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EG&G

ROCKY FLATS

Environmental Restoration Program
Final RFI/RI Work Plan for OU 12 (400/800 Area)

Rocky Flats Environmental Restoration Project

December 1992

Volume I - Text

FINAL

RFI/RI WORK PLAN

ROCKY FLATS PLANT
400/800 AREA
(OPERABLE UNIT NO. 12)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

DECEMBER 1992

VOLUME I - TEXT

EG&G ROCKY FLATS PLANT
Operable Unit No. 12
Phase I RFI/RI Work Plan

Manual: 21100-WP-OU12.1
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May 27, 1994

Approved By:

For W.S. Busby 2/18/94
Director (Date)

Suzanne G Berman 2/18/94
Project Manager (Date)

K. B. [illegible] 5/27/94
Quality Assurance Program Manager (Date)

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JUNE 11, 1991

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400/800 Area

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AEC	U.S. Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirement
ASME	American Society of Mechanical Engineers
ATV	All-Terrain Vehicle
AWQC	Ambient Water Quality Criteria
BRA	Baseline Risk Assessment
BS	Building Sump
CAD	Corrective Action Decisions
CCR	Colorado Code of Regulations
CDH	Colorado Department of Health
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CHWA	Colorado Hazardous Waste Act
CLP	contract laboratory program
CMS	Corrective Measures Study
COC	contaminants of concern
CRP	Community Relations Plan
CSBs	Chemical Specific Benchmarks
CWA	Clean Water Act
CWQCC	Colorado Water Quality Control Commission
DCN	document change notice
DOE	U.S. Department of Energy
DRCOG	Denver Regional Council of Governments
DQO	data quality objective
EE	Environmental Evaluation
EEWP	Environmental Evaluation Work Plan
EG&G	EG&G Rocky Flats, Inc.
EM	Environmental Management
EMD	Environmental Management Division
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERDA	Energy Research and Development Administration
FID	Flame Ionization Detector
FIDLER	Field Instrument for Detection of Low-Energy Radiation
FS	Feasibility Study
FSP	Field Sampling Plan
GC	gas chromatograph

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(Continued)

LIST OF ACRONYMS
(Continued)

GPR	ground penetrating radar
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HEAST	Health Effects Assessment Summary Tables
HPGe	High Purity Germanium
HRR	Historical Release Report
IAG	Interagency Agreement
ICRP	International Commission on Radiological Protection
IHSS	Individual Hazardous Substance Site
IPPCD	Interim Plan for Prevention of Contaminant Dispersion
IRIS	Integrated Risk Information System
KSS	Kansas Soil Sampler
MCL	Maximum Contaminant Level
MPL	Maximum Permissible Limit
NCP	National Contingency Plan
NCRP	National Commission on Radiological Protection
NPDES	National Pollutant Discharge Elimination System
OP	Operating Procedure
OPWL	Original Process Waste Line
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PA	Protected Area
PAC	Potential Area of Concern
PCB	polychlorinated biphenyl
PID	Photoionization Detector
PQL	Practical Quantitation Limit
PRG	Preliminary Remediation Goals
PSZ	Perimeter Security Zone
PVC	polyvinyl chloride
QA	Quality Assurance
QAA	Quality Assurance Addendum
QAPjP	Quality Assurance Project Plan
QAPM	Quality Assurance Project Manager
QC	Quality Control
RAAMP	Radiological Ambient Air Monitoring Program
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RFEDS	Rocky Flats Environmental Database System

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(Continued)

LIST OF ACRONYMS
(Continued)

RFI	RCRA Facility Investigation
RFP	Rocky Flats Plant
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
RSP	Respirable Suspended Particulate
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SWMU	solid waste management unit
TAL	Target Analyte List
TBC	To Be Considered
TCA	trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TDS	total dissolved solids
TIC	tentatively identified compound
TM	technical memorandum
TOC	total organic carbon
TSCA	Toxic Substances Control Act
UBC	under-building contamination
VOA	volatile organic analyses
VOC	volatile organic compound
WQCC	Water Quality Control Commission

Approved by:

Manager, Remediation Programs 2,18,94

RI Project Manager 2,18,94

1.0 INTRODUCTION

This document presents the work plan for the Resource Conservation and Recovery Act (RCRA) Facility Investigation/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RFI/RI) for Operable Unit No. 12 (OU12) at the U.S. Department of Energy (DOE) Rocky Flats Plant (RFP) in Jefferson County, Colorado.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions currently in progress at RFP. These investigations are pursuant to an Interagency Agreement (IAG) between the DOE, the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) dated January 22, 1991 (DOE, 1991a). The IAG developed by DOE, EPA, and CDH addresses RCRA and CERCLA issues, and outlines the activities to be pursued at 16 operable units at RFP. The IAG requires RFI/RI investigations to be in general compliance with both RCRA and CERCLA, CDH is the lead agency for the OU12 RFI/RI and, as stated in the IAG, CDH shall address requirements under Sections 107, 120(f), 121, and 310 of CERCLA, Section 3006 of RCRA, and the Colorado Hazardous Waste Act (CHWA). In accordance with the IAG, the CERCLA terms "Remedial Investigation" (RI), "Feasibility Study" (FS) and "Individual Hazardous Substance Site" (IHSS), are used in this document.

DOCUMENT CLASSIFICATION REVIEW WAIVER
PER R.B. HOFFMAN, CLASSIFICATION OFFICE
JUNE 11, 1991

The operable unit investigations are supported by numerous other sitewide programs including, but not limited to: Background Geochemical Characterization (EG&G, 1990a and EG&G 1992f), Sitewide Geologic Characterization (EG&G, 1991a, 1991c, and 1992b), Historical Release documentation (EG&G, 1992c) and sitewide ground water monitoring of RCRA regulated units (EG&G, 1992g). These programs, as well as summaries of previous investigations at RFP which support the OU12 RI, are mentioned in Sections 1.3 and 2.0 of this plan.

As required by the IAG, this work plan addresses characterization of the nature and extent of potential contamination associated with OU12 IHSSs. The primary emphasis at OU12 IHSSs is to characterize potential soil contamination associated with historical spills or releases. The term "soils" in this context is interpreted to mean vadose zone (unsaturated) surficial deposits. The RFI/RI will also investigate the nature and extent of surface water, ground water, and air contamination and evaluate potential contaminant migration pathways.

In this work plan, existing information is summarized to characterize OU12, data gaps are identified, Data Quality Objectives (DQOs) are established, and a Field Sampling Plan (FSP) is developed to characterize site physical features and to define nature and extent of potential contaminant sources. Components of the Baseline Risk Assessment Plan (BRAP), including the Human Health Risk Assessment Plan and Environmental Evaluation Work Plan, are also included in this work plan.

The RFI/RI will be conducted in accordance with the Interim Final RFI Guidance (EPA, 1989a) and Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988a). Existing data and the data generated by the RFI/RI

will be used to begin developing and screening remedial alternatives and to estimate the risks to human health and the environment posed by potential contamination within OU12.

1.1 ENVIRONMENTAL RESTORATION PROGRAM

The DOE Environmental Restoration (ER) Program, designed for investigation and cleanup of environmentally contaminated sites at DOE facilities, is being implemented in five phases. Phase 1 (Installation Assessment) includes preliminary assessments and site inspections to assess potential environmental concerns. Phase 2 (Remedial Investigations) includes planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites and evaluate potential contaminant migration pathways. Phase 3 (Feasibility Studies) includes evaluation of remedial alternatives and development of remedial action plans to mitigate environmental problems identified in Phase 2 as needing correction. Phase 4 (Remedial Design/Remedial Action) includes design and implementation of site-specific remedial actions selected on the basis of Phase 3 feasibility studies. Phase 5 (Compliance and Verification) includes monitoring and performance assessments of remedial actions as well as verification and documentation of the adequacy of remedial actions carried out under Phase 4. Phase 1 has been completed at the Rocky Flats Plant (DOE, 1986), and this plan is the initial component of Phase 2 (Remedial Investigations) for OU12.

1.2 WORK PLAN OVERVIEW

This work plan presents an evaluation and summary of previous data and investigations, defines DQOs and data needs based on that evaluation, specifies RFI/RI tasks, and presents the FSP for the RFI/RI.

Section 1.0 provides introductory information about the RFI/RI for OU12, including general history and physical setting of the RFP and surrounding region. Section 2.0 (Site Characterization) presents a comprehensive review and analysis of available historical information, previous site investigations, recently published reports, available data, and past and present activities pertinent to OU12. Included in Section 2.0 are characterization results for site geology and hydrology, as well as the known nature and extent of contamination in soils, ground water, and surface water. Additionally, Section 2.0 presents a conceptual model for contaminant migration and exposure pathways based on site physical characteristics and available information regarding the nature and extent of contamination. Section 3.0 presents potential sitewide Chemical Specific Benchmarks (CSBs), as required by the IAG, and a discussion of their application to the RFI/RI activities at OU12. Section 4.0 discusses the DQOs and work plan rationale for the RFI/RI, including data quality objectives for supporting feasibility study and baseline risk assessment needs. Section 5.0 specifies tasks to be performed for the RFI/RI. Section 6.0 presents the FSP to meet the objectives presented in Section 4.0. The schedule for performance of RFI/RI activities is presented in Section 7.0. The Baseline Human Health Risk Assessment Plan is discussed in Section 8.0, and the Environmental Evaluation Work Plan (EEWP) is discussed in Section 9.0. The site-specific Quality Assurance Addendum (QAA) for OU12 is discussed in Section 10.0. Section 11.0 provides references.

