rough, MnOx		78.3-84.3 LIMESTONE; fossiliferous; lt. grey (N7); massive; med. to coarse xtln; chert nodules; fossils are crinoids; slightly weathered and mod. hard to hard.
79	↓					3	Open, rough Open, smooth, MnOx (2)		
80				4 5		2	Open, stylolite, MnOx Open, smooth		
81						2	Open, smooth (2)		
82						4	Tight Open, rough, MnOx Open, rough		
83						3	Open, stylolite Tight Open, rough		
84						2	Tight, stylolite Open, rough Tight, stylolite		Total Depth 84.3'
				5					Installed well consisting of 2" dia. stainless steel. Screen 83.7-73.7', 0.010" slots. Sand pack to 70.0'.

WELDON SPRING SITE REMEDIAL ACTION PROJECT

WELL COMPLETION RECORD

WELL NUMBER 3019 B DATE INSTALLED 4-1-88

PMC REPRESENTATIVE E. Gorove DRILLER W. Johnson - Layne Western



COMMENTS

PMC REPRESENTATIVE SIGNATURE DATE

4019

GEOLOGIC DRILL LOG

PROJECT: FUSRAP WELDON SPRING	JOB NO.: 14581	SHEET NO.: 1 OF 2	HOLE NO.: ~~GMW-19~~		
SITE: BUSH WILDLIFE	COORDINATES: N 98863 W 58161	ANGLE FROM HORIZ.: 90	BEARING: B		
BEGUN: 12/5/86	COMPLETED: 12/9/86	DRILLER: BOB HENSON	DRILL MAKE AND MODEL: MOBILE B-80	HOLE SIZE: NX	OVERBURDEN FT.: 28.2
ROCK FT.: 39.3	TOTAL DEPTH FT.: 59.5				
CORE RECOVERY/FT./%: 33.75/78	CORE BOXES: 2	SAMPLES:	EL. TOP OF CASING: 647.36/17	GROUND EL.: 645.36/66	DEPTH/EL. GROUND WATER: 35.82/609.73
DEPTH/EL. TOP OF ROCK: 28.2/625.15					
SAMPLE HAMMER WEIGHT/FALL: 140 LBS./29 IN.	CASING LEFT IN HOLE: DIA./LENGTH: COMPLETED AS OBSERVATION WELL	LOGGED BY: L.R. VEST			

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS /" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
8.5 IN. AUGER							645.35				0.0 - 28.2 FT. SILTY CLAY DARK BROWN, PLASTIC, MOTTLED GRAY AND BROWN AT 4.0 FT.	HOLE REAMED TO 8 INCHES AND COMPLETED AS OBSERVATION WELL.
							640.35	5				not Reliable
							635.36	10			LIMESTONE AND CHERT GRAVEL (3 - 4 IN.) 10.5 FT.	
							630.35	15			CHANGE TO LIGHT BROWN AND LIGHT GRAY 15.0 - 16.5 FT.	
NX CORE	4.0	2.0	50								LIMESTONE BOULDER 19.0 - 19.2 FT. 19.2 - 28.2 FT. SILTY CLAY, BROWN WITH CHERT AND LIMESTONE BOULDERS.	
	4.0	3.0	75				625.35	20			28.2 - 59.5 FT. LIMESTONE BROWN, WITH CHERT NODULES. WEATHERED 28.2 - 21.0 FT. 21.0 - 24.2 FT. LIMESTONE, GRAY, DECOMPOSED, SOFT.	
	4.0	1.5	38				620.35	25			24.2 - 30.0 FT. HIGHLY FRACTURED, WEATHERED CHERT AND DECOMPOSED LIMESTONE, GRAY, SOFT.	
	2.3	0.9	39									
	2.5	1.0	40				615.35	30				
	1.0	1.0	100									
	0.4	0.3	75									
	1.6	0.9	56								34.5 - 34.75 FT. SHALE, DARK GRAY.	

SS=SPLIT SPOON; ST=SHELBY TUBE; C=CALIFORNIA

SITE: BUSH WILDLIFE

HOLE NO.: GMW-19

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP WELDON SPRING	14501	2 OF 2	GMW-19

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
NX CORE	1.5	1.0	63									
	1.8	1.4	78									
	3.8	2.9	97				685.35	48			48.8 - 45.5 FT. LIMESTONE AND CHERT, GRAY, RECEMENTED IN BROWN MATRIX.	
	4.8	4.8	100				688.35	45			45.5 - 47.8 FT. LIMESTONE, GRAY, FINE GRAINED; AND CHERT, BLUE GRAY, WEATHERED, FRACTURED.	
	4.8	4.8	100								47.8 - 53.4 FT. LIMESTONE AND CHERT, GRAY, RECEMENTED IN BROWN MATRIX.	
							695.35	38			Top of Lower competent	
	3.4	3.4	100	.27	48	6					53.4 - 59.5 FT. LIMESTONE, DARK GRAY, FINE GRAINED, CRYSTALLINE, WITH CHERT, BLUE GRAY.	
	4.5	4.5	100	1.66	58	5	698.35	55				
							585.35	68			BOTTOM OF HOLE: 59.5 FEET.	

SS=SPLIT SPOON; ST=SHELBY TUBE; C=CALIFORNIA

SITE: BUSH WILDLIFE

HOLE NO. GMW-19

MW-3009

GEOLOGIC DRILL LOG

PROJECT: FUSRAP-WELDON SPRING	JOB NO.: 14501	SHEET NO.: 1 OF 3	HOLE NO.: ~~B-21~~	
SITE: DOE PROPERTY-RAFFINATE PIT AREA	COORDINATES: N 98832.52 W 52123.23	ANGLE FROM HORIZ.: 90	BEARING: VERTICAL	
BEGUN: 12 APR. 83	COMPLETED: 18 APR. 83	DRILLER: BOYLES BROTHERS	DRILL MAKE AND MODEL: LONGYEAR 44	HOLE SIZE: 3 TO 4'
OVERBURDEN (FT.): 29.5	ROCK (FT.): 69.9	TOTAL DEPTH: 99.4'		
CORE RECOVERY (FT./%): 54/99	CORE BOXES: 3	SAMPLES:	EL. TOP OF CASING: 646.~~95~~ 43	GROUND EL.: 644.41 30
DEPTH/EL. GROUND WATER: 35.7/608.71 (4/19/83)	DEPTH/EL. TOP OF ROCK: 29.5/614.91			
SAMPLE HAMMER WEIGHT/FALL:	CASING LEFT IN HOLE: DIA./LENGTH: 45' OF 4" PVC	LOGGED BY: E.M.FANELLI		

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
6" ROLLER BIT							644.41				0 cut/Fill	
							643.41				0.0'-1.0': TOPSOIL: BLACKISH-BROWN, ORGANIC-RICH, MOIST TO WET, CLAYEY SILT.	Drilled with 6" roller bit and mud, descriptions based on cuttings and TR-14 log.
							639.41	5			1.0'-5.0': CLAYEY SILT: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAYEY SILT; NON-PLASTIC TO PLASTIC, MODERATELY DENSE WITH DEPTH AND CONTAINS ABUNDANT IRON-OXIDE NODULES. loess	@ 9' -pulled rods
							634.41	10			5.0'-10.0': CLAY: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAY TO SILTY CLAY. THE MATERIAL IS PLASTIC, DENSE, CONTAINS ABUNDANT IRON-OXIDE NODULES, AND HAS SLICKENSIDED SURFACES. forest	
								15			10.0'-23.0': CLAY TILL: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), SILTY, SANDY, DENSE CLAY THAT CONTAINS A FEW PEBBLES OF SUBROUNDED CHERT, QUARTZITE, AND GRANITIC MATERIAL, WHICH GENERALLY COARSEN TO COBBLE SIZES WITH DEPTH. THE MATERIAL HAS MANGANESE-STAINED SURFACES, CONTAINS IRON AND SECONDARY FRIABLE CALCAREOUS CONCRETIONS, AND SHOWS BLOCKY FRACTURING. 10-21	
								20				@ 21' -pulled rods.
							621.41				@ 15'-17': VERY DARK GRAY SILTY LENSES.	
								25			@21'-23': BASAL CHERT TILL: BROWN TO BLACK COBBLE- TO BOULDER-SIZED, ANGULAR TO SUBANGULAR CHERT CLASTS IN A LOOSE, SANDY, SILTY, CLAYEY MATRIX. THE CHERT COMMONLY HAS WHITE WEATHERING RINDS.	
							614.91	30			23.0'-29.5': CHERTY CLAY: BRIGHTER YELLOWISH-ORANGE (10YR8/6). TAN AND BROWN CLAY MATRIX CONTAINING SILT AND ABUNDANT CHERT CLASTS. (CONSIDERED A PENNSYLVANIAN SOIL BY STATE GEOLOGISTS.)	
											29.5-35': RESIDUAL LIMESTONE: DARK YELLOWISH-ORANGE (10YR6/6) WEATHERED BOULDERS OF LIME-STONE AND CHERT IN A LOOSE,	

SS = SPLIT SPOON; ST = SHELBY TUBE; O = OSTERBERG; P = PITCHER; O = OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA

HOLE NO.: B-21

NACP 19-1

MW-3009

GEOLOGIC DRILL LOG

PROJECT: FUSRAP-WELDON SPRING | JOB NO. 14501 | SHEET NO. 2 OF 3 | HOLE NO. ~~B-21~~

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								35			RESIDUAL LIMESTONE CONTINUED: SILTY CLAY MATRIX. LIMESTONE IS VUGGY, AS A RESULT OF SOLUTIONING, AND IRON-OXIDE STAINED. THE CHERT HAS WEATHERING RINDS.	
								40			35-99.4': LIMESTONE: FORMATION NAME: BURLINGTON/KEOKUK; AGE: MISSISSIPPIAN; A LIGHT GRAY (N7) TO VERY LIGHT GRAY (N8), FINE-TO COARSE-GRAINED, FOSSILIFEROUS LIMESTONE INTERBEDDED WITH LENSES AND NODULES OF SPECKLED, BANDED, AND MOTTLED LIGHT-BLUISH-GRAY (5B7/1) AND BLUISH-WHITE (5B9/1), FOSSILIFEROUS CHERT. THE FORMATION IS IRON-OXIDE STAINED, MODERATE YELLOWISH ORANGE (10YR6/6) WHERE WEATHERED, AND BECOMES LESS WEATHERED WITH DEPTH. IT IS MANGANESED STAINED AND GENERALLY HARD AND MASSIVE, BUT SHOWS SMALL-SCALE GRADED BEDDING LOCALLY. THE FOSSILS ARE PREDOMINANTLY CRINOIDS, BRYOZOA AND BRACHIOPODS, WHICH ARE LOCALLY REPLACED BY PYRITE. A FEW CALCITE AND QUARTZ CRYSTALS ARE ASSOCIATED WITH VOIDS, ESPECIALLY AT LIMESTONE-CHERT CONTACTS. THE FORMATION CONTAINS ABUNDANT STYLOLITES (PRESSURE SOLUTION FEATURES), WHICH ARE SECONDARY FEATURES THAT ARE PERPENDICULAR TO BEDDING AND INTERSECT FOSSILS. STYLOLITE SUTURES ARE ASSOCIATED WITH A THIN (1/4") BLACKISH-GRAY, CARBONACEOUS, SILTY CLAY, THAT CONTAINS IRON. THE CHERT IS VERY HARD, AND IS (1) BANDED IF PARALLEL TO BEDDING, (2) CONCENTRICALLY BANDED IF NODULAR, OR (3) SPECKLED IF FOSSILIFEROUS. THE CHERT IS GENERALLY SPECKLED TOWARDS TOP OF UNIT; SECONDARY CHERT IS OFTEN MIXED WITH FINE-GRAINED LIMESTONE.	@ 40' -drilling hard; 600 psi down pressure.
								45				@ 45' -cemented in 4" PVC casing; began NX coring.
								50				
								55				
								60				
								65			@54' - LIMESTONE IS GENERALLY FRESH AND UNWEATHERED-COLOR CHANGE TO GRAY (N6).	
								70				
NX Wireline	2.8	2.8	45.0-47.8' 100									
	4.4	4.4	47.8-52.2' 100									
	4.6	4.6	52.2-56.8' 100									
	5.1	5.1	56.8-61.9' 100									
	4.2	4.2	61.9-66.1' 100									
	4.7	4.7	66.1-70.8' 100									
	4.8	4.8	70.8-75.6' 100									

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA | HOLE NO. B-21

M&CF 19-2

MW-3009

GEOLOGIC DRILL LOG

PROJECT: FMRAP-WELDON SPRING | JOB NO.: 14501 | SHEET NO.: 3 OF 3 | HOLE NO.: B-21

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE SLOTS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								75				
	4.7	4.7	75.6-80.3' 100								@56.-56.9' CORE BECOMES SHALEY CONTAINS ABUNDANT PYRITE AND SOME GLAUCONITE AND/OR CHLORITE.	
	4.7	4.7	80.3-85.0' 100					80				
	5.0	5.0	85.0-90.0' 100					85				
	4.8	4.8	90.0-94.8' 100					90				
	4.6	4.2	94.8-99.4' 91					95				@ 95' -drilling very soft.
							545.01	100			BOH @ 99.4' HOLE COMPLETED AS A ROCK OBSERVATION WELL.	@ 99.4' -bailed well recovered @ .44 gpm.
											NOTE: ROCK AND SOIL COLORS ARE INDEXED ON THE ROCK-COLOR CHART PUBLISHED BY THE GEOLOGICAL SOCIETY OF AMERICA.	