The appendices contain available supporting information used to characterize the physical setting and contamination at OU12. Appendices A through H are referenced in Section 2.0. Available analytical data, obtained from the EG&G Rocky Flats Environmental Database System (RFEDS), are presented in Appendix A. These data are in the process of being validated in accordance with EMD Quality Assurance (QA) procedures. As of early 1992,

approximately 60 percent of the data has been validated. These data can be considered only qualitative measures of the analyte concentrations.

Appendix B contains documentation of the nitric and sulfuric acid spill and other spills in the Comprehensive Environmental Assessment and Response Program (CEARP) Phase I Installation Assessment (DOE, 1986) and RCRA contingency plan implementation reports, Appendix C contains engineering drawings of footing drain locations in OU12, and contains data from footing drain sample analyses. Appendix D contains radiometric surveys requested in the IAG and completed at RFP from 1981 to 1989, and Appendix E contains borehole logs used in subsurface characterization of OU12. Appendix F contains RCRA ground water quality monitoring information for select wells upgradient and downgradient of OU12. Appendix G contains technical information on the high purity germanium (HPGe) detector, including calibration, operation, and data quality information. Appendix H contains procedures for field measurements referenced in Section 6.0 Field Sampling Plan. Appendix I contains Rocky Flats Environmental Database System (RFEDS) field data forms.

1.3 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

The following sections provide general information on RFP and the surrounding region, including RFP history, regional land use and population data, and site conditions. Site-specific conditions at OU12 are addressed in Section 2.0.

1.3.1 Facility Background and Plant Operations

RFP is a government-owned, contractor-operated facility, which is part of the nationwide Nuclear Weapons Complex. The plant was operated for the U.S. Atomic Energy Commission (AEC) from its inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the plant was assigned to the Energy Research and Development

Administration (ERDA), which was succeeded by DOE in 1977. Dow Chemical U.S.A., an operating unit of the Dow Chemical Company, was the prime operating contractor of the facility from 1951 until June 30, 1975. Rockwell International was the prime contractor responsible for operating the RFP July 1, 1975, until December 31, 1989. EG&G became the prime contractor at RFP on January 1, 1990.

Operations at RFP consist of fabrication of nuclear weapons components from plutonium, uranium, and other, nonradioactive metals (principally beryllium and stainless steel). Parts made at the RFP are shipped elsewhere for assembly. In addition, the RFP reprocesses components after they are removed from obsolete weapons for recovery of plutonium. Other activities at RFP include research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes are generated in the production process. Current waste handling practices involve onsite and offsite recycling of hazardous materials, onsite storage of hazardous and radioactive mixed wastes, and offsite disposal of solid radioactive materials at another DOE facility. However, RFP operating procedures historically included both onsite storage and disposal of hazardous, radioactive, and radioactive mixed wastes. Preliminary assessments under the ER Program identified some of the past onsite storage and disposal locations as potential sources of environmental contamination.

1.3.2 Previous Investigations

Various sitewide studies have been conducted at RFP to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the environment. The investigations performed prior to 1986 were summarized by Rockwell International (1986a) and include the following:

1. Detailed description of the regional geology (Malde, 1955; Spencer, 1961; Scott, 1960, 1963, 1970, 1972, and 1975; Van Horn, 1972 and 1976; Dames and Moore, 1981; and Robson, et al, 1981a and 1981b)

2. Several drilling programs beginning in 1960 that resulted in construction of approximately 60 monitoring wells by 1982

3. An investigation of surface water and ground water flow systems by the U.S. Geological Survey (Hurr, 1976)

4. Environmental, ecological, and public health studies that culminated in an Environmental Impact Statement (DOE, 1980)

5. A summary report on ground water hydrology using data from 1960 to 1985 (Hydro-Search, 1985)

6. A preliminary electromagnetic survey of the plant perimeter (Hydro-Search, 1986)

7. A soil-gas survey of the plant perimeter and buffer zone (Tracer, 1986)

8. Routine environmental monitoring programs addressing air, surface water, ground water, and soils (Rockwell, 1975 through 1985, and 1986b).

In 1986, two major investigations were completed at the plant. The first was the DOE CEARP Phase I Installation Assessment (DOE, 1986), which included analyses and identification of current operational activities, active and inactive waste sites, current and past waste management practices, and potential environmental pathways through which contaminants could be transported. CEARP later was succeeded by the ER Program. A number of sites that could potentially have adverse impacts on the environment were identified. These sites were designated as Solid Waste Management Units (SWMUs) by Rockwell International (1987). In accordance with the IAG, SWMUs are now designated as IHSSs, and are divided into three categories:

1. Hazardous substance sites that will continue to operate and need a RCRA operating permit

2. Hazardous substance sites that will be closed under RCRA interim status

3. Inactive hazardous substance sites that will be investigated and cleaned up under Section 3004(u) of RCRA or under CERCLA.

The second major investigation completed at RFP in 1986 involved a hydrogeologic and hydrochemical characterization of the plant site. Plans for this study were presented by Rockwell International (1986c and 1986d), and study results were reported by Rockwell International (1986e). Investigation results identified areas considered to be significant contributors to environmental contamination. Other investigations conducted previously that relate more directly to characterization of the OU12 area are mentioned in Section 2.3 of this document.

1.3.3 Physical Setting

1.3.3.1 Location

RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). Other surrounding cities include Boulder, Westminster, and Arvada, all of which are located less than 10 miles to the northwest, east, and southeast of RFP, respectively. The RFP consists of approximately 6,550 acres of federal land in Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th Principal Meridian. Most plant structures are located within a protected central area site of approximately 400 acres, and surrounded by a buffer zone of approximately 6,150 acres.

RFP is bounded on the north by State Highway 128, on the east by Jefferson County Highway 17, (also known as Indiana Street), on the south by agricultural and industrial properties and Highway 72, and on the west by State Highway 93 (Figure 1-1).

1.3.3.2 Topography

RFP is located along the eastern edge of the southern Rocky Mountain region immediately east of the Colorado Front Range. The plant site is situated on a broad, eastward-sloping pediment that is capped by alluvial deposits of Quaternary age (Rocky Flats Alluvium). The pediment surface has a fan-like form, with its apex and distal margins approximately 2 miles east of RFP. The tops of alluvial-covered pediments are nearly flat but slope gently eastward at 50 to 100 feet per mile (EG&G, 1991a). At RFP, the pediment surface is dissected by a series of east-northeast trending stream-cut valleys. The valleys containing Rock Creek, North and South Walnut Creeks, and Woman Creek lie 50 to 200 feet below the level of the older pediment surface. These valleys are incised into the bedrock underlying alluvial deposits, but most bedrock is concealed beneath colluvial material accumulated along the gentle valley slopes. The combined effects of stream-cut topographic relief and the shallow dip of the bedrock units beneath RFP suggest a potentially shallow depth to the Laramie Formation in the valley bottoms.

1.3.3.3 Meteorology

The area surrounding RFP has a semiarid climate characteristic of much of the central Rocky Mountain region. Based on precipitation averages recorded between 1953 and 1976, the mean annual precipitation at the plant is 15 inches. Approximately 40 percent of the precipitation falls during the spring season, much of it as wet snow. Thunderstorms (June to August) account for an additional 30 percent of the annual precipitation. Autumn and winter are drier seasons, with snowmelt accounting for 19 and 11 percent of the annual

precipitation, respectively. Snowfall averages 85 inches per year, falling from October through May (DOE, 1980).

Evaporation from the RFP area is estimated from several sources. Evaporative losses from "Class A Plan" measurements gathered during several studies have been translated into actual annual evaporation ranging from 28 inches per year (Kohler et.al., 1955) to approximately 46 inches per year (EPA, 1983). The most commonly reported values of annual evaporation for the area are 38 to 40 inches per year. Values would be greater if evapotranspirative rates were included.

Winds at RFP, although variable, are predominantly from northerly directions. Stronger winds occur during the winter, and due to its location near the Front Range the area occasionally experiences Chinook winds with gusts up to 100 miles per hour. The canyons along the Front Range tend to channel the air flow during both up-slope and downslope conditions, especially when there is strong atmospheric stability (DOE, 1980).

Figure 1-2 presents the wind rose for the RFP area using data from 1990. The figure shows that approximately 20 percent of the time the wind is from the northwest and 15 percent of the time from the northeast. The highest velocity winds (greater than 15 meters per second) are generally from the northwest. Winds also originate from the southeast approximately 10 percent of the time with velocities between 7 and 15 meters per second. Based on the above information, the area to the southeast of RFP could be impacted by atmospheric dispersion from RFP.

Rocky Flats meteorology is strongly influenced by the diurnal cycle of mountain and valley breezes. Two dominant flow patterns exist, one during daytime and one at night. During

daytime hours, as the earth heats, air tends to flow toward the higher elevations (up-slope). During up-slope conditions air flow generally moves up the South Platte River Valley and then enters the canyons into the Front Range. After sunset, the air against the mountain side is cooled and begins to flow toward the lower elevations (downslope). During downslope conditions, air flows down the canyons of the Front Range onto the plains.

Temperatures at RFP are moderate. Extremely warm or cold weather is usually of short duration. On average, daily summer temperatures range from 55 to 85 degrees Fahrenheit (° F), and winter temperatures range from 20 to 45° F. Temperature extremes recorded at the plant range from 102° F on July 12, 1971, to -26° F on January 12, 1963. The 24-year daily average maximum temperature for the period 1952 to 1976 is 76° F, the daily minimum is 22° F, and the average mean is 50° F. Average relative humidity is 46 percent (DOE, 1980).

Review of historical climatological data for RFP has indicated that some of the data are invalid under current quality standards. 1989 and 1990 RFP monthly and annual environmental monitoring reports prepared by EG&G (EG&G, 1989, 1990c) contain climatological data that has been validated under current quality assurance protocol.

1.3.3.4 Surface Water Hydrology

Three intermittent streams that flow generally from west to east drain the RFP area. These drainages are Rock Creek, Walnut Creek, and Woman Creek (Figure 1-3).

Rock Creek drains the northwestern corner of the buffer zone and flows northeastward through the buffer zone to its offsite confluence with Coal Creek. Rock Creek is peripheral to the RFP facility and is not known to have been impacted by RFP activities. North and

South Walnut Creeks and an unnamed tributary drain the northern portion of RFP. These three forks of Walnut Creek join in the buffer zone and flow toward Great Western Reservoir approximately one mile east of the confluence. Flow is diverted around Great Western Reservoir into Big Dry Creek via the Broomfield Diversion Ditch. Rock Creek, North and South Walnut Creeks, and the unnamed tributary are intermittent streams. Flow generally occurs in these streams only after precipitation events and spring snowmelt. An east-west trending interfluve separates Walnut Creek from Woman Creek. OU12 is situated on this interfluve and OU12 surface water drains to these creeks as shown on Figure 1-4. Woman Creek drains the southern Rocky Flats buffer zone and flows eastward into Standley Lake with periodic diversions into Mower Reservoir.

Surface water retention ponds constructed to control runoff from RFP are also depicted on Figure 1-3. The retention ponds are located on North Walnut Creek, South Walnut Creek and Woman Creek. The areas of the plant that drain to these respective drainages are shown on Figure 1-4 as are locations of surface water monitoring stations for each area of the plant. The series of retention ponds known as the A-series ponds are located on North Walnut Creek, the B-series retention ponds are located on South Walnut Creek, and the C-series retention ponds are located on Woman Creek. The A-series ponds on North Walnut Creek are designated A-1, A-2, A-3, and A-4 from west to east. They receive runoff from the western and northern portions of the plant site, including the 100, 300, and portions of the 700 building areas. The B-series ponds on South Walnut Creek are designated B-1, B-2, B-3, and B-4, and receive surface water runoff from the central portion of the plant site including the majority of OU12. Ponds C-1 and C-2 are located in the Woman Creek drainage and receive runoff from the southern portion of the site. Figure 1-4 indicates a relatively small portion of the OU12 area drains to Woman Creek, including the extreme western and southern portions of the 400, 600, and 800 building areas.

The South Interceptor Ditch is located between the RFP main production facility and Woman Creek. The South Interceptor Ditch collects runoff from the southern portion of the production facility and diverts it to pond C-2, where it is monitored in accordance with RFP National Pollutant Discharge Elimination System (NPDES) permit.

1.3.3.5 Ecology

A variety of vegetation is found within the buffer zone surrounding RFP. Included are species of flora representative of tall-grass prairie, short-grass plains, lower montane, and foothill ravine regions. Riparian vegetation exists along RFP drainages and in wetlands. Since acquisition of RFP property, vegetative recovery has occurred, as evidenced by the presence of disturbance-sensitive grass species such as big bluestem (*Andropogon gerardii*) and side oats grama (*Bouteloua curtipendula*). No vegetative stresses attributable to hazardous waste contamination have been identified (DOE, 1980).

The fauna inhabiting RFP and its buffer zone consist of species associated with western prairie regions. The most common large mammal is the mule deer (*Odocoileus hemionus*), with an estimated 100 to 125 permanent residents. There are a number of small carnivores, such as the coyote (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*ephitis mephitis*), and long-tailed weasel (*ustela frenata*). Small herbivores can be found throughout the plant complex and buffer zone, including species such as the pocket gopher (*Thomomys talpoides*), cottontail (*Sylvilagus sp.*) around buildings and along drainages, white-tailed jackrabbit (*Lepus townsendii*), and the meadow vole (*icrotus pennsylvanicus*) (DOE, 1980).

Commonly observed birds include western meadowlarks (*Sturnella neglecta*), horned larks (*Eremophila alpestris*), mourning doves (*Zenaidura macroura*), and vesper sparrows (*Pooecetes gramineus*), western kingbirds (*Tyrannus vociferans*), black-billed magpies (*Pica pica*), american

robins (*Turdus migratorius*), and yellow warblers (*Dendroica magnolia*). Killdeer (*Charadrius vociferus*), and red-winged black birds (*Agelaius phoeniceus*) are seen in areas adjacent to ponds. Mallards (*Anas platyrhynochos*) and other ducks (*Anas sp.*) frequently nest and rear young on several of the ponds. Common birds of prey in the area include northern harriers (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), american kestrels (Falco sparverius) and great horned owls (*Bubo virginianus*) (DOE, 1980).

Bull snakes (*Pituophis melanoleucus*) and rattlesnakes (*Crotalus sp.*) are the most frequently observed reptiles. Eastern yellow-bellied racers (*Coluber constrictor flaviventris*) have also been seen. The eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) has been reported on the site, but these and other lizards are not commonly observed. The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds (DOE, 1980).

Wetlands play an important role in ecosystem processing and in providing habitat to a variety of plant and animal species. Wetlands at RFP were identified in conjunction with the National Wetlands Inventory (1979) and field checked by U.S. Army Corp of Engineers personnel to verify their jurisdictional status (EG&G, 1990d). There are approximately 107 acres of aerial wetlands and 84,970 feet of linear wetlands within the Rocky Flats site. In addition, there are approximately 156 acres of aerial wetlands and 14,190 feet of linear wetlands outside of the Rocky Flats site which are generally to the east of the site. Of the 156 acres of aerial wetlands outside of the Rocky Flats site, 140 acres can be attributed to Great Western Reservoir (EG&G, 1990d).

Within the Rocky Flats site, six ephemeral streams traverse the property. Of these, Walnut Creek, South Walnut Creek, and Woman Creek are relatively important because they drain the plant site. The other three streams in the general area of the RFP are Coal Creek, Rock Creek, and Leyden Gulch. The headwaters of Walnut Creek and South Walnut Creek occur within the Rocky Flats site and generally flow eastward. South Walnut Creek is tributary to Walnut Creek which flows toward the Great Western Reservoir into Big Dry Creek. The headwaters of Woman Creek occur in the area, which drain the south side of the Rocky Flats site, and flow eastward into Standley Lake. Coal Creek and Rock Creek flow northward outside of the RFP area and Leyden Gulch drains the southern part of the area. Leyden Gulch is tributary to Leyden Lake. Wetlands along the creeks are dominated by a narrow band of cattails, with occasional cottonwoods, willows, and other shrubs (EG&G, 1990d).

Aquatic life is not well developed in the streams, wastewater discharge system ponds, or other ponds. Black bass (probably largemouth bass, *Micropterus salmoides*), fathead minnows (*Pimephales promelas*), and bluegills (*Lepomis macrochirus*) were reported in one or more of the ponds (W-W Services, 1976). Data from 1976 indicates that crayfish and benthic macroinvertebrates, including the relatively sensitive sideswimmers (Amphipoda), mayflies (Ephemeroptera), caddisflies (Trichoptera), and facultative organisms, were found primarily in Pond B4 and in Woman Creek (W-W Services, 1976). Current studies (December 1990 to August 1991) in the protected area, OU1 and OU2 have added golden shiner (*Notemigonus crysoleucas*), creek chub (*Semotilus atromaculatus*), stoneroller (*Campostoma anomalum*), white sucker (*Catostomus commersoni*), and green sunfish (*Lepomis cyanellus*) to the list and verified the presence of fathead minnows and largemouth bass. Current studies have also added six amphibians, three of which are common: tiger salamander (*Ambystoma tigrinum*), boreal chorus frog (*Pseudacris triseriatus*), and northern leopard frog (*Rana pipiens*).

Ecological surveys for identification and management of threatened and endangered species at RFP have been conducted according to EG&G Environmental Management Department SOPs, Volume 5.0, Ecology. The SOPs have been approved for use on RFI/RIs by EPA, CDH, U.S. Fish and Wildlife Service (USFWS) and the Colorado Division of Wildlife (CDOW). Plant and animal species which have been documented at RFP have been summarized in a Species of Concern (SOC) Species Compliance List along with the preferred habitat of the species and the time of year the species may be present. Of the species identified, only the forktip three awn (*Artistida basiramea*) is likely to occur other than a transient at any of the OU12 IHSSs. The table and a discussion of its potential applicability to OU12 are in Section 9.0, Environmental Evaluation Work Plan. Applicability is determined either by sightings of the species in OU12 or the presence of preferred habitat.

1.3.3.6 Surrounding Land Use and Population Density

The population, economics, and land use of areas surrounding RFP are described in a 1989 Rocky Flats vicinity demographics report prepared by DOE (DOE, 1991b). This report divides general use of areas within zero to ten miles of RFP into residential, commercial, industrial, parks and open spaces, agricultural and vacant, and institutional classifications, and also considers current and future land use near RFP.