MX Vitrline

SS = SPLIT SPOON; ST = SHELBY TUBE; R = REMISON; P = PITCHER; O = OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA | HOLE NO.: B-21

HSCF 19-2

MW-3009

OBSERVATION WELL

PROJECT	WELL NO.
FUSRAP - Weldon Spring	~~B-21~~

JOB NO.	SITE	COORDINATES
14501	DOE PROPERTY - RAFFINATE PIT AREA	98832.52 N 52123.23 W

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
4/12/83	4/18/83	E.M. FANELLI	Top of Surface Casing

GENERALIZED GEOLOGIC LOG

0-1': TOPSOIL - Blackish, organic-rich soil.

1'-5': CLAYEY SILT - Gray and yellowish-orange, slightly plastic, clayey silt.

5'-10': CLAY - Gray and orangish, plastic, dense clay.

10'-23': GLACIAL TILL -

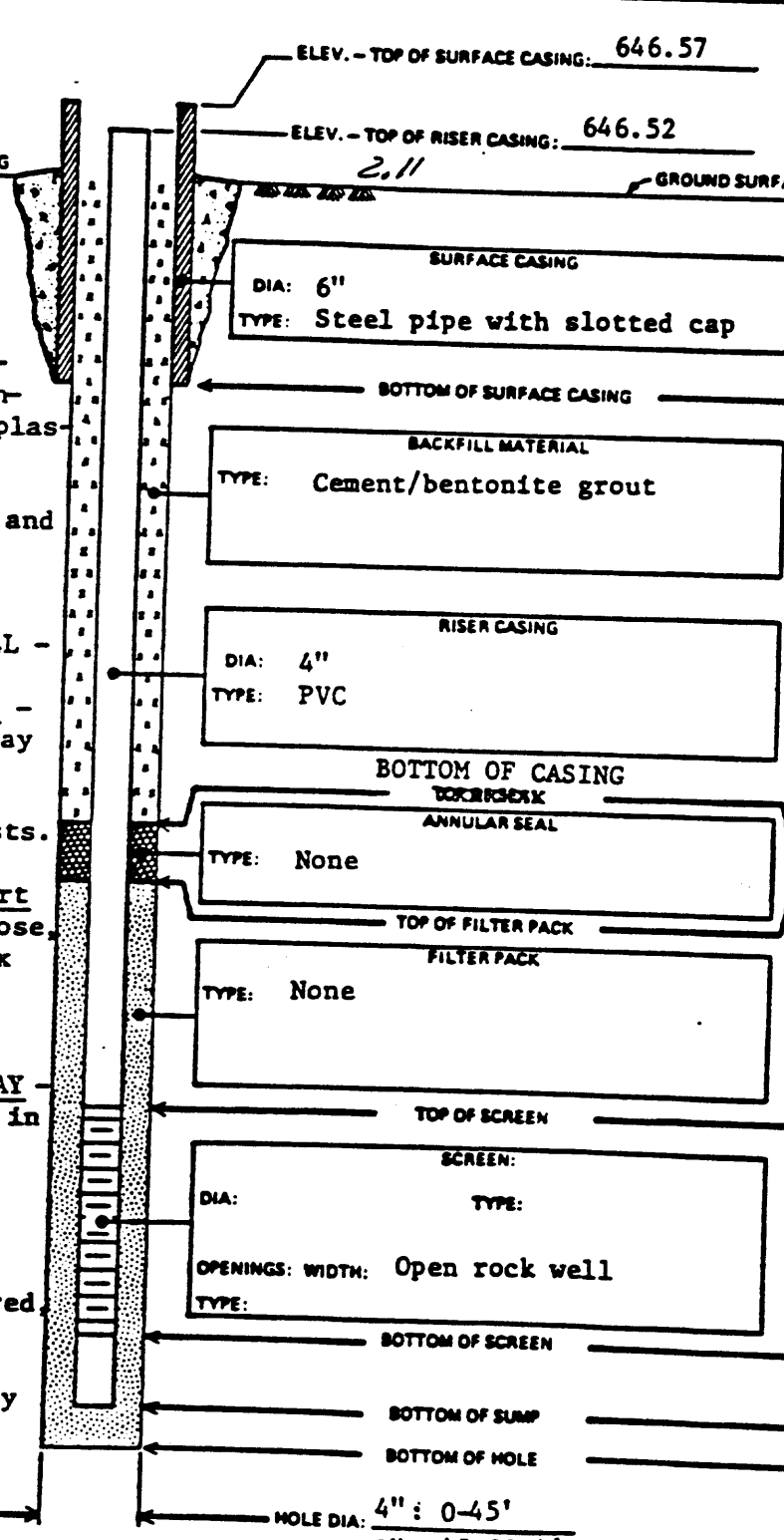
10'-21': Clay Till - gray and orange clay with a few small chert, quartz and granitic rock clasts.

21'-23': Basal Chert Till - grayish, loose, silty, sandy matrix containing large chert clasts.

26'-29.5': CHERTY CLAY - Large chert clasts in a multihued, brown and yellow clay matrix.

29.5'-35': RESIDUAL LIMESTONE - Weathered broken limestone boulders and chert clasts in silty clay matrix.

35'-99.4(BOH): LIMESTONE - Gray, fossiliferous, limestone.



	DEPTH	ELEV.
GROUND SURFACE	0	644.41
BOTTOM OF SURFACE CASING	2.84	641.57
BOTTOM OF CASING / ANNULAR SEAL	45'	599.41
TOP OF FILTER PACK		
TOP OF SCREEN		
BOTTOM OF SCREEN		
BOTTOM OF SUMP		
BOTTOM OF HOLE	99.4	545.01

MW3-3010

GEOLOGIC DRILL LOG

PROJECT: FUSRAP-WELDON SPRING	JOB NO.: 14501	SHEET NO.: 1 OF 3	HOLE NO.: ~~B-33~~	
SITE: DOE PROPERTY-RAFFINATE PIT AREA	COORDINATES: N 98471.52 W 50936.42	ANGLE FROM HORIZ.: 90	BEARING: VERTICAL	
BEGUN: 13 APR 83	COMPLETED: 19 APR. 83	DRILLER: BOYLES BROTHERS	DRILL MAKE AND MODEL: LONGYEAR 44	HOLE SIZE: 3 TO 4'
OVERBURDEN (FT.): 38.0	ROCK (FT.): 52.7	TOTAL DEPTH: 90.7		
CORE RECOVERY (FT/%): 37.9'/99	CORE BOXES: 2	SAMPLES: 0	EL. TOP OF CASING: ~~667.09~~ 666.92	GROUND EL.: 665.09 402
DEPTH/EL. GROUND WATER: 52/613.1(4/19/83)	DEPTH/EL. TOP OF ROCK: 38'/627.09			
SAMPLE HAMMER WEIGHT/FALL: 150 LBS/30 IN.	CASING LEFT IN HOLE: DIA./LENGTH: 4'/52.5	LOGGED BY: E.M.PANELLI		

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
6" ROLLER BIT			No Sampling				665.09 664.09 659.09 655.09	5 10 15 20 25 30			0 cut/fill 0.0'-1.0': TOPSOIL: BLACK-BROWN, ORGANIC-RICH, MOIST TO WET, CLAYEY SILT. 1.0'-6.0': CLAYEY SILT: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAYEY SILT; NON-PLASTIC TO PLASTIC, MODERATELY DENSE WITH DEPTH AND CONTAINS ABUNDANT IRON-OXIDE NODULES. Loess 6.0'-10.0': CLAY: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK YELLOWISH-ORANGE (10YR6/6), CLAY TO SILTY CLAY. THE MATERIAL IS PLASTIC, DENSE, CONTAINS ABUNDANT IRON-OXIDE NODULES, AND HAS SLICKENSIDED SURFACES. Terrace 10.0'-38.0': CLAY TILL: MOTTLED GRAY (N7) AND MODERATE YELLOWISH-BROWN (10YR5/4) OR DARK-YELLOWISH-ORANGE 10YR6/6), SILTY, SANDY, DENSE CLAY THAT CONTAINS A FEW PEBBLES OF SUBROUNDED CHERT, QUARTZITE, AND GRANITIC MATERIAL, WHICH GENERALLY COARSEN TO COBBLE SIZES WITH DEPTH. THE MATERIAL HAS MANGANESE-STAINED SURFACES, CONTAINS IRON AND SECONDARY FRIABLE CALCAREOUS CONCRETIONS, AND SHOWS BLOCKY FRACTURING. 10-36.5	Drilled with 6" roller bit and mud to 52.5'.

SS = SPLIT SPOON; ST = SHELBY TUBE; B = BERNINGHOM; P = PITCHER; O = OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA

HOLE NO.: B-23

MACF 19-1

MW-30D

GEOLOGIC DRILL LOG

PROJECT: FUSRAP-WELDON SPRING | JOB NO.: 14501 | SHEET NO.: 2 OF 3 | HOLE NO.: B-23

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							627.1 628.59	35			36.5'-38': BASAL CHERT TILL: BROWN TO BLACK COBBLE TO BOULDER-SIZED, ANGULAR TO SUBROUNDED CHERT CLASTS IN A LOOSE, SANDY, SILTY, CLAYEY MATRIX. THE CHERT COMMONLY HAS WHITE RINDS.	@36.5' - drilling harder.
								40			38'-90.7': LIMESTONE: FORMATION NAME: BURLINGTON/KEOKUK; AGE: MISSISSIPPIAN; A LIGHT GRAY (N7) TO VERY LIGHT GRAY (N8), FINE- TO COARSE-GRAINED, FOSSILIFEROUS LIMESTONE INTERBEDDED WITH LENSES AND NODULES OF SPECKLED, BANDED, AND MOTTLED LIGHT BLUISH-GRAY (5B7/1) AND BLUISH-WHITE (5B9/1), FOSSILIFEROUS CHERT. THE FORMATION IS IRON-OXIDE STAINED, MODERATE YELLOWISH-ORANGE (10YR6/6) WHERE WEATHERED, AND BECOMES LESS WEATHERED WITH DEPTH. IT IS MANGANESED STAINED AND GENERALLY HARD AND MASSIVE, BUT SHOWS SMALL-SCALE GRADED BEDDING LOCALLY. THE FOSSILS ARE PREDOMINANTLY CRINOIDS, BRYOZOA AND BRACHIOPODS, WHICH ARE LOCALLY REPLACED BY PYRITE. A FEW CALCITE AND QUARTZ CRYSTALS ARE ASSOCIATED WITH VOIDS, ESPECIALLY AT LIMESTONE-CHERT CONTACTS. THE FORMATION CONTAINS ABUNDANT STYLOLITES (PRESSURE SOLUTION FEATURES), WHICH ARE SECONDARY FEATURES THAT ARE PERPENDICULAR TO BEDDING AND INTERSECT FOSSILS. STYLOLITE SUTURES ARE ASSOCIATED WITH A THIN (1/4") BLACKISH-GRAY, CARBONACEOUS, SILTY CLAY, THAT CONTAINS IRON. THE CHERT IS VERY HARD, AND IS (1) BANDED IF PARALLEL TO BEDDING (2) CONCENTRICALLY BANDED IF NODULAR, OR (3) SPECKLED IF FOSSILIFEROUS. THE CHERT IS GENERALLY SPECKLED TOWARDS TOP OF UNIT; SECONDARY CHERT IS OFTEN MIXED WITH FINE-GRAINED LIMESTONE.	@ 38' -drilling harder and steady; 500 psi down pressure; first limey return.
NX Wireline		52.5-57.6'						45				
	5.1	5.0	98									
		57.6-62.5'						50				@ 52.2' - cemented in 4" PVC, began NX coring.
	4.9	4.9	100									
		62.5-67.7'						55				
	5.2	5.0	96									
		67.7-71.7'						60				
	4.0	4.0	100									
		71.7-76.3'						65				
	4.6	4.6	100									
								70				
								75				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: DOE PROPERTY-RAFFINATE PIT AREA | HOLE NO.: B-23