The majority of residential use within five miles of RFP is located immediately northeast, east, and southeast of the plant. The 1989 population distribution within five miles of the RFP main production facility (i.e., the center of the RFP site) is illustrated in Figure 1-5. Commercial development is concentrated near residential developments north and southwest of Standley Lake as well as around Jefferson County Airport, approximately three miles northeast of RFP. Industrial land use within five miles of the plant is limited to quarrying and mining operations. Open space lands are located northeast of RFP near the City of

Broomfield and in small parcels adjoining major drainages and small neighborhood parks in the cities of Westminster and Arvada. The west, north, and east sides of Standley Lake are encompassed by Standley Lake Park open space. Irrigated and non-irrigated croplands, producing primarily wheat and barley, are located north and northeast of RFP near the cities of Broomfield, Lafayette, Louisville and Boulder, and in scattered parcels adjacent to the eastern boundary of the plant. Several horse operations and small hay fields are located south of RFP. The demographic report characterizes much of the vacant land adjacent to RFP as rangeland (DOE, 1991b).

Future land use in the vicinity of RFP most likely involves continued urban expansion, increasing the density of residential, commercial, and perhaps industrial land use in the areas. The expected trend in population growth in the vicinity of RFP is also addressed in the DOE demographic study (DOE, 1991b). The report considers expected variations in population density by comparing the current (1989) setting to population projections for the years 2000 and 2010. A 21-year profile of projected population growth in the vicinity of RFP can thus be examined. DOE's projections are based primarily on long-term population projections developed by the Denver Regional Council of Governments (DRCOG) and reported in the DOE demographic study (DOE, 1991b). Estimated population density and distribution around RFP for the years 2000 and 2010 are shown in Figures 1-6 and 1-7, respectively.

1.3.3.7 Soils

Soils in the vicinity of RFP have been mapped by the Soil Conservation Service and are presented on Figure 1-8. As shown on the figure, three predominant soil series occur at the plant site including the Nederland, Flatirons, and Denver series. Nederland series soils are mapped near South Walnut Creek, unnamed tributary of Walnut Creek, and Woman Creek drainages. Nederland series soils consist of deep, well drained soils on piedmont fan terraces,

alluvial terraces, stable summits, and terrace escarpments (Soil Conservation Service, 1980). Flatiron series soils are mapped throughout most of the RFP controlled area, including most of the OU12 area. Flatiron series soils consist of deep, well drained soils on high terraces, hill slopes and piedmonts. The soils formed are most commonly noncalcareous, cobbly, stoney, gravelly, and loamy material of the Rocky Flats Alluvium (Soil Conservation Service, 1980).

Denver Kutch-Midway soil complex is shown on Figure 1-8 as the next mappable unit to Nederland Series soils in the RFP drainages. Denver series soils consist of deep, well drained soils on fans, high terraces, hill slopes, and table lands. The soils are formed in calcareous, clayey material derived from mudstone and shale (Soil Conservation Service, 1980). Kutch series soils are similar to those described for Denver series, but are found on shoulders, ridges, and hill slopes. Midway series soils also are on hill slopes and ridge crests, and formed in calcareous, clayey material derived from shale and mudstone.

1.3.3.8 Regional Geology

RFP is located on a broad, eastward-sloping pediment surface along the western edge of the Denver Basin (Figure 1-9). The area is underlain by more than 10,000 feet of Pennsylvanian to Upper Cretaceous sedimentary rocks that have been locally folded and faulted. Along the foothills west of RFP, sedimentary strata are steeply east-dipping to overturned. In the western buffer zone, Upper Cretaceous sandstones of the Laramie formation make up an east-dipping (45° to 55°) hogback that strikes approximately north-northwest (Scott, 1960). Immediately east of the hogback, steeply dipping sedimentary strata abruptly flatten to less than 2 degrees under and east of RFP (EG&G, 1991a, 1992b). The sedimentary bedrock is unconformably overlain by Quaternary alluvial gravels that cap pediment surfaces of several distinct ages as shown in Figure 1-9 (Scott, 1963).

Figure 1-10 shows the local stratigraphic section for the Rocky Flats area. Upper Cretaceous bedrock units directly underlying RFP and pertinent to plant site hydrogeology include, in descending stratigraphic order, the Arapahoe Formation, the Laramie Formation, the Fox Hills Sandstone, and the Pierre Shale. These bedrock units and the overlying surficial Quaternary Deposits surfacing in the RFP vicinity are shown on Figure 1-11 and described below. A regional geologic cross section of the vicinity is shown on Figure 1-12. The east-west trending cross section depicts geology approximately one mile north of the plant site, and is shown as section A-A' on Figure 1-11. Figures 1-11 and 1-12 are taken from the Final Report of the Phase II Geologic Characterization Data Acquisition (EG&G, 1992b).

Quaternary Deposits

The Quaternary-age deposits in the RFP area, shown in Figures 1-9 and 1-11, have been categorized into pediment cover and valley-fill. The Rocky Flats, Verdos, and Slocum Alluviums represent pediment covers. The valley-fill alluviums include the Louviers and the Broadway Alluviums. Additional recent alluvial valley-fill deposits include the Piney Creek and Post Piney Creek Alluviums (EG&G, 1991c).

The Rocky Flats Alluvium is the oldest alluvial deposit in the Denver area, east of the Front Range. The alluvium consists of poorly sorted, angular to rounded, coarse gravels, sands, and gravelly clay. Caliche amounts vary from trace to abundant (EG&G, 1991c). Dominant lithologies include detritus from Precambrian quartzite, schist, and gneiss deposited by Coal Creek. Thickness at the type locality just south of RFP is 50 feet, and ranges from 10 to 90 feet (Machette, et al, 1976). Alluvial thickness in the OU12 area is presented in Section 2.0. As shown on Figures 1-9 and 1-11, the RFP overlies Rocky Flats Alluvium.

Upper Cretaceous Deposits

Depositional environments east of the Front Range in the Late Cretaceous period were influenced by the Laramide Orogeny which resulted in the uplift of the ancestral Colorado Front Range Mountains. The uplift caused a regression of the intercontinental Cretaceous sea from the west to the east, resulting in a lateral progradation of Pierre Shale prodelta shales and siltstones, Fox Hills Formation delta front sandstones, Laramie Formation delta plain sandstones, claystones, and coals, and Arapahoe Formation fluvial conglomerates, sandstones and claystones (Weimer, 1973).

The Arapahoe Formation is the uppermost bedrock unit underlying RFP and consists primarily of claystones, silty claystones, and some sandstones. Arapahoe sandstones are very fine-grained to medium-grained, with minor conglomeratic lenses. Weathered sandstones are pale orange, yellowish gray, and dark yellowish orange. Unweathered sandstones are light gray to olive gray. The sandstones typically are interlayered with clay lenses and are lenticular in geometry. The majority of the Arapahoe Formation is composed of claystones and silty claystones which are light olive gray to medium olive gray and weathered to a dark yellowish-orange.

Lithologic similarities between the Arapahoe Formation and the underlying Laramie Formation makes defining the contact between the formations difficult. Two recent geologic studies of the RFP area established conflicting thicknesses of the Arapahoe Formation based on differing placement of the contact between the Arapahoe and Laramie Formations. The first report, the Geologic Characterization Report, identified five individual sandstone bodies within the Arapahoe Formation and placed the lower contact of the Arapahoe Formation at the base of the fifth and lowermost sandstone body (EG&G, 1991c). By placing the contact below the fifth sandstone body, the thickness of the Arapahoe Formation was established

at 150 ft. The placement of the contact for this report was determined by evaluating offsite geophysical logs and comparing them with elevation data from drill cores on RFP. However, no lithologic criteria was used in defining the sandstone bodies or contact placement.

The second and most recent interpretation, the Phase II Geologic Characterization Data Acquisition, used field mapping and lithologic criteria to place the lower contact of the Arapahoe Formation beneath the first sandstone body (EG&G, 1992b). This interpretation defines the two formations as having different field characteristics and provenances and establishes a discontinuous medium-grained to conglomeratic crossbedded sandstone marker bed as the basal unit of the Arapahoe Formation. The second interpretation places the lower contact of the Arapahoe Formation significantly higher in the section establishing the thickness of the formation at 15 to 25 feet. Any further reference to the Arapahoe Formation in the OU12 work plan will refer to the second and most recent interpretation of the Arapahoe Formation.

The Laramie Formation, which is composed of an upper claystone interval and a lower sandstone and coal interval, is approximately 800 feet thick. The upper Laramie Formation consists of silty claystones and siltstones, and fine-grained lenticular fluvial sandstones. The silty claystones are light olive gray to olive black, massive, occasionally sandy, and contain carbonaceous material. The siltstones are also carbonaceous, with iron oxide nodules and slickensides along fractures. The lower Laramie Formation consists of very-fine-grained to medium-grained sandstones up to 50 feet thick and coal beds ranging from two to eight feet thick (EG&G, 1991c).

The Fox Hills Formation averages 75 feet thick and consists of thick-bedded to massive, very-fine-grained to medium-grained feldspathic sandstone which is grayish orange to light gray

in color. The sandstones are interlayered with thin beds of siltstone and claystone (EG&G, 1991c). The Fox Hills Formation crops out west of the RFP and is not likely impacted by RFP activities.