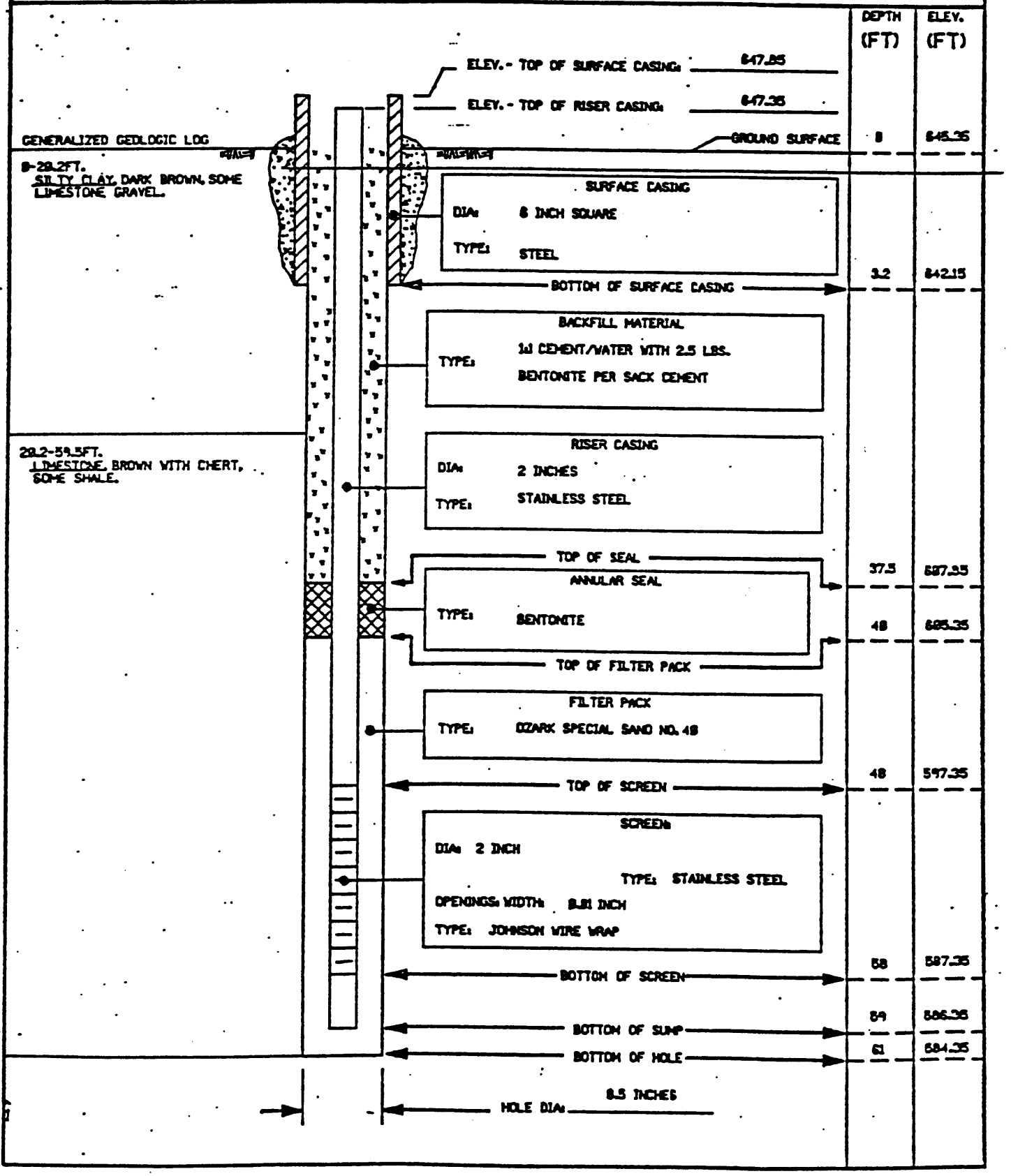
M&CP 19-2

OBSERVATION WELL

PROJECT	WELL NO.
FUSRAP WELDON SPRING	GMW-19

JOB NO.	SITE	COORDINATES
14581	BUSH WILDLIFE	N 98863 W 58161

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
12/8/86	12/9/86	L.R. WEST	TOP OF 2 INCH DIAMETER SS PIPE



FUSRAP - JOB No. 14501

WELDON SPRING GEOLOGIC TRENCH LOGS

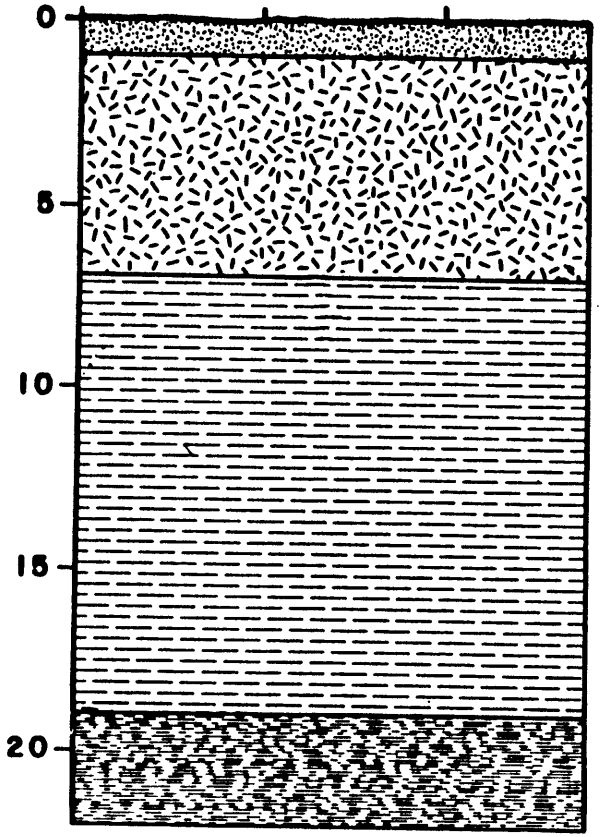
TRENCH: TR-4 **DATE:** 12/15/82 **LENGTH:** 14 FT. **DEPTH:** 22.1 FT. **BEARING:** N10°E

LOGGED BY: E.M. FANELLI

SCALE: 1" = 5', NO VERTICAL EXAGGERATION

LOCATION: 98335.99 N 50922.02 W

DEPTH



0-1': TOPSOIL - Black, organic-rich topsoil; loose, silty, soft, wet and clayey.

1'-7': CLAYEY SILT - Mottled gray (N7) and dark yellowish-orange (10YR6/6), clayey silt, cohesive but crumbly, semi-plastic when pressure is applied; contains some very fine-grained quartz sand that is generally angular; contains some red, weathered iron-oxide nodules.

7'-19': CLAY - Mottled gray (N7) and dark yellowish-orange (10YR6/6), slightly silty clay, contains small amounts of very fine-grained sand; plastic, dense, and has slickensided surfaces; manganese staining on surfaces; small pebble- to coarse sand-sized, red, weathered iron-oxide nodules.

19'-22.1': GLACIAL TILL-CLAY TILL - Mottled gray (N7) and dark yellowish-orange (10YR6/6), clayey, silty matrix, becoming siltier and sandy with depth, containing subrounded to subangular clasts of chert, granitic material and quartz; clasts become more abundant with depth. Material shows blocky fracture and contains some black manganese on surfaces.

FUSRAP - JOB No. 14501

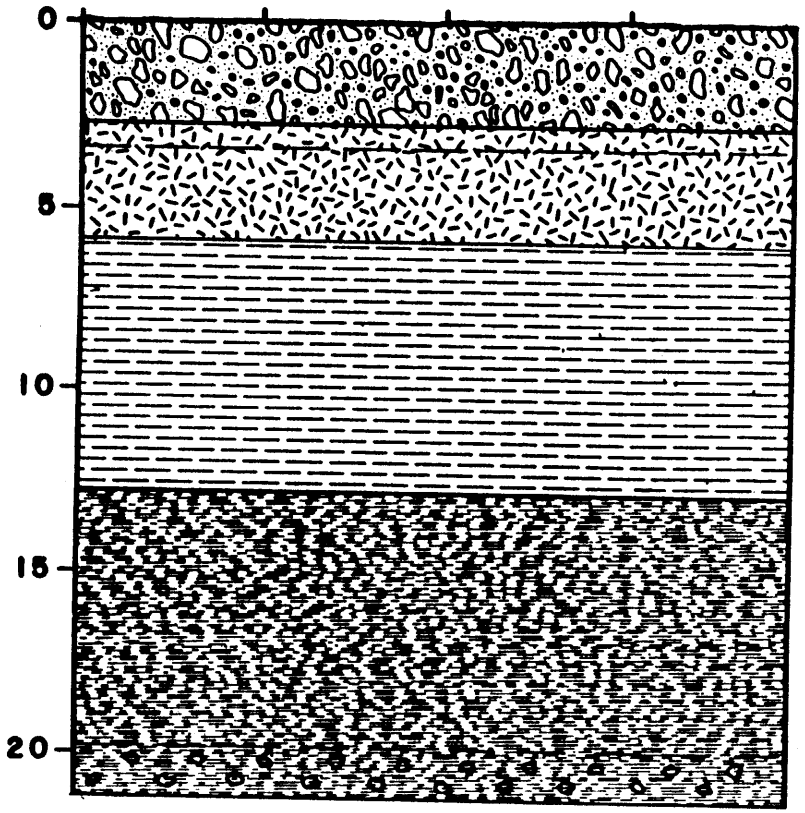
WELDON SPRING GEOLOGIC TRENCH LOGS

TRENCH: TR-6 **DATE:** 12/16/82 **LENGTH:** 19.5 FT. **DEPTH:** 21.1 FT. **BEARING:** N6°E

LOGGED BY: E.M. FANELLI

LOCATION: 98433.51 N 51235.23 W

SCALE: 1" = 5', NO VERTICAL EXAGGERATION



0-2.75': FILL - Large gravel-sized fill material.

2.75'-3.75': CLAYEY SILT - (old soil surface) - Black-brown, organic-rich, clayey and silty, crumbly but plastic if pressure is applied; contains roots.

3.75'-6.0': CLAYEY SILT - Mottled gray (N7) to dark yellowish-orange (10YR6/6) very clayey silt, crumbly but plastic with applied pressure; becomes denser and more plastic with depth. Contains some secondary calcite streaks and concretions, and numerous pea-sized or smaller iron-oxide nodules.

6'-12.8': CLAY - Mottled gray (N7) and dark yellowish-orange (10YR6/6) to mainly gray (N7), massive, very dense clay containing abundant iron-oxide nodules, slight amounts of fine-grained quartz sand, and very slight amounts of secondary calcite, and has slickensided surfaces.

12.8'-21.1': GLACIAL TILL -

@ 12.8'-19.8' - Clay Till - Mottled gray (N7) and dark yellowish-orange (10YR6/6) very dense, clay matrix containing some medium- to fine-grained, subrounded and subspherical quartz, quartzite, granitic, and chert clasts. Matrix becomes sandier and siltier with depth, shows blocky fracture, has manganese-stained and some slickensided surfaces.

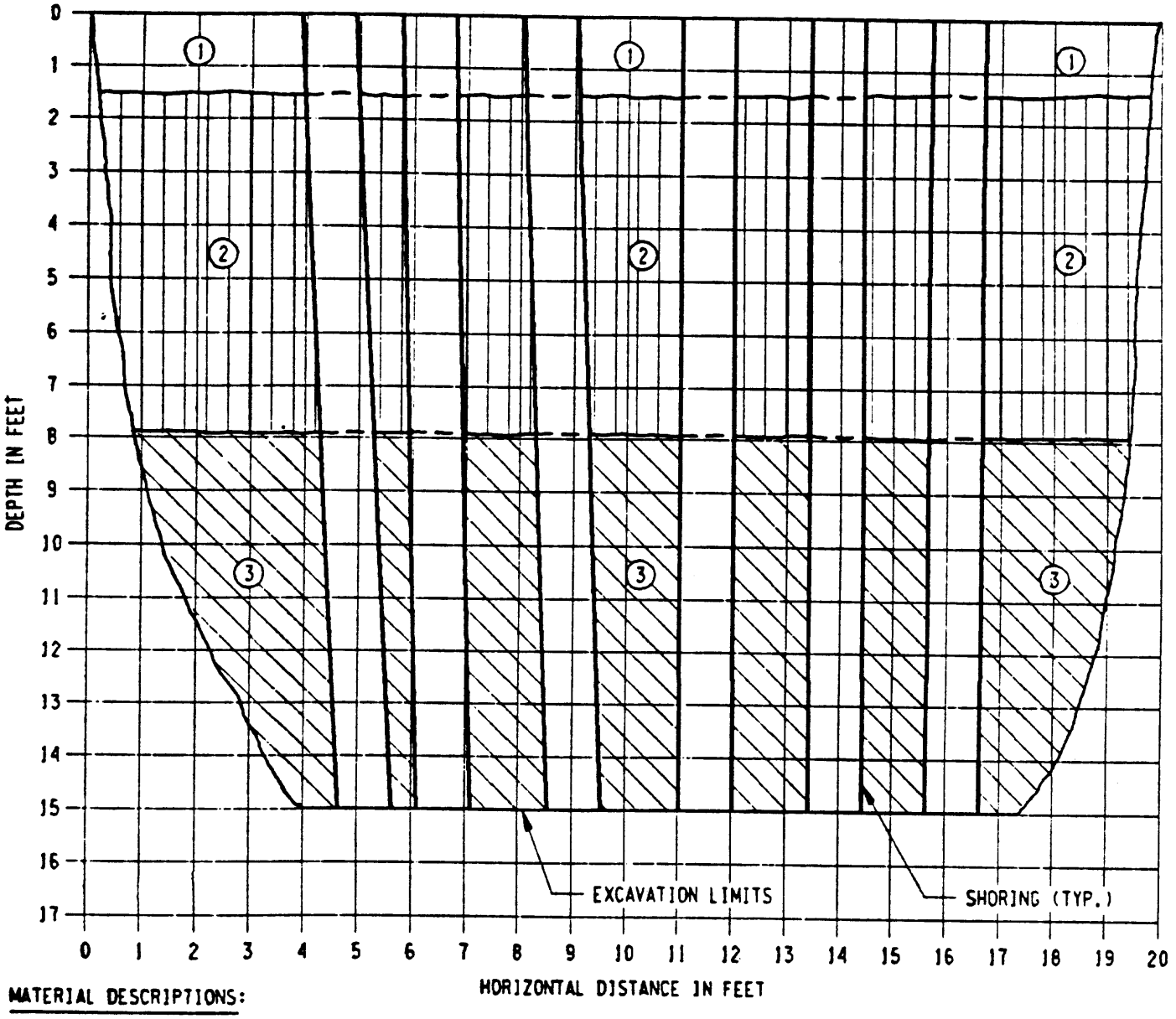
@ 19.8'-21.1' - Basal Chert Till - Abundant chert clasts and some fossiliferous chert. Less matrix, than the clay till, but cohesive if reworked. Becomes siltier and looser with depth; clasts are generally well rounded, spherical to elongate and show weathering rinds.

BECHTEL TRENCH LOG

EXCAVATION NO. T-3

PROJECT WELDON SPRING JOB NO. 14501-201 GROUND EL. 665.8 LOCATION N98,621 W50,844

DATE EXCAVATED 4-29-86 METHOD OF EXCAVATION BACKHOE DATE BACKFILLED 5-1-86



MATERIAL DESCRIPTIONS:

(1) FILL - BROWN, CLAYEY SILT, DRY, SOME SCATTERED GRAVEL.

(2) SILT (LOESS) - MOTTLED GRAY AND YELLOW BROWN, SLIGHTLY CLAYEY (CLAY CONTENT INCREASES WITH DEPTH), SLIGHTLY DAMP, FRIABLE, MANGANESE STAINING, MANY VERY WEATHERED IRON NODULES.

(3) CLAY (FERRELVIEW FORMATION) - MOTTLED MEDIUM GRAY WITH YELLOW BROWN, SLIGHTLY SILTY, DAMP, MODERATELY PLASTIC INCREASING WITH DEPTH, SCATTERED PIECES OF FINE TO MEDIUM SAND AND ANGULAR TO SUBROUNDED CHERT GRAVEL (1/2" - 2"ø). BREAKS CONCOIDALLY. FEW VERY WEATHERED IRON NODULES. MANGANESE STAINING ALONG SOME BREAKS.

SIDE EAST BEARING N20°W EXCAVATOR WEST END CONSTRUCTION CO., INC. GEOLOGIST E. BERGLUND

WSST3.DGN

FUSRAP - JOB No. 14501

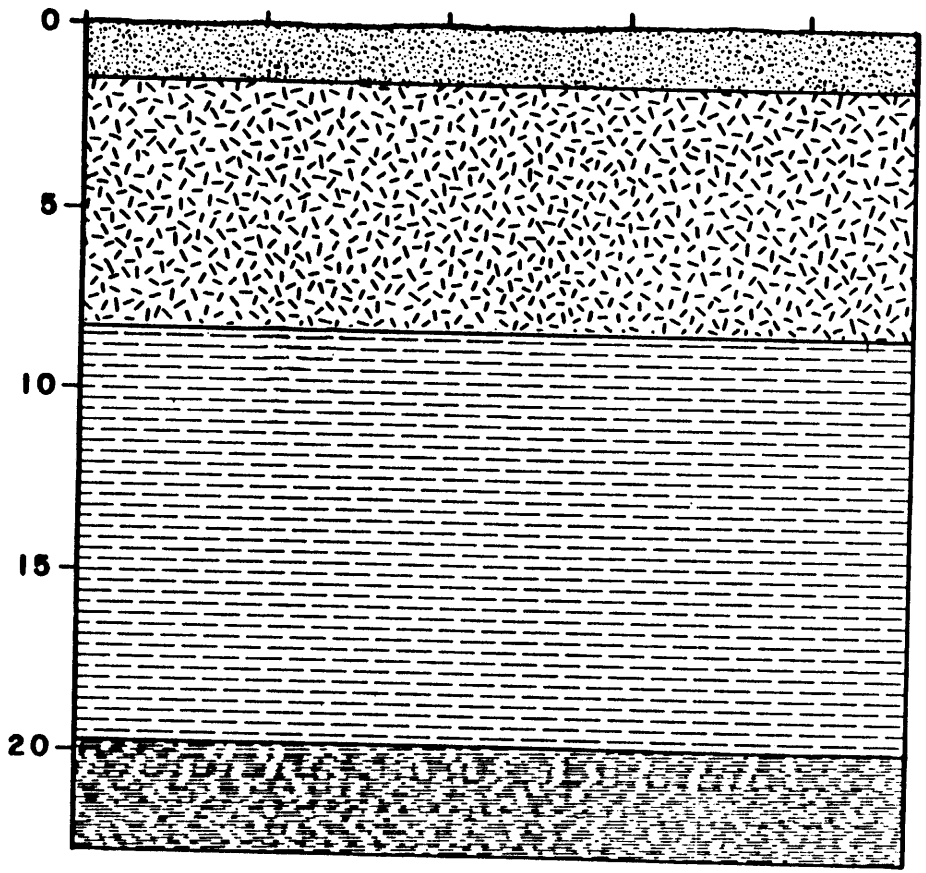
WELDON SPRING GEOLOGIC TRENCH LOGS

TRENCH: TR-5 **DATE:** 12/16/82 **LENGTH:** 23 FT. **DEPTH:** 22.8 FT. **BEARING:** N71°W

LOGGED BY: E.M. FANELLI

SCALE: 1" = 5', NO VERTICAL EXAGGERATION

LOCATION: 98952.51 N 51074.38 W



0-1.5': TOPSOIL - Brown-black, organic-rich, silty, clayey, crumbly, wet, topsoil.

1.5'-8.5': CLAYEY SILT - Mottled gray (N7) and moderate yellow brown (10YR5/4) clayey silt; contains some very fine-grained sand and small pea-sized, red, oxidized iron nodules. Material tends to be crumbly in places but plastic when pressure is applied. Material is very moist.

8.5'-19.8': CLAY - Mottled gray (N7) and moderate yellow brown (10YR5/4), slightly silty, very dense, massive, plastic, clay with very slight amounts of fine-grained, subangular quartz sand, with a few coarse, sand-sized chert clasts and small to pea-size oxidized, red iron nodules.

@ 14.4' - Material has small streaks and concreations (.25") of leached, secondary calcarious material that is continuous throughout the section below.

19.8'-22.8': GLACIAL TILL - Mottled gray (N7) and moderate yellow brown (10YR5/4), clayey, silty fine- to coarse-grained sandy matrix that becomes siltier with depth. Contains subrounded to subangular clasts of chert, quartz and grantic material ranging from pebble- to granule-sized. At 22', the matrix becomes more gray (N7) and less mottled; clasts coarsen and silt and sand content increases with depth; shows blocky fracture and manganese staining on the fracture surfaces.

APPENDIX D

Weldon Spring Feed Materials Plant Biased Sampling Locations - A Series Boreholes

POINT A-#	COORDINATES WEST	NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS*	RATIONALE
Buildings 433, 434, 435, 436, 437, & 438								
29)	50,740	98,250	Drum storage area west of 436	2	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Unknown contents of drum
30)	50,710	98,350	Drum storage area, west and adjacent to 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Unknown contents of drums
31)	50,830	98,410	Drum storage area, west of 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	F,G,H,L	Unknown contents of drums
32)	50,680	98,410	Drum storage area, east and adjacent to 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,G,H,F,L	Unknown contents of drums
33)	50,610	98,370	Drum storage area west of 435	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents of drums
34)	50,570	98,330	Drum storage area west of 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents of drums
52)	50,790	98,300	Transformer substation, west of 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	M	Possible PCBs
69)	50,590	98,210	Fuel storage tank south of 436	5	Composite Samples at 2' intervals 40 10' (0-2, 2-4, 4-6, 6-8, 8-10)	Composite at each interval	F	Underground fuel tanks; PCBs, sulfuric acid, nitric acid, sodium fluoride

WSOW Biased Soil Sampling Locations - C Series Boreholes

Borehole Number	Coordinates West	Coordinates North	Borehole Depth	Number of Samples	Chemical Analysis
TNT Production Line No.4 T-9 Building Area					
49	51,225	98,775	10	5	A, L, O, P
50	51,200	98,800	8	4	" "
51	51,225	98,825	8	4	" "
TNT Production Line No.4 T-10 Building Area					
53	51,334	98,945	10	5	" "
54	51,322	98,950	8	4	" "

Random Sampling Locations

Sample Number D-	Sample Coordinates West	North	Cut or Fill Depth	Borehole Depth	Number of Samples	Composite Intervals		Soil Chemical Analysis
*74	51,450	98,850	2'F	17'	3	"	"	A, B2, C1
79	51,350	99,000	2'F	17'	3	"	"	A, B2, C1
83	51,300	98,790	2'F	17'	3	"	"	A, B2, C1
87	51,040	98,550	0'	15'	2	"	"	A, B1
89	50,950	98,300	0'	15'	2	"	"	A, B1
90	50,500	98,350	0'	15'	2	"	"	A, B1
91	50,800	98,150	0'	15'	2	"	"	A, B1

* Location moved off grid to accessible location
A = 0-1, 2-3, 4-5, 6-7 ANALYZED FOR A, D, F, G, H, L, N, O.
B = 8-9, 10-11, 12-13, 14-15 (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)
C = 16-17, 18-19, 20-21, 22-23 DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)
D = 24-25, 26-27, 28-29, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)
E = 30-31, 32-33, 34-35, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

Key for Soil Chemical Analyses

A = Nitroaromatics group (2,4-DNT; 2,6-DNT; 1,3-DNB; 1,3,5-TNB, and 2,4,6-TNT)

B = Nitrite

C = Sulfate

D = Metals

E = Mercury

F = GC/MS volatile fraction

G = GC/MS acid fraction

H = GC/MS BNA fraction

I = Hexavalent chromium

K = Asbestos

L = Inorganics, SO_4, SO_3, NO_3, NO_2, Fl

M = Pesticides/PCBs

N = TOX

O = Soil pH

P = Select metals - aluminum, antimony, barium, iron, lead, magnesium, manganese

NOTE: See WSSRAP, RI/FS, QAPP for method description, detection limits, and holding times

INORGANIC ANION DATA - PHASE II SOILS

BHOL #	COORDINATES AND DEPTHS	DATE SAMPLED	Fluoride	Nitrate	Nitrite	Sulfate
			DETECTION LIMITS - UG/G			
			1.25	0.5	0.5	5.0
			CONCENTRATIONS - UG/G			
A-29	S2-050740,098250-0.0,0.5	08/25/88	2.50	8.37	ND	50.41
A-29	S2-050740,098250-2.0,2.5	08/25/88	3.01	3.01	ND	215.18
A-29	S2-050740,098250-4.5,5.0	08/25/88	2.50	2.60	ND	
A-29	S2.050740,098250-4.5,5.0	08/25/88				187.00
A-30	S2-050710,098350-0.0,1.0	08/26/88	2.20	3.84	ND	40.5
A-30	S2-050710,098350-2.0,2.5	08/26/88	5.33	ND	ND	112.8
A-30	S2-050710,098350-4.0,5.0	08/26/88	4.28	ND	ND	59.4
A-30	S2-050710,098350-4.0,5.0-DU	08/26/88	5.96	0.85	ND	85.4
A-31	S2-050830,098410-0.0,1.0	08/26/88	1.72	5.37	ND	43.5
A-31	S2-050830,098410-2.0,2.5	08/26/88	3.30	1.76	ND	71.7
A-31	S2-050830,098410-4.5,5.0	08/26/88	8.10	ND	ND	153
A-32	S2-050680,098410-0.0,1.0	08/26/88	2.28	13.36	ND	40.74
A-32	S2-050680,098410-2.0,2.5	08/26/88	4.06	0.78	ND	48.27
A-32	S2-050680,098410-4.5,5.0	08/26/88	11.19	ND	ND	46.00
A-33	S2-050610,098370-0.0,2.0	08/26/88	4.21	ND	ND	80.18
A-33	S2-050610,098370-2.5,3.0	08/26/88	1.26	ND	ND	217.12
A-33	S2-050610,098370-4.5,5.0	08/26/88	8.16	ND	ND	48.59
A-34	S2-050570,098330-0.0,0.5	08/25/88	ND	12.20	ND	8.84
A-34	S2-050570,098330-2.0,2.5	08/25/88	10.86	ND	ND	55.89
A-34	S2-050570,098330-4.5,5.0	08/25/88	2.92	9.47	ND	56.68
A-35	S2-050560,098440-0.0,1.0	08/26/88	5.17	2.53	ND	93.21
A-35	S2-050560,098440-2.0,2.5	08/26/88	2.79	ND	ND	71.87
A-35	S2-050560,098440-4.5,5.0	08/26/88	4.97	ND	ND	180.19
B- 1	S2-044289,104389-0.0,7.0	10/08/88	5.96	5.74	ND	59.64
B- 1	S2-044289,104389-8.0,15.0	10/08/88	3.57	2.38	ND	4.88
B- 2	S2-044195,104655-0.0,7.0	10/08/88	1.56	1.56	ND	12.55
B- 2	S2-044195,104655-8.0,15.0	10/08/88	2.49	24.95	ND	5.90
B- 3	S2-044281,104933-0.0,7.0	10/08/88	2.59	9.93	ND	37.90
B- 3	S2-044281,104933-0.0,7.0-MS	10/08/88	14.40	15.23	10.59	32.37
B- 3	S2-044281,104933-0.0,7.0-MSD	10/08/88	2.04	7.60	ND	18.82
B- 3	S2-044281,104933-8.0,15.0	10/08/88	6.85	ND	ND	11.23
B- 4	S2-044234,105105-0.0,7.0	10/08/88	ND	ND	ND	50.35
B- 4	S2-044234,105105-8.0,15.0	10/08/88	2.76	2.04	ND	ND
B- 5	S2-044561,104951-0.0,7.0	10/08/88	6.32	2.81	ND	41.92
B- 5	S2-044561,104951-0.0,7.0-MS	10/08/88	16.70	15.30	10.16	41.00
B- 5	S2-044561,104951-0.0,7.0-MSD	10/08/88	5.94	5.10	ND	62.67
B- 5	S2-044561,104951-8.0,15.0	10/08/88	6.06	3.50	ND	4.78
B- 6	S2-044510,104529-0.0,7.0	10/08/88	4.32	2.34	ND	13.78
B- 6	S2-044510,104529-8.0,15.0	10/08/88	2.49	1.58	ND	5.88
B- 7	S2-044789,104577-0.0,7.0	10/08/88	3.89	6.25	ND	35.40
B- 7	S2-044789,104577-0.0,7.0-MS	10/08/88	16.61	16.97	10.41	40.01
B- 7	S2-044789,104577-0.0,7.0-MSD	10/08/88	2.31	2.08	ND	30.44
B- 7	S2-044789,104577-8.0,15.0	10/08/88	7.23	1.26	ND	8.84