1.3.3.9 Ground Water Hydrology

RFP is situated in a regional ground water recharge area. Recharge to the alluvium occurs as a result of precipitation, snowmelt, and water losses from streams, ditches, and ponds cut into the alluvium (EG&G, 1991c).

Discharge from the alluvium occurs at seeps that may or may not be covered by colluvium at the alluvium/bedrock contact along the edges of the valleys. Most seeps flow intermittently (EG&G, 1990a). Ground water recharge to Arapahoe and Laramie sandstones occurs primarily from infiltration of precipitation into bedrock which crops out in the western portion of RFP along the west limb of the monoclinal fold and from water losses from streams incised into bedrock. Recharge is greatest during the spring and early summer when rainfall and stream flow are at a maximum and water levels in the Rocky Flats alluvium are high. Discharge occurs at the edges of valleys (EG&G, 1990a).

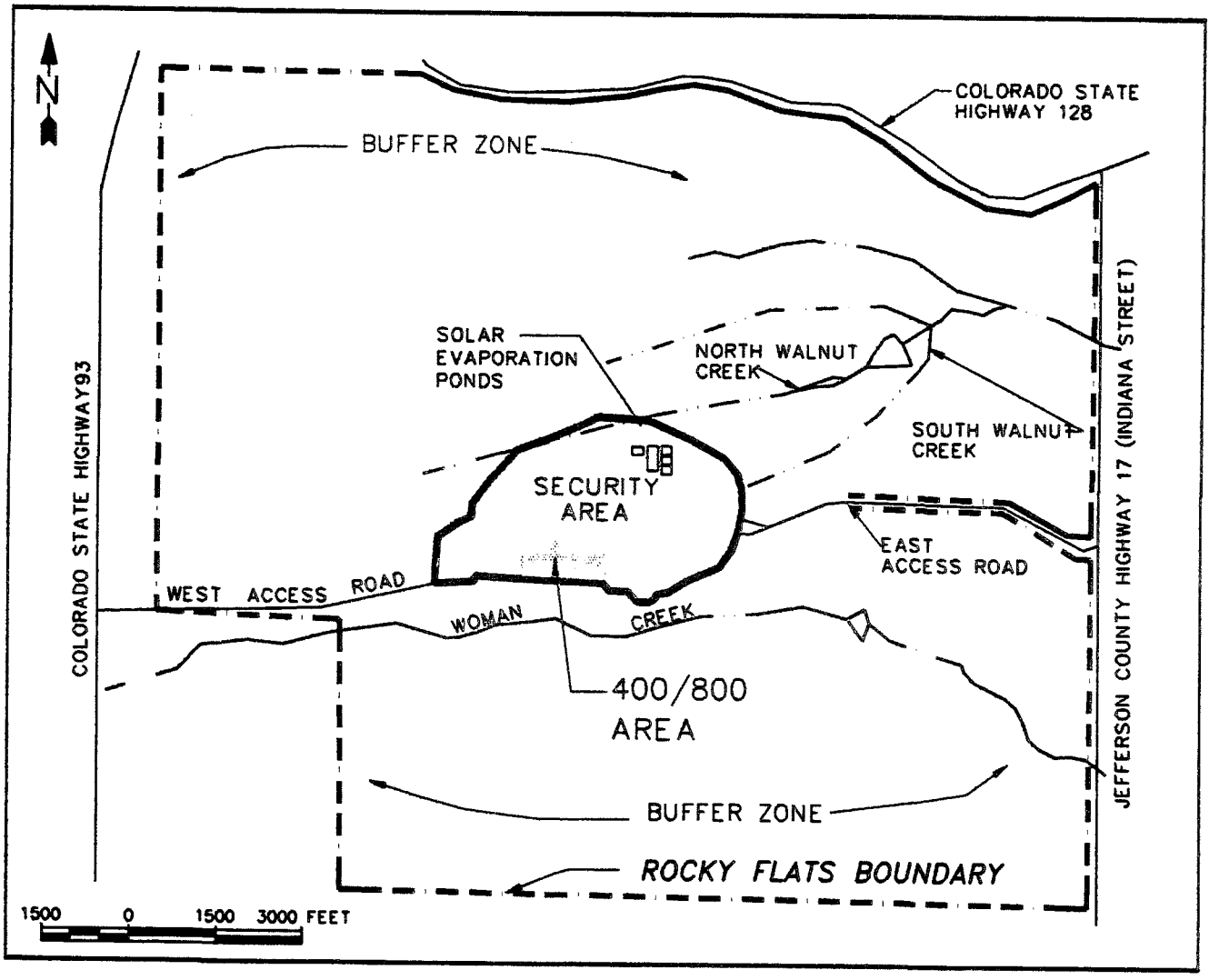
Unconfined ground water occurs at RFP in the unconsolidated Quaternary alluvial deposits. These include the Rocky Flats Alluvium and other pediment cover deposits present on broad topographic highs, and the various valley-fill alluvium deposits present in modern stream drainages. Ground water levels in the Rocky Flats Alluvium rise in response to recharge during the spring and decline during the remainder of the year. During periods of high surface water flow, water is lost to bank storage in the valley fill alluvium and returns to the stream after the runoff subsides. Seasonal ground water fluctuations for the OU12 area are discussed in Section 2.0. In the western portion of RFP, where the alluvium is thickest, the

depth to water is 50 to 70 feet below the surface. Although the water table is variable, it becomes generally shallower from west to east as the alluvium thins. Seeps are common in stream drainages along the contact between the Rocky Flats Alluvium and the underlying Arapahoe and Laramie Formations, and where Arapahoe Formation sandstone crops out. The unconfined ground water flows generally to the east along the gently sloping contact between the alluvium and the underlying bedrock. Unconfined ground water also exists in Arapahoe Formation sandstone which subcrops below the Rocky Flats Alluvium at RFP. Laramie Formation sandstones subcrop in limited areas along valley slopes. The Rocky Flats Alluvium and Arapahoe Formation sandstone, siltstone, and claystone constitute the uppermost aquifer at RFP (EG&G, 1991c and 1992b).

Ground water in Arapahoe and Laramie Formation sandstones, that do not subcrop, exists under confined conditions throughout most of the RFP area. The confining layers for the sandstones are the Arapahoe and Laramie Formation claystones and silty claystones.

Saturated zones in the Arapahoe Formation and the uppermost Rocky Flats Alluvium have relatively low hydraulic conductivities. The uppermost water bearing zone aquifer is a heterogeneous deposit which displays a significant degree of variability laterally and vertically. Consequently, the uppermost water bearing zone exhibits a highly variable range of hydraulic conductivity values. Hydraulic conductivity values reported for the Rocky Flats Alluvium range from 1×10^{-2} cm/s (Hurr, 1976) to 4×10^{-8} cm/s (DOE, 1988). The most recent hydrogeologic investigation suggests the hydraulic conductivity of the uppermost water bearing zone is approximately 6×10^{-5} cm/s (EG&G, 1991c). The claystones which typically underlie the alluvium have a hydraulic conductivity on the order of 1×10^{-7} centimeters per second (cm/s), and effectively constrain much of the unconfined ground water flow to the more permeable alluvial deposits.

The Laramie Formation sandstones, formerly referred to as Arapahoe sandstones 3, 4, and 5, have a hydraulic conductivity of approximately 10^{-6} cm/s (EG&G, 1991c). Currently, there are ongoing hydraulic conductivity studies being conducted on both a sitewide and OU-specific basis. Hydraulic conductivity values presented in past studies are being validated and new permeameter testing is being conducted. Pump testing and packer testing results are being evaluated for OU1. Results of the evaluation have only recently become available.



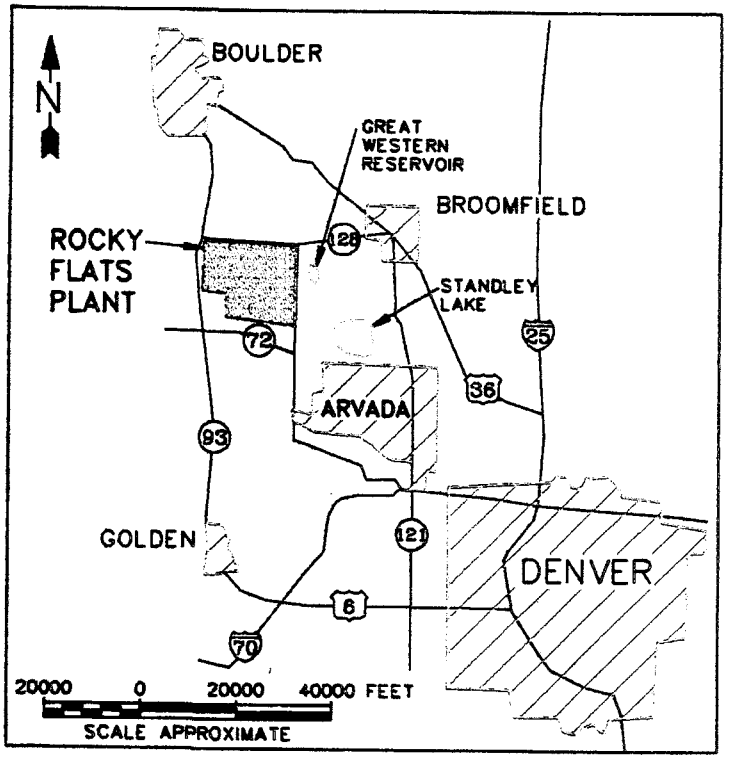


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FIGURE 1-1
ROCKY FLATS LOCATION MAP