TEMPSTOR/TXTJOANN

INORGANIC ANION DATA - PHASE II SOILS (continued)

BHOL #	COORDINATES AND DEPTHS	DATE SAMPLED	Fluoride	Nitrate	Nitrite	Sulfate
			DETECTION LIMITS - UG/G			
			1.25	0.5	0.5	5.0
			CONCENTRATIONS - UG/G			
B- 8	S2-044701,105187-0.0,7.0	10/06/88	11.28	0.82	ND	79.98
B- 8	S2-044701,105187-0.0,7.0-DU	10/06/88	13.08	0.99	ND	37.68
B- 8	S2-044701,105187-8.0,15.0	10/06/88	9.43	2.12	ND	6.37
B- 9	S2-044469,105618-0.0,7.0	10/08/88	4.91	4.34	ND	39.36
B- 9	S2-044469,105618-8.0,15.0	10/08/88	4.88	14.05	1.51	9.29
B-10	S2-044261,105997-0.0,7.0	10/08/88	6.73	5.82	ND	29.89
B-10	S2-044261,105997-8.0,15.0	10/08/88	2.70	97.44	ND	6.46
B-11	S2-044289,104901-0.0,7.0	10/08/88	2.72	3.19	ND	32.83
B-11	S2-044289,104901-8.0,15.0	10/08/88	3.50	1.40	ND	7.94
B-12	S2-045023,105290-0.0,7.0	10/06/88	2.69	ND	ND	44.35
B-12	S2-045023,105290-8.0,15.0	10/06/88	6.21	11.37	ND	22.15
B-12	S2-045023,105290-8.0,15.0-MS	10/06/88	17.77	16.95	14.24	57.32
B-12	S2-045023,105290-8.0,15.0-MSD	10/06/88	5.95	5.47	ND	51.88
B-13	S2-044836,105520-0.0,7.0	10/06/88	2.95	15.18	ND	46.68
B-13	S2-044836,105520-0.0,7.0-MS	10/06/88	15.87	17.22	12.33	54.46
B-13	S2-044836,105520-0.0,7.0-MSD	10/06/88	4.53	8.94	ND	55.90
B-13	S2-044836,105520-8.0,15.0	10/06/88	9.12	2.01	ND	8.30
B-13	S2-044836,105520-8.0,15.0-DU	10/06/88	8.81	2.02	ND	9.16
B-14	S2-044670,105980-0.0,7.0	10/06/88	5.31	1.81	ND	115.16
B-14	S2-044670,105980-8.0,15.0	10/06/88	12.67	3.64	ND	7.16
B-14	S2-044670,105980-8.0,15.0-DU	10/06/88	13.37	4.27	ND	7.15
B-15	S2-044321,106293-0.0,7.0	10/06/88	8.88	2.88	ND	77.25
B-15	S2-044321,106293-8.0,15.0	10/06/88	15.35	1.56	ND	14.75
B-15	S2-044321,106293-8.0,15.0-DU	10/06/88	15.34	2.73	ND	17.36
B-16	S2-044143,106675-0.0,7.0	10/06/88	8.47	ND	ND	81.88
B-16	S2-044143,106675-0.0,7.0-DU	10/06/88	7.98	ND	ND	46.76
B-16	S2-044143,106675-8.0,15.0	10/06/88	10.60	ND	ND	38.40
B-17	S2-045353,105253-0.0,7.0	10/06/88	4.01	3.44	ND	46.37
B-17	S2-045353,105253-0.0,7.0-DU	10/06/88	2.29	4.59	ND	33.26
B-17	S2-045353,105253-8.0,15.0	10/06/88	3.20	1.08	ND	ND
B-18	S2-045014,105878-0.0,7.0	10/06/88	5.22	4.65	ND	50.85
B-18	S2-045014,105878-0.0,7.0-DU	10/06/88	4.76	4.76	ND	ND
B-18	S2-045014,105878-8.0,15.0-DU	10/06/88	4.66	5.00	ND	47.14
B-18	S2-045014,105878-8.0,15.0	10/06/88	5.57	5.10	ND	ND
B-19	S2-044836,106310-0.0,7.0	10/06/88	3.40	5.38	ND	48.53
B-19	S2-044836,106310-8.0,15.0	10/06/88	9.45	23.34	ND	14.35
B-20	S2-044524,106625-0.0,7.0	10/06/88	5.03	6.48	ND	119.63
B-20	S2-044524,106625-0.0,7.0-DU	10/06/88	5.00	3.56	ND	61.16
B-20	S2-044524,106625-8.0,15.0	10/06/88	11.31	15.71	ND	21.78
B-21	S2-044327,106997-0.0,7.0	10/06/88	7.21	ND	ND	21.07
B-21	S2-044327,106997-0.0,7.0-DU	10/06/88	6.16	0.75	ND	29.53
B-21	S2-044327,106997-8.0,15.0	10/06/88	15.82	ND	ND	ND
B-22	S2-045515,105614-0.0,7.0	10/06/88	4.75	0.83	ND	27.24

INORGANIC ANION DATA - PHASE II SOILS (continued)

BHOL #	COORDINATES AND DEPTHS	DATE SAMPLED	Fluoride	Nitrate	Nitrite	Sulfate
			DETECTION LIMITS - UG/G			
			1.25	0.5	0.5	5.0
			CONCENTRATIONS - UG/G			
B-22	S2-045515,105614-8.0,15.0	10/06/88	2.16	ND	ND	13.47
B-23	S2-045388,105951-0.0,7.0	10/06/88	2.61	3.06	ND	32.52
B-23	S2-045388,105951-8.0,15.0	10/06/88	2.83	7.54	ND	12.13
B-23	S2-045388,105951-8.0,15.0-MS	10/06/88	14.92	21.87	14.16	14.79
B-23	S2-045388,105951-8.0,15.0-MSD	10/06/88	4.03	8.43	ND	5.13
B-24	S2-045027,106627-0.0,7.0	10/06/88	6.95	2.90	ND	69.08
B-24	S2-045027,106627-8.0,15.0	10/06/88	13.85	3.79	ND	15.63
B-24	S2-045027,106627-8.0,15.0-DU	10/06/88	3.68	3.68	ND	38.31
B-25	S2-044781,107039-0.0,7.0	10/06/88	7.85	5.31	ND	71.32
B-25	S2-044781,107039-8.0,15.0	10/06/88	10.56	80.72	ND	28.73
B-25	S2-044781,107039-8.0,15.0-DU	10/06/88	4.27	66.95	ND	34.90
D-91	S2-050800,098150-8.0,15.0-MSD	08/25/88	5.2	0.9	N	

WSOW METALS RESULTS

BOREHOLE NUMBER	WSSRAP ID	CONCENTRATION UG/G	PARAMETER
C-49	S2-051225,98775-6.0,8.0	34715.88	Aluminum
C-49	S2-051225,98775-8.0,10.0	645.70	BARIUM
C-50	S2-051200,98800-0.0,2.0	6253.50	Magnesium
C-50	S2-051200,98800-0.0,2.0	1469.00	BARIUM
C-50	S2-051200,98800-4.0,6.0	6809.00	Magnesium
C-50	S2-051200,98800-6.0,8.0	33525.36	Aluminum
C-51	S2-051225,98825-0.0,2.0	254.15	LEAD
C-51	S2-051225,98825-4.0,6.0	1560.34	BARIUM
C-54	S2-051322,98950-2.0,4.0	544.18	BARIUM

TEMPSTOR/TXTJOANN

WSUFMP METALS RESULTS

BOREHOLE NUMBER	WSSRAP ID	CONCENTRATION UG/G	PARAMETER
A-30	S2-050710,098350-0.0,1.0	10118.25	Magnesium
A-30	S2-050710,098350-0.0,1.0	73559.30	CALCIUM
A-30	S2-050710,098350-2.0,2.5	2058.70	POTASSIUM
A-30	S2-050710,098350-2.0,2.5	61.99	VANADIUM
A-30	S2-050710,098350-4.0,5.0	94.80	ARSENIC
A-30	S2-050710,098350-4.0,5.0	0.17	MERCURY
A-30	S2-050710,098350-4.0,5.0	2123.14	POTASSIUM
A-30	S2-050710,098350-4.0,5.0	62.25	VANADIUM
A-32	S2-050680,098410-0.0,1.0	64854.00	CALCIUM
A-32	S2-050680,098410-0.0,1.0	8190.72	Magnesium
A-32	S2-050680,098410-2.0,2.5	34410.24	Aluminum
A-32	S2-050680,098410-2.0,2.5	68.14	VANADIUM
A-32	S2-050680,098410-2.0,2.5	2474.47	POTASSIUM
A-32	S2-050680,098410-4.5,5.0	1978.18	POTASSIUM
A-33	S2-050610,098370-0.0,2.0	0.33	MERCURY
A-33	S2-050610,098370-0.0,2.0	61541.92	CALCIUM
A-33	S2-050610,098370-2.5,3.0	1792.47	POTASSIUM
A-35	S2-050560,098440-0.0,1.0	14542.36	CALCIUM
A-35	S2-050560,098440-0.0,1.0	63.24	ARSENIC
A-35	S2-050560,098440-0.0,1.0	0.19	MERCURY
A-35	S2-050560,098440-2.0,2.5	0.28	MERCURY
A-35	S2-050560,098440-4.5,5.0	0.31	MERCURY

TEMPSTOR/TXTJOANN

RANDOM BOREHOLE METALS RESULTS

BOREHOLE NUMBER	WSSRAP ID	CONC. UG/G	PARAMETER
D-74	S2-051450,098850-0.0,7.0	34295.30	Aluminum
D-74	S2-051450,098850-0.0,7.0	0.39	MERCURY
D-74	S2-051450,098850-8.0,15.0	35.17	ARSENIC
D-74	S2-051450,098850-8.0,15.0	33554.60	Aluminum
D-74	S2-051450,098850-8.0,15.0	0.41	MERCURY
D-83	S2-051300,098790-0.0,7.0	47.60	CADMIUM
D-83	S2-051300,098790-0.0,7.0	2571.03	SODIUM
D-83	S2-051300,098790-0.0,7.0	70.84	COBALT
D-83	S2-051300,098790-0.0,7.0	0.20	MERCURY
D-83	S2-051300,098790-8.0,15.0	0.12	MERCURY
D-83	S2-051300,098790-8.0,15.0	61.03	ARSENIC
D-83	S2-051300,098790-8.0,15.0	5042.69	CADMIUM
D-91	S2-050800,098150-0.0,7.0	0.20	MERCURY
D-91	S2-050800,098150-0.0,7.0	14970.25	CALCIUM

APPENDIX E

Weldon Spring Radionuclide Data

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 8					
275	98828.0	51494.0	0.00	1.00	MML252	0.70	----	----	1.20
275	98828.0	51494.0	1.00	2.00	MML253	0.30	----	----	1.10
275	98828.0	51494.0	2.00	3.00	MML254	0.30	----	----	0.60
275	98828.0	51494.0	3.00	4.00	MML255	<0.30	----	----	0.90
275	98828.0	51494.0	4.00	5.00	MML256	<0.30	----	----	1.20
275	98828.0	51494.0	5.00	6.00	MHN879	<0.30	----	----	----
275	98828.0	51494.0	5.00	6.00	MML257	0.30	----	----	----
275	98828.0	51494.0	6.00	7.00	MML258	0.30	----	----	----
275	98828.0	51494.0	7.00	8.00	MML259	<0.30	----	----	----
275	98828.0	51494.0	29.00	30.00	MML281	----	----	----	0.70
279	98951.0	51412.0	0.00	1.00	MNC630	----	----	----	1.30
279	98951.0	51412.0	1.00	2.00	MNC631	----	----	----	1.10
286	99083.0	52129.0	2.00	3.00	MNE885	----	----	----	1.50
286	99083.0	52129.0	21.00	21.83	MNE904	----	----	----	0.80
289	98778.0	51899.0	0.00	1.00	MNE950	0.70	----	----	0.70
289	98778.0	51899.0	23.00	24.00	MNE973	<0.30	----	----	0.40
291	99193.0	52131.0	5.00	6.00	MNC939	----	----	----	1.10
291	99193.0	52131.0	9.00	10.00	MNC943	----	----	----	0.80
291	99193.0	52131.0	12.00	13.00	MHN777	0.70	----	----	1.10
291	99193.0	52131.0	23.00	23.83	MNC957	<0.30	----	----	0.60
297	99288.0	52168.0	2.00	3.00	MHN877	----	----	----	2.50
297	99288.0	52168.0	2.00	3.00	MNE611	----	----	----	2.60
297	99288.0	52168.0	3.00	4.00	MNE612	----	----	----	3.10
369	98100.0	51095.0	0.00	1.00	MNB057	----	----	----	0.40
369	98100.0	51095.0	1.00	2.00	MNB057	----	----	----	0.60
369	98100.0	51095.0	2.00	3.00	MNB057	----	----	----	1.20
369	98100.0	51095.0	3.00	4.00	MNB057	----	----	----	1.40
369	98100.0	51095.0	3.00	4.00	MNB057	----	----	----	1.20
369	98100.0	51095.0	4.00	5.00	MNB057	----	----	----	1.90
370	98000.0	50900.0	0.00	1.00	MNB037	----	----	----	2.40
370	98000.0	50900.0	1.00	2.00	MNB038	----	----	----	1.30
370	98000.0	50900.0	2.00	3.00	MNB039	----	----	----	1.50
370	98000.0	50900.0	3.00	4.00	MNB040	----	----	----	1.20
370	98000.0	50900.0	4.00	5.00	MNB041	----	----	----	1.30
371	98100.0	50900.0	0.00	1.00	MNB047	----	----	----	0.90
371	98100.0	50900.0	1.00	2.00	MNB048	----	----	----	1.70
371	98100.0	50900.0	2.00	3.00	MNB049	----	----	----	0.80

Weldon Spring Radionuclide Data (Continued)

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 8					
371	98100.0	50900.0	3.00	4.00	MNB050	----	----	----	1.40
371	98100.0	50900.0	4.00	5.00	MNB051	----	----	----	1.30
372	98100.0	50800.0	0.00	1.00	MNB042	----	----	----	1.80
372	98100.0	50800.0	1.00	2.00	MNB043	----	----	----	1.20
372	98100.0	50800.0	2.00	3.00	MNB044	----	----	----	1.30
372	98100.0	50800.0	3.00	4.00	MNB045	----	----	----	1.10
372	98100.0	50800.0	4.00	5.00	MHN701	----	----	----	1.10
372	98100.0	50800.0	4.00	5.00	MNB046	----	----	----	1.20
373	98200.0	51000.0	0.00	1.00	MNB052	----	----	----	1.70
373	98200.0	51000.0	1.00	2.00	MNB053	----	----	----	2.10
373	98200.0	51000.0	2.00	3.00	MNB054	----	----	----	1.10
373	98200.0	51000.0	3.00	4.00	MNB055	----	----	----	1.20
373	98200.0	51000.0	4.00	5.00	MHN702	----	----	----	1.10
373	98200.0	51000.0	4.00	5.00	MNB056	----	----	----	1.40
374	98300.0	51100.0	0.00	1.00	MNB063	----	----	----	1.10
374	98300.0	51100.0	1.00	2.00	MNB064	----	----	----	1.20
374	98300.0	51100.0	2.00	3.00	MNB065	----	----	----	1.20
374	98300.0	51100.0	3.00	4.00	MHN703	----	----	----	1.10
374	98300.0	51100.0	3.00	4.00	MNB066	----	----	----	1.20
374	98300.0	51100.0	4.00	5.00	MNB067	----	----	----	1.00
377	98400.0	51200.0	0.00	1.00	MNB068	----	----	----	1.10
377	98400.0	51200.0	1.00	2.00	MNB069	----	----	----	1.10
377	98400.0	51200.0	2.00	3.00	MNB070	----	----	----	1.20
377	98400.0	51200.0	3.00	4.00	MNB071	----	----	----	1.10
377	98400.0	51200.0	4.00	5.00	MNB072	----	----	----	1.30
379	98510.0	51300.0	0.00	1.00	MNB087	----	----	----	1.50
379	98510.0	51300.0	1.00	2.00	MNB088	----	----	----	1.60
379	98510.0	51300.0	2.00	3.00	MNB089	----	----	----	1.70
379	98510.0	51300.0	3.00	4.00	MNB090	----	----	----	1.40
379	98510.0	51300.0	4.00	5.00	MNB091	----	----	----	1.10
380	98500.0	51100.0	0.00	1.00	MNB073	----	----	----	0.90
380	98500.0	51100.0	1.00	2.00	MNB074	----	----	----	1.20
380	98500.0	51100.0	2.00	3.00	MNB075	----	----	----	1.10
380	98500.0	51100.0	3.00	4.00	MHN704	----	----	----	1.10
380	98500.0	51100.0	3.00	4.00	MNB076	----	----	----	1.50
380	98500.0	51100.0	4.00	5.00	MNB077	----	----	----	1.50
383	98600.0	51600.0	0.00	1.00	MNB092	----	----	----	0.70
383	98600.0	51600.0	1.00	2.00	MNB093	----	----	----	0.70
383	98600.0	51600.0	2.00	3.00	MNB094	----	----	----	1.20

Weldon Spring Radionuclide Data (Continued)

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 8					
383	98600.0	51600.0	3.00	4.00	MNB095	----	----	----	1.20
383	98600.0	51600.0	4.00	5.00	MHN706	----	----	----	1.10
383	98600.0	51600.0	4.00	5.00	MNB096	----	----	----	1.00
384	98600.0	50900.0	0.00	1.00	MNB102	----	----	----	1.10
384	98600.0	50900.0	1.00	2.00	MNB103	----	----	----	1.50
384	98600.0	50900.0	2.00	3.00	MNB104	----	----	----	1.60
384	98600.0	50900.0	3.00	4.00	MNB105	----	----	----	1.10
384	98600.0	50900.0	4.00	5.00	MHN707	----	----	----	1.30
384	98600.0	50900.0	4.00	5.00	MNB106	----	----	----	1.00
385	98700.0	52000.0	0.00	1.00	MNB097	----	----	----	1.00
385	98700.0	52000.0	1.00	2.00	MNB098	----	----	----	1.60
385	98700.0	52000.0	2.00	3.00	MNB099	----	----	----	1.10
385	98700.0	52000.0	3.00	4.00	MNB100	----	----	----	0.90
385	98700.0	52000.0	4.00	5.00	MNB101	----	----	----	1.50
386	98700.0	51200.0	0.00	1.00	MNB078	----	0.70	1.10	1.60
386	98700.0	51200.0	1.00	2.00	MNB079	----	0.60	0.80	1.10
386	98700.0	51200.0	2.00	3.00	MNB080	----	0.90	0.80	1.90
386	98700.0	51200.0	3.00	4.00	MNB081	----	0.70	0.80	1.20
386	98700.0	51200.0	4.00	5.00	MNB082	----	1.00	0.90	1.40
386	98700.0	51200.0	5.00	6.00	MNB083	----	1.00	1.00	1.30
386	98700.0	51200.0	6.00	7.00	MNB084	----	0.90	2.00	1.30
386	98700.0	51200.0	7.00	8.00	MNB085	----	1.00	1.20	1.10
386	98700.0	51200.0	9.00	10.00	MHN705	----	----	----	1.20
386	98700.0	51200.0	9.00	10.00	MNB086	----	0.90	0.70	0.90
600	98000.0	50950.0	0.00	0.50	WSC172	15.30	1.60	1.50	----
601	98000.0	50900.0	0.00	1.00	UNC319	11.40	0.80	1.20	----
601	98000.0	50900.0	0.00	0.50	WSC159	22.40	1.60	1.70	----
601	98000.0	50900.0	0.00	1.00	WSC169	<5.70	1.70	<1.30	----
601	98000.0	50900.0	1.00	2.00	UNC320	<2.80	1.20	<0.50	----
601	98000.0	50900.0	2.00	3.00	UNC321	<2.60	1.00	1.20	----
601	98000.0	50900.0	3.00	4.00	UNC322	<2.40	1.10	1.00	----
601	98000.0	50900.0	4.00	5.00	UNC323	<2.50	0.70	0.90	----
602	98000.0	50800.0	0.00	0.50	WSC158	2.30	1.70	1.30	----
603	98050.0	50775.0	0.00	0.50	WSC197	13.30	0.70	1.40	----
604	98100.0	51100.0	0.00	1.00	UNC339	0.20	0.20	0.20	----
604	98100.0	51100.0	1.00	2.00	UNC339	1.20	0.30	0.10	----
604	98100.0	51100.0	2.00	3.00	UNC339	2.50	1.00	0.70	----
604	98100.0	51100.0	3.00	4.00	UNC339	2.40	0.70	0.80	----

Weldon Spring Radionuclide Data (Continued)

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 8					
604	98100.0	51100.0	4.00	5.00	UNC339	2.40	1.10	0.50	----
604	98100.0	51100.0	5.00	6.00	UNC339	2.30	0.90	0.60	----
605	98100.0	51000.0	0.00	0.50	WSC173	26.40	1.70	1.40	----
606	98100.0	50950.0	0.00	0.50	WSC207	231.70	3.80	2.60	----
607	98100.0	50900.0	0.00	1.00	UNC329	12.00	0.80	1.00	----
607	98100.0	50900.0	0.00	0.50	WSC161	20.10	1.50	1.40	----
607	98100.0	50900.0	1.00	2.00	UNC330	<3.20	1.10	1.50	----
607	98100.0	50900.0	2.00	3.00	UNC331	<3.00	1.10	1.10	----
607	98100.0	50900.0	3.00	4.00	UNC332	<2.60	0.70	<0.50	----
607	98100.0	50900.0	4.00	5.00	UNC328	<2.50	0.90	<0.40	----
607	98100.0	50900.0	4.00	5.00	UNC333	<3.00	0.90	1.30	----
*608	98100.0	50800.0	0.00	1.00	UNC324	<2.70	1.20	1.20	----
608	98100.0	50800.0	0.00	0.50	WSC160	2.30	2.00	1.60	----
*608	98100.0	50800.0	1.00	2.00	UNC325	<2.80	1.10	1.40	----
*608	98100.0	50800.0	2.00	3.00	UNC326	<2.50	1.00	1.30	----
*608	98100.0	50800.0	3.00	4.00	UNC327	<2.60	0.70	0.80	----
609	98100.0	50750.0	0.00	0.50	WSC171	1.60	1.40	1.70	----
611	98150.0	51050.0	0.00	0.50	WSC175	20.90	1.50	2.10	----
612	98150.0	51000.0	0.00	0.50	WSC198	146.90	2.80	4.70	----
612	98150.0	51000.0	0.50	1.00	WSC199	41.00	1.80	1.50	----
612	98150.0	51000.0	1.00	1.50	WSC200	9.40	1.80	1.60	----
612	98150.0	51000.0	1.50	2.00	WSC201	2.40	1.70	1.50	----
613	98150.0	50999.0	0.00	0.50	WSC208	171.20	5.80	5.10	----
614	98150.0	50800.0	0.00	0.50	WSC174	<1.60	1.40	0.70	----
615	98200.0	51000.0	0.00	0.50	WSC164	49.40	1.70	1.40	----
615	98200.0	51000.0	0.00	1.00	WSC170	7.70	1.50	1.40	----
616	98200.0	50900.0	0.00	1.00	UNC334	43.60	1.10	1.00	----
616	98200.0	50900.0	0.00	0.50	WSC163	<10.00	1.60	1.50	----
616	98200.0	50900.0	1.00	2.00	UNC335	2.60	<0.40	0.80	----
616	98200.0	50900.0	2.00	3.00	UNC336	<3.70	0.90	1.10	----
616	98200.0	50900.0	3.00	4.00	UNC337	<2.60	1.10	1.10	----
616	98200.0	50900.0	4.00	5.00	UNC338	11.10	1.00	1.40	----
617	98250.0	51155.0	0.00	0.50	WSC202	326.70	1.30	1.10	----
617	98250.0	51155.0	0.50	1.00	WSC203	129.00	1.50	<1.70	----

Weldon Spring Radionuclide Data (Continued)

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 8					
617	98250.0	51155.0	1.00	1.50	WSC204	28.50	1.60	1.40	----
617	98250.0	51155.0	1.50	2.00	WSC205	4.40	1.70	1.60	----
617	98250.0	51155.0	2.00	2.50	WSC206	<1.80	1.60	1.30	----
618	98250.0	50850.0	0.00	0.50	WSC162	9.40	1.70	1.60	----
619	98300.0	51100.0	0.00	1.00	UNC345	<2.10	0.70	0.90	----
619	98300.0	51100.0	0.00	0.50	WSC168	<3.90	1.30	<0.80	----
619	98300.0	51100.0	1.00	2.00	UNC346	<2.40	1.10	0.50	----
619	98300.0	51100.0	2.00	3.00	UNC347	<2.60	0.90	0.70	----
619	98300.0	51100.0	3.00	4.00	UNC348	<2.80	1.00	1.10	----
619	98300.0	51100.0	4.00	5.00	UNC349	<2.70	0.90	0.80	----
620	98300.0	51000.0	0.00	0.50	WSC166	12.70	2.10	2.00	----
621	98300.0	50900.0	0.00	0.50	WSC165	<4.90	1.50	1.30	----
623	98345.0	51152.0	0.00	0.50	WSC189	2259.30	<2.00	<0.70	----
623	98345.0	51152.0	0.50	1.00	WSC190	302.90	1.10	<0.70	----
623	98345.0	51152.0	1.00	1.50	WSC191	122.00	1.70	1.70	----
623	98345.0	51152.0	1.50	2.00	WSC192	25.70	1.40	1.50	----
623	98345.0	51152.0	2.00	2.50	WSC193	9.60	1.70	1.40	----
623	98345.0	51152.0	2.50	3.00	WSC194	35.40	1.70	0.70	----
623	98345.0	51152.0	3.00	3.50	WSC195	69.90	1.20	1.30	----
623	98345.0	51152.0	3.50	4.00	WSC196	35.70	1.90	<1.10	----
624	98370.0	51210.0	0.00	0.50	WSC186	61.10	<1.90	<2.10	----
624	98370.0	51210.0	0.50	1.00	WSC187	19.70	1.60	1.50	----
624	98370.0	51210.0	1.00	1.50	WSC188	8.50	1.80	1.60	----
625	98400.0	51200.0	0.00	1.00	UNC350	15.40	0.90	<0.60	----
625	98400.0	51200.0	0.00	0.50	WSC182	29.20	1.70	2.50	----
625	98400.0	51200.0	1.00	2.00	UNC351	<3.10	1.30	1.00	----
625	98400.0	51200.0	2.00	3.00	UNC352	<3.50	0.90	0.40	----
625	98400.0	51200.0	3.00	4.00	UNC353	<3.00	0.80	0.90	----
625	98400.0	51200.0	4.00	5.00	UNC354	<3.00	1.20	1.20	----
626	98400.0	51150.0	0.00	0.50	WSC177	<1.80	1.20	<0.80	----
627	98400.0	51100.0	0.00	0.50	WSC176	<3.70	1.30	0.60	----
628	98400.0	51050.0	0.00	0.50	WSC183	<5.10	1.70	<0.80	----
629	98400.0	50900.0	0.00	0.50	WSC167	<6.50	<1.70	1.30	----
630	98450.0	51050.0	0.00	0.50	WSC180	7.70	1.50	1.50	----