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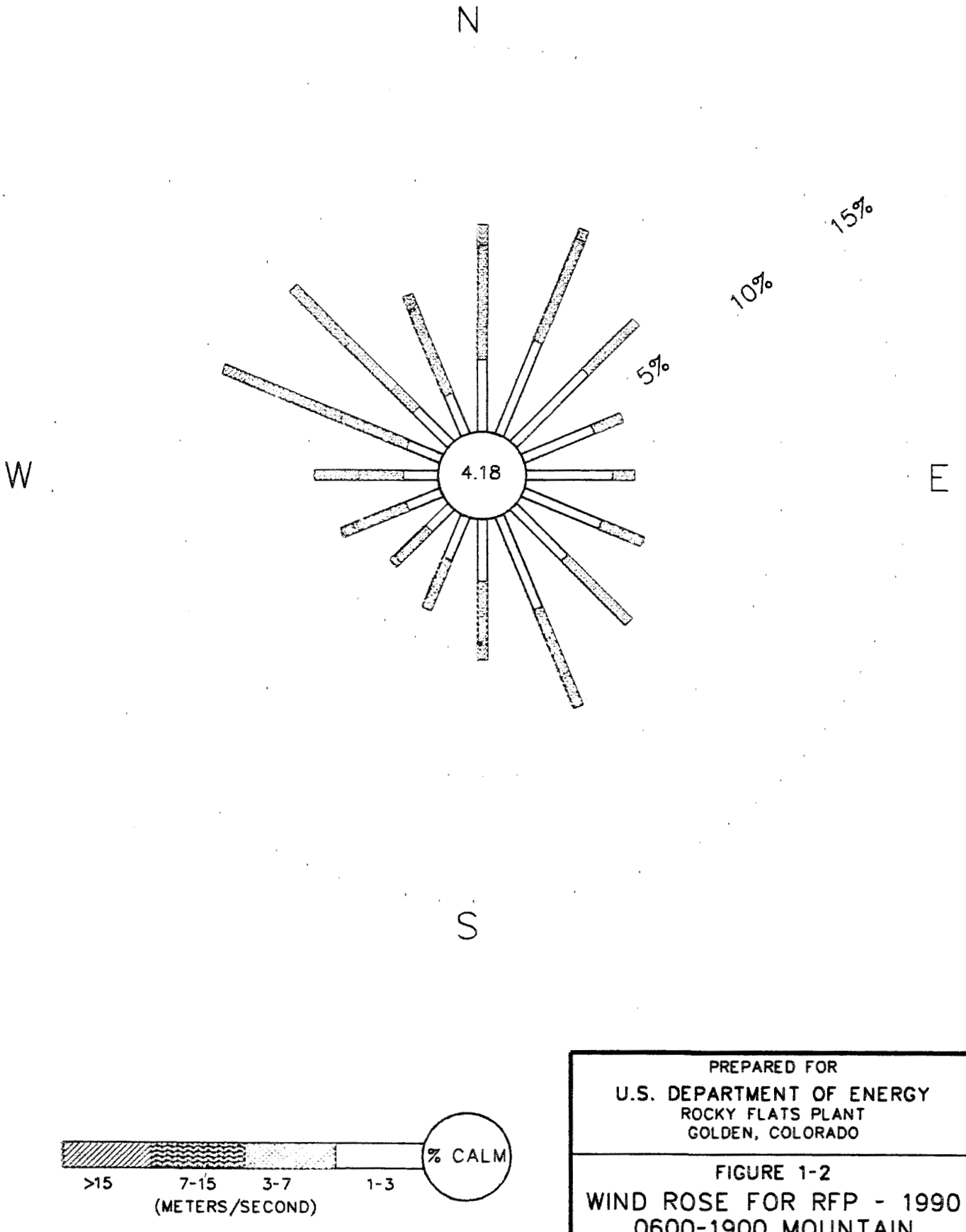

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FIGURE 1-2
WIND ROSE FOR RFP - 1990
0600-1900 MOUNTAIN
STANDARD TIME

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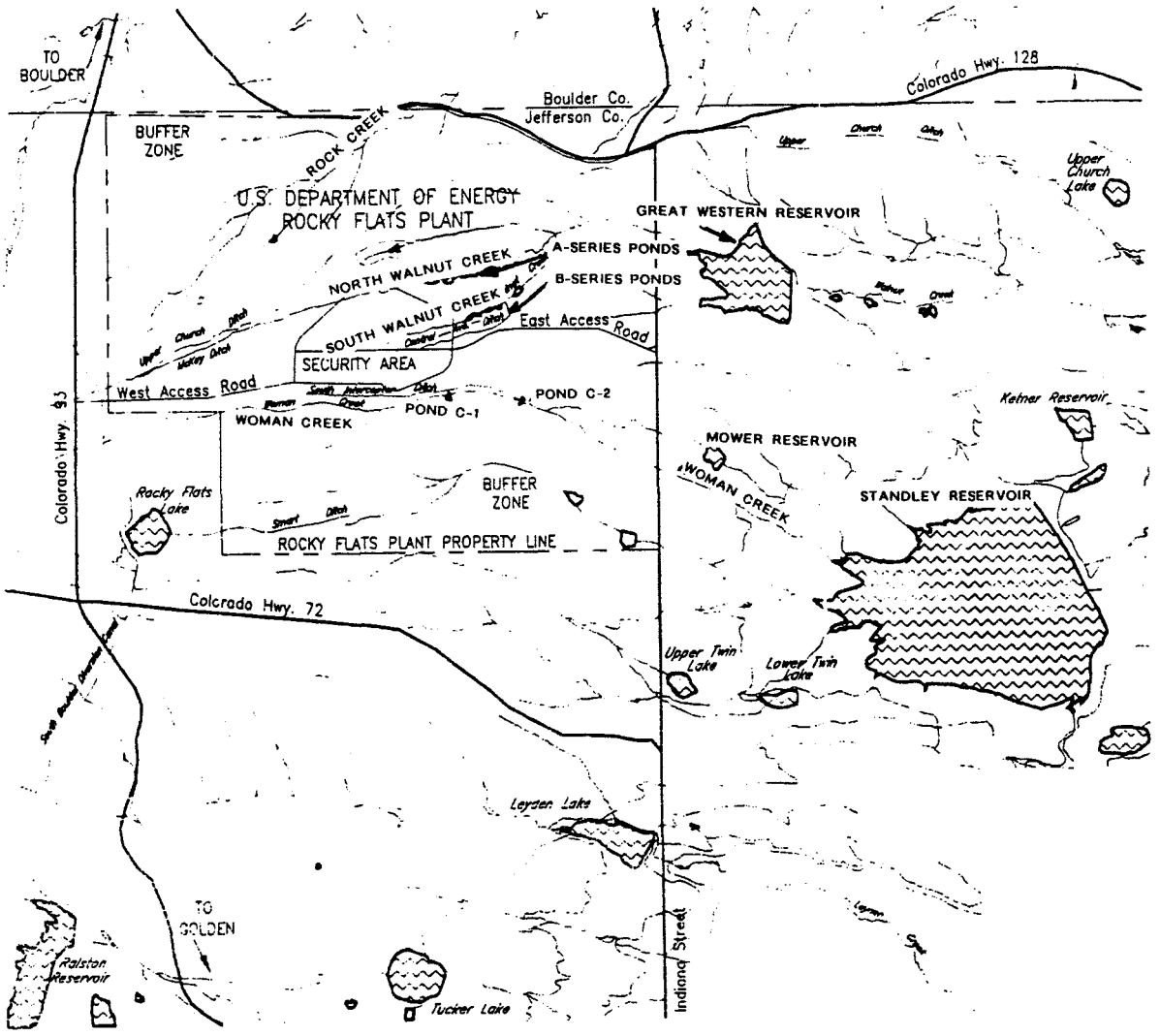

0 1.25 MILES

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FIGURE 1-3

SURFACE WATER FEATURES IN THE VICINITY OF ROCKY FLATS PLANT

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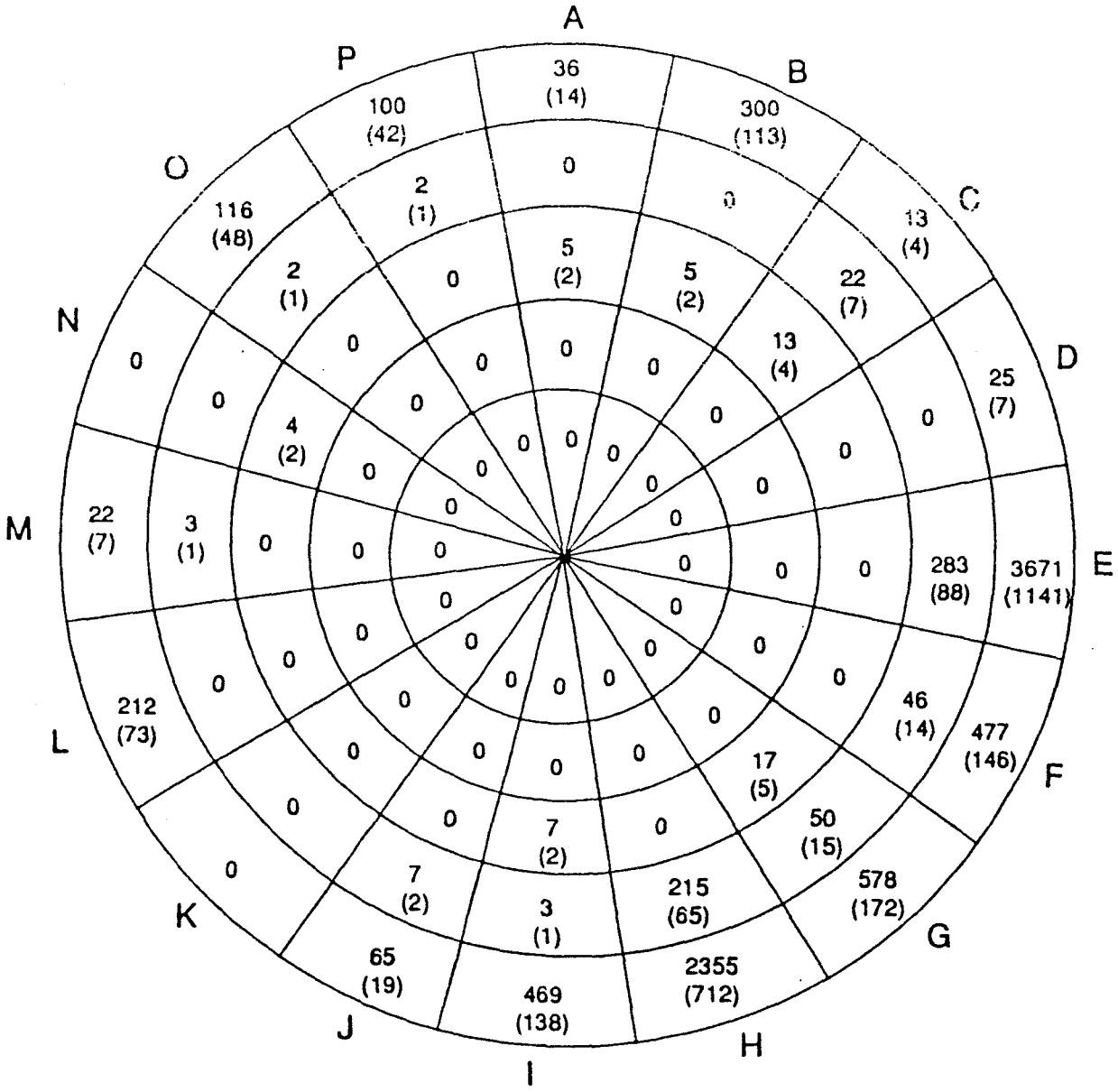

REFERENCE: DOE, 1989 POPULATION ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT (1991b)

Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5

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FIGURE 1-5

1989 POPULATIONS AND (HOUSEHOLDS) SECTORS 1-5

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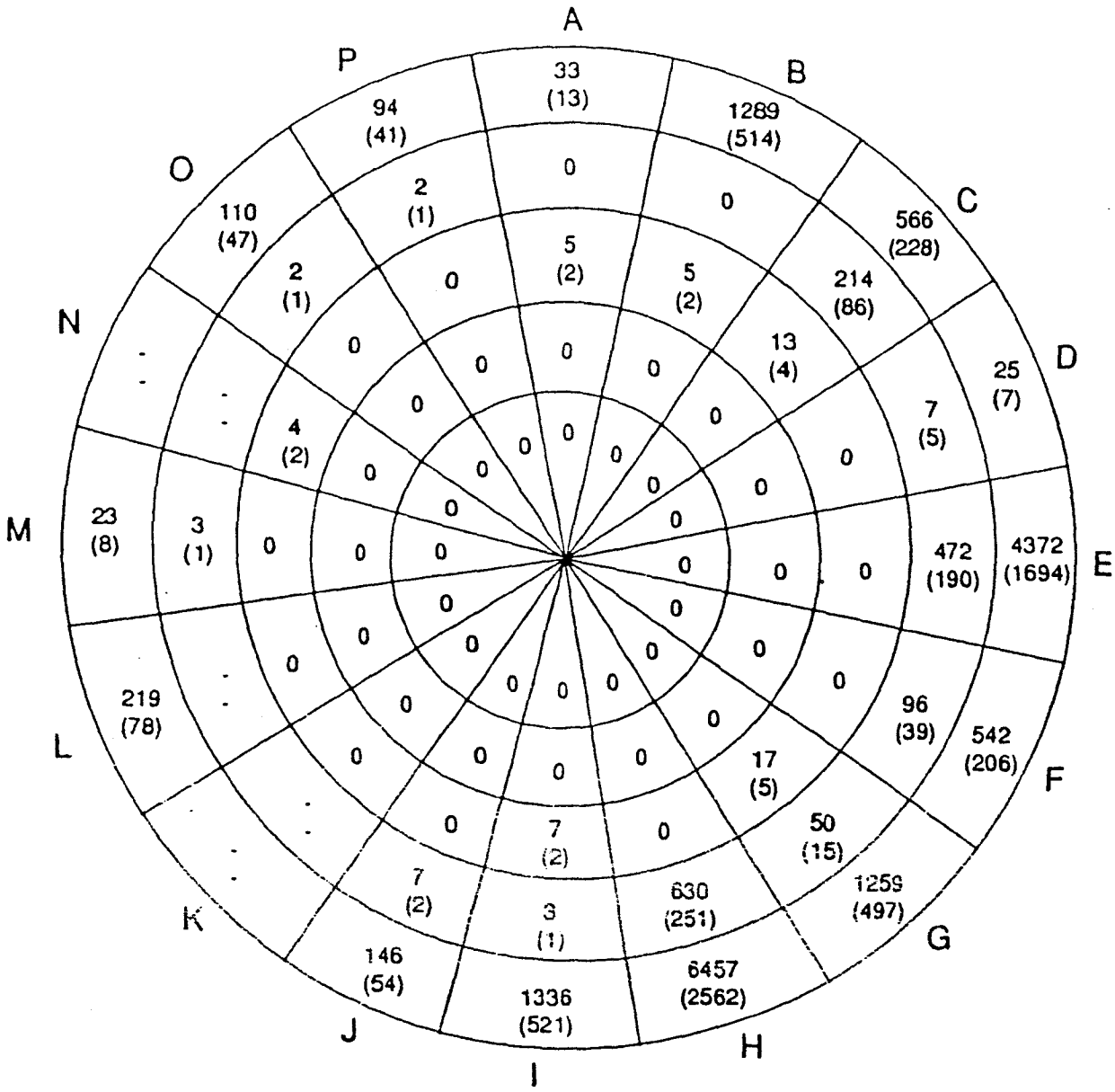

REFERENCE: DOE, 1989 POPULATION ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT (1991b)

Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5

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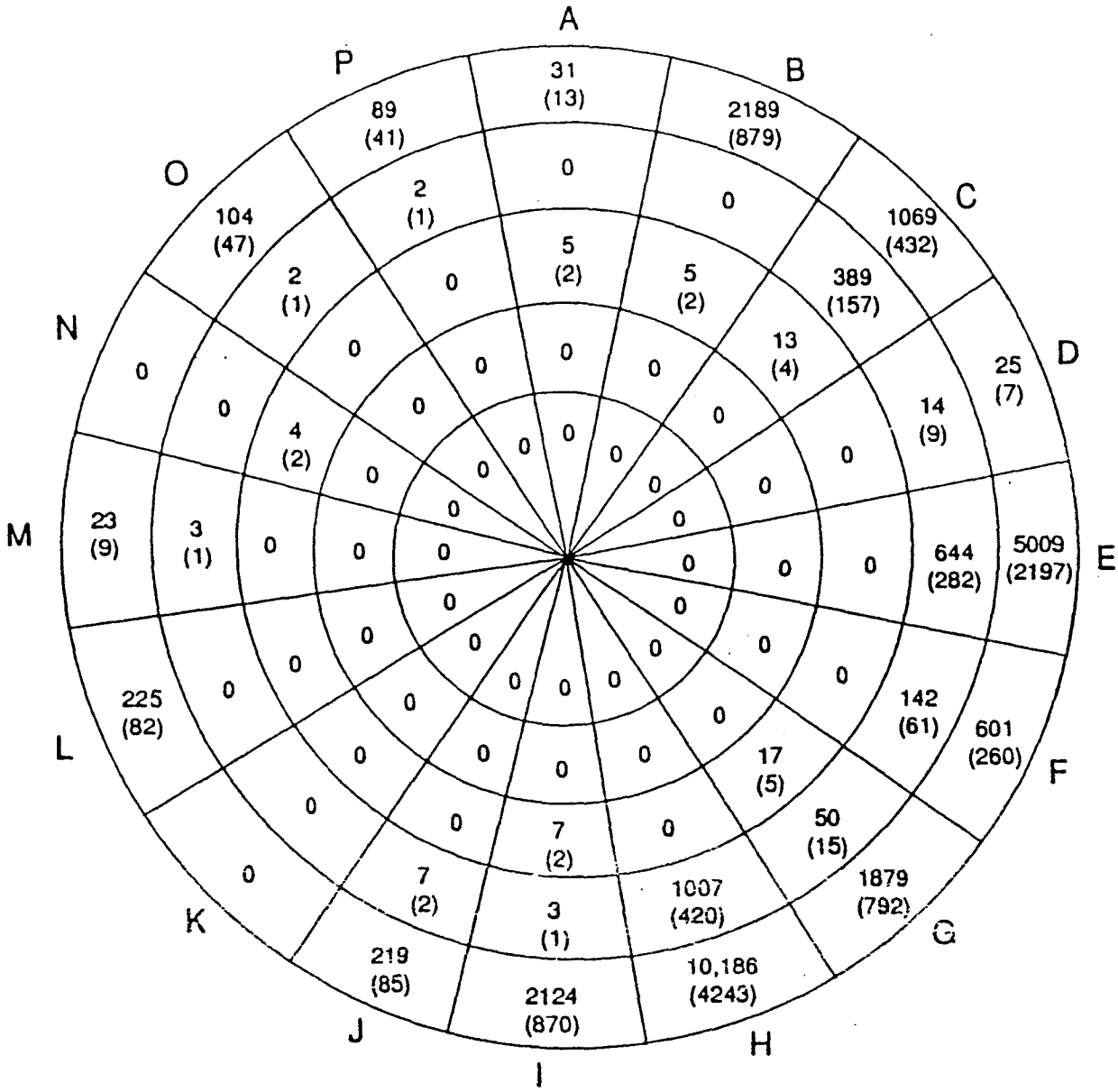
FIGURE 1-6