Weldon Spring Radionuclide Data (Continued)

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 8					
632	98500.0	51300.0	0.00	1.00	UNC369	<2.00	0.60	0.40	----
632	98500.0	51300.0	1.00	2.00	UNC370	<2.30	1.00	0.40	----
632	98500.0	51300.0	2.00	3.00	UNC371	<2.40	1.10	0.60	----
632	98500.0	51300.0	4.00	5.00	UNC373	<2.20	1.00	0.80	----
633	98500.0	51100.0	0.00	1.00	UNC355	<2.50	1.00	0.70	----
633	98500.0	51100.0	1.00	2.00	UNC356	<2.60	0.90	<0.40	----
633	98500.0	51100.0	2.00	3.00	UNC357	<3.10	1.20	1.30	----
633	98500.0	51100.0	3.00	4.00	UNC358	<3.10	1.00	<0.60	----
633	98500.0	51100.0	4.00	5.00	UNC359	<3.10	1.10	<0.60	----
634	98600.0	51600.0	0.00	1.00	UNC374	<2.60	0.90	1.10	----
634	98600.0	51600.0	1.00	2.00	UNC375	<2.70	1.10	1.00	----
634	98600.0	51600.0	2.00	3.00	UNC376	<2.80	1.00	1.10	----
634	98600.0	51600.0	3.00	4.00	UNC377	<2.40	0.80	0.70	----
634	98600.0	51600.0	4.00	5.00	UNC378	<2.50	0.80	0.80	----
635	98600.0	51025.0	0.00	0.50	WSC185	256.65	2.10	<1.60	----
636	98650.0	51250.0	0.00	0.50	WSC184	<2.60	1.60	1.50	----
637	98650.0	51200.0	0.00	0.50	WSC178	<1.70	1.10	0.70	----
638	98650.0	51150.0	0.00	0.50	WSC179	<4.10	1.40	<1.30	----
639	98650.0	51100.0	0.00	0.50	WSC181	<4.50	1.20	<1.00	----
642	98700.0	51200.0	0.00	1.00	UNC360	<2.30	0.70	1.10	----
642	98700.0	51200.0	1.00	2.00	UNC361	<2.20	0.60	0.80	----
642	98700.0	51200.0	2.00	3.00	UNC362	<2.40	0.90	0.80	----
642	98700.0	51200.0	3.00	4.00	UNC363	<2.20	0.70	0.80	----
642	98700.0	51200.0	4.00	5.00	UNC364	<2.40	1.00	0.90	----
642	98700.0	51200.0	5.00	6.00	UNC365	<2.20	1.00	1.00	----
642	98700.0	51200.0	6.00	7.00	UNC366	<4.50	1.50	2.00	----
642	98700.0	51200.0	7.00	8.00	UNC367	<2.20	1.00	1.20	----
642	98700.0	51200.0	8.00	9.00	UNC368	<2.30	0.90	0.70	----
				REGION 9					
266	98690.0	50700.0	0.00	1.00	MNC335	----	----	----	1.50
266	98690.0	50700.0	1.00	2.00	MNC336	----	----	----	1.00
267	98714.0	50837.0	0.00	1.00	MML284	----	----	----	8.90
267	98714.0	50837.0	19.00	20.00	MML303	----	----	----	0.90

Weldon Spring Radionuclide Data (Continued)

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 9					
268	98709.0	50621.0	0.00	1.00	MNC330	----	----	----	3.90
268	98709.0	50621.0	1.00	2.00	MNC331	----	----	----	1.00
272	98790.0	50924.0	0.00	1.00	MNC285	----	----	----	1.30
272	98790.0	50924.0	1.00	2.00	MNC286	----	----	----	1.20
277	98900.0	50925.0	0.00	1.00	MNC280	----	----	----	2.30
277	98900.0	50925.0	1.00	2.00	MNC281	----	----	----	1.00
281	99000.0	50925.0	0.00	1.00	MNC275	----	----	----	1.70
281	99000.0	50925.0	1.00	2.00	MHN779	----	----	----	1.10
281	99000.0	50925.0	1.00	2.00	MNC276	----	----	----	1.60
375	98300.0	50789.0	0.00	1.00	MNB112	----	----	----	2.20
375	98300.0	50789.0	1.00	2.00	MNB113	----	----	----	1.30
375	98300.0	50789.0	2.00	3.00	MNB114	----	----	----	1.50
375	98300.0	50789.0	3.00	4.00	MNB115	----	----	----	1.40
375	98300.0	50789.0	4.00	5.00	MHN708	----	----	----	1.40
375	98300.0	50789.0	4.00	5.00	MNB116	----	----	----	1.10
376	98290.0	50700.0	0.00	1.00	MNB117	----	----	----	0.90
376	98290.0	50700.0	1.00	2.00	MNB118	----	----	----	1.30
376	98290.0	50700.0	2.00	3.00	MNB119	----	----	----	1.30
376	98290.0	50700.0	4.00	5.00	MNB120	----	----	----	1.30
376	98290.0	50700.0	5.00	6.00	MNB121	----	----	----	1.00
376	98290.0	50700.0	6.00	7.00	MNB127	----	----	----	1.50
376	98290.0	50700.0	7.00	8.00	MNB128	----	----	----	1.30
378	98400.0	50300.0	0.00	1.00	MNB129	2.30	----	----	----
378	98400.0	50300.0	1.00	2.00	MNB130	1.00	----	----	----
378	98400.0	50300.0	2.00	3.00	MNB131	1.00	----	----	----
378	98400.0	50300.0	3.00	4.00	MNB132	0.70	----	----	----
378	98400.0	50300.0	4.00	5.00	MNB133	0.70	----	----	----
381	98500.0	50800.0	0.00	1.00	MNB107	----	----	----	0.80
381	98500.0	50800.0	1.00	2.00	MNB108	----	----	----	0.50
381	98500.0	50800.0	2.00	3.00	MNB109	----	----	----	1.30
381	98500.0	50800.0	3.00	4.00	MNB110	----	----	----	1.30
381	98500.0	50800.0	4.00	5.00	MNB111	----	----	----	1.20
382	98500.0	50600.0	0.00	1.00	MNB122	----	----	----	0.90
382	98500.0	50600.0	1.00	2.00	MNB123	----	----	----	0.70
382	98500.0	50600.0	2.00	3.00	MNB124	----	----	----	1.30
382	98500.0	50600.0	3.00	4.00	MNB125	----	----	----	1.40
382	98500.0	50600.0	4.00	5.00	MHN709	----	----	----	1.30
382	98500.0	50600.0	4.00	5.00	MNB126	----	----	----	1.30

Weldon Spring Radionuclide Data (Continued)

Borehole No.	Northing	Westing	Top Depth	Bottom Depth	Sample #	U-238	RA-226	RA-228	TH-230
				REGION 9					
622	98300.0	50800.0	0.00	1.00	UNC379	10.00	1.00	0.60	----
622	98300.0	50800.0	1.00	2.00	UNC380	<2.60	0.90	1.10	----
622	98300.0	50800.0	2.00	3.00	UNC381	<3.20	1.20	1.40	----
622	98300.0	50800.0	3.00	4.00	UNC382	<3.30	0.80	0.60	----
622	98300.0	50800.0	4.00	5.00	UNC383	<3.20	1.10	0.50	----

APPENDIX F

TABLE F-1 Bulk Sample Analysis for Asbestos Content

Building 435

SAMPLE NO.	DESCRIPTION	CONTENT (APPROXIMATE PERCENTAGE) ASBESTOS	NON-ASBESTOS FIBERS	NON-FIBROUS MATERIAL
BA-2040-112988	Fiberboard	Not detected: <1%	Cellulose: 50-75%	Remainder

TABLE F-2 Bulk and Swipe Sample Analysis for PCB Content

Building 435

SAMPLE NO.	LOCATION DESIGNATION	DESCRIPTION	LOCATION	DATE OF SAMPLE	TYPE OF SAMPLE	PCB CONTAMINATION
OT-2158-0687	2158	Cement floor	Electrician shop	06/26/87	Swipe	<1 ug/100 cm^2
OT-2159-0687	2159	Cement floor	2nd room from south	06/26/87	Swipe	<1 ug/100 cm^2
OT-2001-122188	41	Clean concrete	South room	12/21/88	Swipe	<1 ug/100 cm^2
OT-2002-122188	42	Clean concrete	2nd room from south	12/21/88	Swipe	28 ug/100 cm^2
OT-2003-122188	43	Clean concrete	2nd room from south	12/21/88	Swipe	31 ug/100 cm^2
OT-2004-122188	44	Clean concrete	Central room	12/21/88	Swipe	<1 ug/100 cm^2
OT-2005-122188	45	Dirty concrete	2nd room from north	12/21/88	Swipe	2 ug/100 cm^2
OT-2006-122188	46	Clean concrete	Electrician shop	12/21/88	Swipe	3 ug/100 cm^2

TABLE F-3 Bulk Sample Analysis for Asbestos Content

Building 436

SAMPLE NO.	DESCRIPTION	CONTENT (APPROXIMATE PERCENTAGE) ASBESTOS	NON-ASBESTOS FIBERS	NON-FIBROUS MATERIAL
BA-2032-112988	Gypsum wallboard	Not detected: <1%	Cellulose: 25-50%	Remainder
BA-2033-112988	Kaiser Aluminum Refractory brick	Not detected: <1%	Cellulose: 1-10%	Remainder
BA-2034-112988	Red firebrick	Not detected: <1%	Cellulose: 1-10%	Remainder
BA-2035-112988	Gypsum wallboard	Not detected: <1%	Cellulose: 25-50%	Remainder
BA-2036-112988	Gypsum wallboard	Not detected: <1%	Cellulose: 10-25%	Remainder
BA-2037-112988	Refractory brick	Not detected: <1%	Cellulose: 1-10%	Remainder
BA-2038-112988	Red/orange firebrick	Not detected: <1%	Cellulose: 1-10%	Remainder
BA-2039-112988	Bulletin board	Not detected: <1%	Cellulose: 50-75%	Remainder

TABLE F-4 Bulk and Swipe Sample Analysis for PCB Content

Building 436

SAMPLE NO.	LOCATION DESIGNATION	DESCRIPTION	LOCATION	DATE OF SAMPLE	TYPE OF SAMPLE	PCB CONTAMINATION
OT-2160-0687	2160	Drip trough	South room	06/26/87	Sediment	<5 ppm
OT-2161-0687	2161	Cement floor	Inside north doors	06/26/87	Swipe	<1 ug/100 cm^2
OT-2162-0687		Soil	Road west of building	06/26/87	Soil	<5 ppm
OT-2007-122188	47	Cement floor	South room	12/21/88	Swipe	<1 ug/100 cm^2
OT-2008-122188	48	Cement floor	South room	12/21/88	Swipe	<1 ug/100 cm^2
OT-2009-122188	49	Cement floor	South room	12/21/88	Swipe	2.17 ug/100 cm^2
OT-2010-122188	50	Cement floor	North room	12/21/88	Swipe	1.01 ug/100 cm^2
OT-2011-122188	51	Cement floor	North room	12/21/88	Swipe	<1 ug/100 cm^2
OT-2012-122188	52	Cement floor	North room	12/21/88	Swipe	<1 ug/100 cm^2

TABLE F-5 Bulk Sample analysis for Asbestos Content

Building 437

SAMPLE NO.	DESCRIPTION	CONTENT (APPROXIMATE PERCENTAGE) ASBESTOS	NON-ASBESTOS FIBERS	NON-FIBROUS MATERIAL
BA-2022-112988	Concrete roofing material	Not Detected: <1%	Cellulose: 1-10%	Remainder
BA-2023-112988	Roofing tar	Not Detected: <1%	Cellulose: 1-5%	Remainder
BA-2024-112988	Concrete roofing material	Not Detected: <1%	Cellulose: 10-25%	Remainder
BA-2025-112988 (Ashed)	Tar paper (felt)	Not Detected: <1%	Cellulose: 1-10% Synthetics: 1-5%	Remainder
BA-2026-112988 (Ashed)	Tar paper (felt)	Not Detected: <1%	Cellulose: 1-10% Synthetics: 1-5%	Remainder
BA-2027-112988	Concrete Roofing	Not Detected: <1%	Cellulose: 10-25% Synthetics: 1-5%	Remainder
BA-2028-112988	Transite wall paneling shavings	Chrysotile: 1-10%	Cellulose: 1-10%	Remainder
BA-2029-112988	Transite wall paneling	Chrysotile: 25-50%	Cellulose: 1-5%	Remainder
BA-2030-112988	Transite wall paneling	Chrysotile: 25-50%	Cellulose: 1-5%	Remainder
BA-2031-112988	Concrete wall coating	Not Detected: <1%	Cellulose: 1-5%	Remainder

TABLE F-5 Bulk Sample Analysis for Asbestos Content (Continued)

Building 437

SAMPLE NO.	DESCRIPTION	CONTENT (APPROXIMATE PERCENTAGE) ASBESTOS	NON-ASBESTOS FIBERS	NON-FIBROUS MATERIAL
BA-2200-042589	Roofing tar S end of building	Chrysotile: Trace: <1%	Cellulose: 1-5% Fibrous Glass: Trace <1%	Remainder
BA-2201-042589	Roofing tar NW corner	Not detected: <1%	Cellulose 1-10% Synthetics 1-5%	Remainder
BA-2202-042589	Roofing tar E side	Not detected: <1%	Cellulose: 1-5% Fibrous Glass: Trace <1%	Remainder
BA-2203-042589	Roofing material east side	Not detected: <1%	Cellulose: 1-5% Fibrous Glass: Trace <1%	Remainder

TABLE F-6 Bulk and Swipe Sample Analysis for PCB Content

Building 437

SAMPLE NO.	LOCATION DESIGNATION	DESCRIPTION	LOCATION	DATE OF SAMPLE	TYPE OF SAMPLE	PCB CONTAMINATION
OT-2009-111488	33	Concrete floor No visible oil	North room	11/14/88	Swipe	<1 ug/100 cm^2
OT-2010-111488	34	Concrete floor No visible oil	Doorway to north room	11/14/88	Swipe	<1 ug/100 cm^2
OT-2011-111488	35	Concrete floor No visible oil	Central room	11/14/88	Swipe	No Data[a]
OT-2012-111488	36	Concrete floor No visible oil	South room	11/14/88	Swipe	<1 ug/100 cm^2
OT-2013-111488	37	Concrete floor No visible oil	Toilet	11/14/88	Swipe	<1 ug/100 cm^2
OT-2014-111488	38	Concrete floor No visible oil	North room	11/14/88	Swipe	<1 ug/100 cm^2
OT-2015-111488	39	Concrete floor No visible oil	Central room	11/14/88	Swipe	<1 ug/100 cm^2
OT-2016-111488	40	Concrete floor No visible oil	South room	11/14/88	Swipe	<1 ug/100 cm^2

a sample lost during analysis

TABLE F-7 Bulk Sample analysis for Asbestos Content

Building 438

CONTENT (APPROXIMATE PERCENTAGE)

SAMPLE NO.	DESCRIPTION	ASBESTOS	NON-ASBESTOS FIBERS	NON-FIBROUS MATERIAL
BA-2001-120588	Gypsum board	Not detected: <1%	Fibrous glass: trace <1% Cellulose: 25-50%	Remainder
BA-2002-120588	Gypsum board	Not detected: <1%	Fibrous glass: trace <1% Cellulose: 25-50%	Remainder
BA-2003-120588	Gypsum board	Not detected: <1%	Fibrous glass: trace <1% Cellulose: 25-50%	Remainder
BA-2004-120588	Fiberboard	Not detected: <1%	Cellulose: 75-100%	Remainder
BA-2005-120588	Fiberboard	Not detected: <1%	Cellulose: 75-100%	Remainder
BA-2006-120588	Gypsum board	Not detected: <1%	Fibrous glass: trace <1% Cellulose: 25-50%	Remainder
BA-2007-120588	Fiberboard	Not detected: <1%	Cellulose: 50-75%	Remainder

TABLE F-8 Bulk and Swipe Sample Analysis for PCB Content

Building 438

SAMPLE NO.	LOCATION DESIGNATION	DESCRIPTION	LOCATION	DATE OF SAMPLE	TYPE OF SAMPLE	PCB CONTAMINATION
OT-2165-0687		Discrete spills ~ 30 ft square	Center of room	06/26/87	Swipe	3 ug/100 cm^2
OT-2002-111488	26	Clean cement	NW area of main room	11/14/88	Swipe	1 ug/100 cm^2
OT-2003-111488	27	Clean cement	Main room	11/14/88	Swipe	1 ug/100 cm^2
OT-2004-111488	28	Clean cement	Main room	11/14/88	Swipe	1 ug/100 cm^2
OT-2005-111488	29	Clean cement	SW area of main room	11/14/88	Swipe	1 ug/100 cm^2
OT-2006-111488	30	Clean cement	NE area of main room	11/14/88	Swipe	4 ug/100 cm^2
OT-2007-111488	31	Clean cement	Main room	11/14/88	Swipe	2 ug/100 cm^2
OT-2008-111488	32	Clean cement	SE area of main room	11/14/88	Swipe	3 ug/100 cm^2

APPENDIX G

TABLE G-1 Building 435 Radiological Survey Results

ITEM(S)	MEASUREMENT TYPE	RELEASABLE	NO. OF MEASUREMENTS	ACTIVITY (DPA)* MINIMUM	MAXIMUM	AVERAGE
Exterior						
North Wall	Total Beta-Gamma	Yes	30	<540	2,180	<654
	Removable Alpha		30	<6	<6	
South Wall	Total Beta-Gamma	Yes	30	<540	1,073	<634
	Removable Alpha		30	<6	<6	
East Wall	Total Beta-Gamma	Yes	30	<540	900	<576
	Removable Alpha		30	<6	<6	
West Wall	Total Beta-Gamma	Yes	30	<540	934	<567
	Removable Alpha		30	<6	<6	
Roof	Total Beta-Gamma	Yes	60	<540	1,349	<796
	Removable Alpha		60	<6	<6	
Interior						
Floor	Total Beta-Gamma	No	30	658	50,041	4,069
	Removable Alpha		30	<6	13	
Walls and Ceiling	Total Beta-Gamma	Yes	30	<568	<568	<568
	Removable Alpha		30	<6	9	
Beams	Total Beta-Gamma	Yes	30	<568	2,533	<882
	Removable Alpha		30	<6	13	
Columns	Total Beta-Gamma	Yes	30	<568	<568	<568
	Removable Alpha		30	<6	<6	
Conduit/Piping	Total Beta-Gamma	Yes	30	<568	1,711	<610
	Removable Alpha		30	<6	13	

* Disintegrations per minute per 100 cm^2

TABLE G-2 Building 435 Air Sample Results

Long-Lived Alpha Air Particulate Concentrations

Sample Type	Concentration (μCi/ml)
Breathing Zone	2.9×10^{-13}
Breathing Zone	5.7×10^{-14}
Breathing Zone	2.8×10^{-13}
Breathing Zone	2.1×10^{-13}
Breathing Zone	2.2×10^{-13}
Breathing Zone	8.8×10^{-13}
Breathing Zone	6.0×10^{-13}
Breathing Zone	3.9×10^{-13}

Radon/Thoron Gas Concentrations

Radon Concentration (pCi/l)	Monitor Type
0.7	F
0.7	M
1.5	F
0.4	M

TABLE G-3 Building 436 Radiological Survey Results

ITEM(S)	MEASUREMENT TYPE	RELEASABLE	NO. OF MEASUREMENTS	ACTIVITY (DPA)* MINIMUM	MAXIMUM	AVERAGE
Exterior						
North Wall	Total Beta-Gamma	Yes	30	<540	727	<577
	Removable Alpha		30	<6	<6	
South Wall	Total Beta-Gamma	Yes	30	<574	<574	<574
	Removable Alpha		30	<6	<6	
East Wall	Total Beta-Gamma	Yes	30	<521	2,237	<680
	Removable Alpha		30	<6	<6	
West Wall	Total Beta-Gamma	Yes	30	<521	588	<532
	Removable Alpha		30	<6	<6	
Roof	Total Beta-Gamma	Yes	40	<521	2,698	1,074
	Removable Alpha		40	<6	<6	
Interior						
Conduit/Piping	Total Beta-Gamma	No	30	<540	4,256	<821
	Removable Alpha		30	<6	9	
North Room,						
Floor	Total Beta-Gamma	No	30	<553	14,641	<2,139
	Removable Alpha		30	<6	13	
Walls and Ceiling	Total Beta-Gamma	Yes	30	<553	691	<572
	Removable Alpha		30	<6	<6	
Beams	Total Beta-Gamma	Yes	30	<553	2,500	<861
	Removable Alpha		30	<6	13	
Columns	Total Beta-Gamma	Yes	30	<553	<553	<553
	Removable Alpha		30	<6	9	

* Disintegration per minute per 100 cm^2

TABLE G-3 Building 436 Radiological Survey Results (Continued)

ITEM(S)	MEASUREMENT TYPE	RELEASABLE	NO. OF MEASUREMENTS	ACTIVITY (DPA)* MINIMUM	MAXIMUM	AVERAGE
South Room,						
Floor	Total Beta-Gamma	No	30	<553	18,227	<3,151
	Removable Alpha		30	<6	13	
Walls and Ceiling	Total Beta-Gamma	Yes	30	<553	823	<568
	Removable Alpha		30	<6	9	
Beams	Total Beta-Gamma	No	30	<553	47,080	<2,762
	Removable Alpha		30	<6	9	
Columns	Total Beta-Gamma	Yes	30	<553	<553	<553
	Removable Alpha		30	<6	<6	

* Disintegration per minute per 100 cm^2

TABLE G-4 Building 436 Air Sample Results

Long-Lived Alpha Air Particulate Concentrations

Sample Type	Concentration (μCi/ml)
Breathing Zone	2.2×10^{-13}
Breathing Zone	$<9.7 \times 10^{-13}$
Breathing Zone	5.1×10^{-13}
Breathing Zone	3.3×10^{-12}
Breathing Zone	1.6×10^{-13}

Radon/Thoron Gas Concentrations

Radon Concentrations (pCi/l)	Monitor Type
0.4	F
0.5	M
0.4	F
0.2	M

Radon Daughter Concentration

RDC
0.001 WL

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TABLE G-5 Building 437 Radiological Survey Results

ITEM(S)	MEASUREMENT TYPE	RELEASABLE	NO. OF MEASUREMENTS	ACTIVITY (DPA)* MINIMUM	MAXIMUM	AVERAGE
Exterior						
North Wall	Total Beta-Gamma	No	30	<568	2,145	<1,034
	Removable Alpha		30	<6	<6	
South Wall	Total Beta-Gamma	No	40	<568	1,872	<1,240
	Removable Alpha		30	<6	<6	
East Wall	Total Beta-Gamma	No	30	<568	2,040	<1,207
	Removable Alpha		30	<6	<6	
West Wall	Total Beta-Gamma	No	30	<568	1,908	<1,339
	Removable Alpha		30	<6	9	
Roof	Total Beta-Gamma	Yes	30	<568	757	<603
	Removable Alpha		30	<6	<6	
Interior						
Floor	Total Beta-Gamma	No	30	<540	1,107	<667
	Removable Alpha		30	<6	9	
Walls and Ceiling	Total Beta-Gamma	No	30	<553	1,546	<822
	Removable Alpha		30	<6	<6	

* Disintegration per minute per 100 cm^2

TABLE G-6 Building 437 Air Sample Results

Long-Lived Alpha Air Particulate Concentrations

Sample Type	Concentration (μCi/ml)
Breathing Zone	1.4×10^{-13}
Breathing Zone	7.9×10^{-14}

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TABLE G-7 Building 438 Radiological Survey Results

ITEM(S)	MEASUREMENT TYPE	RELEASABLE	NO. OF MEASUREMENTS	ACTIVITY (DPA)* MINIMUM	MAXIMUM	AVERAGE
Exterior						
North Wall	Total Beta-Gamma	Yes	30	<521	<540	<531
	Removable Alpha		30	<6	<6	
South Wall	Total Beta-Gamma	Yes	30	<521	588	<532
	Removable Alpha		30	<6	<6	
East Wall	Total Beta-Gamma	No	30	<521	1,176	<575
	Removable Alpha		30	<6	<6	
West Wall	Total Beta-Gamma	No	30	<540	969	<567
	Removable Alpha		30	<6	<6	
Roof	Total Beta-Gamma	No	30	<521	1,753	<781
	Removable Alpha		30	<6	<6	
Interior						
Floor	Total Beta-Gamma	No	30	<568	84,454	<7,888
	Removable Alpha		30	<6	22	
Walls and Ceiling	Total Beta-Gamma	Yes	30	<568	<568	<568
	Removable Alpha		30	<6	18	
Columns	Total Beta-Gamma	Yes	30	<553	<568	<554
	Removable Alpha		30	<6	<6	
Beams	Total Beta-Gamma	No	30	<553	15,331	<1,829
	Removable Alpha		30	<6	<6	

* Disintegration per minute per 100 cm^2

TABLE G-8 Building 438 Air Sample Results

Long-Lived Alpha Air Particulate Concentrations

Sample Type	Concentration (µCi/ml)
Breathing Zone	$<2.0 \times 10^{-14}$
Breathing Zone	3.0×10^{-13}
Breathing Zone	2.6×10^{-13}
Breathing Zone	2.9×10^{-12}
Breathing Zone	$<1.1 \times 10^{-13}$
Breathing Zone	1.4×10^{-13}
Breathing Zone	2.0×10^{-13}
Breathing Zone	1.3×10^{-12}

Radon/Thoron Gas Concentrations

Radon Concentration (pCi/l)	Monitor Type
0.4	F
0.0	M
0.6	F
0.4	M

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