2000 ESTIMATED POPULATIONS AND (HOUSEHOLDS) SECTORS 1-5

REVISION NO. 0 | FILE NAME 40103\F01-106.DWG | DATE 4/30/92 | DRAWN BY JAA | APPROVED BY BJN | CHECKED BY BJN



REFERENCE: DOE, 1989 POPULATION ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT (1991b)

Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5

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FIGURE 1-7

2010 ESTIMATED POPULATIONS AND (HOUSEHOLDS) SECTORS 1-5

REVISION NO. 0 | FILE NAME 40103\F01-107.DWG | DATE 5/4/92 | DRAWN BY JAA | APPROVED BY BJN | CHECKED BY BJN

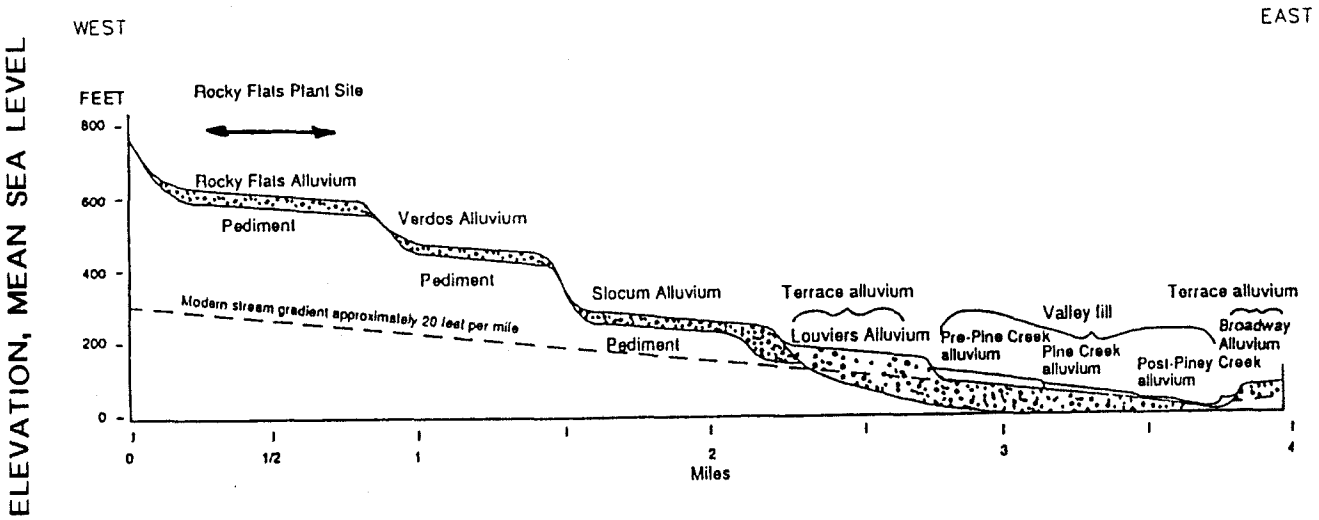

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FIGURE 1-9

EROSIONAL SURFACES AND ALLUVIAL DEPOSITS EAST OF THE FRONT RANGE, COLORADO

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CHECKED BY BJN	APPROVED BY BJN	DRAWN BY EMH	DATE 9/15/92	FILE NAME 40103\F01-110.DWG	REVISION NO. 0

Age	Formation	Thickness (feet)	Rocky Flats Graphic Section	Rocky Flats Graphic Section	Thickness (feet)	Formation	Summary Description
			EG&G (1991c) (central portion RFP)	This Study (EG&G 1992b)			
Quaternary	Rocky Flats Alluvium	0-100			10-20	Rocky Flats Alluvium	Clayey Sandy Gravels - reddish brown to yellowish brown matrix, grayish-orange to dark gray, poorly sorted, angular to subrounded, cobbles, coarse gravels, coarse sands and gravelly clays: varying amounts of caliche
Cretaceous	Arapahoe Formation	150	Sandstone #1 Sandstone #2 Sandstone #3 Sandstone #4 Sandstone #5		15-25	Arapahoe Fm.	Claystones, Silty Claystones, and Sandstone - light to medium olive-gray with some dark olive-black claystone and silty claystone weathers yellowish orange to yellowish brown; a mappable, light to olive gray, medium- to coarse-grained, frosted sandstone to conglomeratic sandstone occurs locally at the base (Arapahoe marker bed)
	Laramie Formation	800 upper interval: 500 lower interval: 300			600-800 upper interval: 300-500 lower interval: 300	Laramie Formation	Claystones, Silty Claystones, Clayey Sandstones, and Sandstones - kaolinitic, light to medium gray claystone and silty claystone and some dark gray to black carbonaceous claystone, thin (2') coal beds and thin discontinuous, very fine to medium-grained, moderately sorted sandstone intervals Claystones, Sandstones, and Coals - light to medium gray, fine- to coarse-grained, poorly to moderately sorted, silty, immature quartzitic sandstone with numerous lenticular, sub-bituminous coal beds and seams that range from 2' to 8' thick
	Fox Hills Sandstone	75-125			90-140	Fox Hills Sandstone	Sandstones - grayish orange to light gray, calcareous, fine-grained, subrounded, glauconitic, friable sandstone
	Pierre Shale and older units					Pierre Shale and older units	

LEGEND

- Alluvium-Sandy Gravel
- Conglomeratic Sandstone
- Fine to Medium Sandstone
- Very Fine to Fine Sandstone
- Claystones and Siltstones
- Claystones and Silty Claystones (Shale)

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FIGURE 1-10

REVISED STRATIGRAPHIC SECTION OF ROCKY FLATS CENTRAL PLANT

Approved by:

Manager, Remediation Programs 2/18/94

RI Project Manager 2/18/94

2.0 SITE CHARACTERIZATION

2.1 OPERABLE UNIT 12 BACKGROUND

Operable Unit 12 (OU12) originally consisted of 12 Individual Hazardous Substance Sites (IHSSs) identified in the 1986 Comprehensive Environmental Assessment and Response Program (CEARP). The boundaries of OU12 fall within the 400, 600, and 800 Rocky Flats Plant (RFP) building areas, as shown in Figure 2-1. The OU12 boundaries were established as a result of negotiations among the U.S. Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the U.S. Department of Energy (DOE) for the establishment of the Interagency Agreement (IAG). The IAG was signed in final form on January 22, 1991. On April 21, 1992, one IHSS (IHSS 147.1) was transferred to OU9 (Original Process Waste Lines) for investigation and remediation (CDH, 1992).

An ongoing investigation of the history and location of the 12 IHSSs originally identified in the IAG is summarized in the Historical Release Report (HRR) (EG&G, 1992c). Information contained in the HRR was obtained from record reviews and personnel interviews. The HRR indicates that of the original 12 IHSSs, in the IAG, only 10 remain in OU12. The existence of IAG IHSS 136.1 cannot be documented in the HRR and, therefore cannot be investigated, and IHSS 147.1 has been formally transferred to OU9. Table 2.1 lists the 12 original IHSSs identified in the CEARP, the 10 IHSSs remaining in OU12 as a result of the HRR, and the reason for discrepancies or location changes. The recent information developed in the HRR is the most complete and accurate compilation

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PER R.B. HOFFMAN, CLASSIFICATION OFFICE
JUNE 11, 1991

of IHSS history currently available and will be used as a basis of this work plan. The revised IHSS locations and historical accounts in the HRR will be used for development of the Field Sampling Plan (FSP). If inconsistencies in history or rationale are identified in the HRR, the original IHSS location will also be considered in development of the FSP.

The RFP 400, 600, and 800 building areas which encompass OU12 are in the southwestern portion of the main plant, which lies on an alluvial pediment referred to as the Rocky Flats Mesa. The pediment is an erosional surface capped with alluvial deposits, which slopes gently to the east at a dip of approximately one degree. Surface elevations at the site area range between 6,020 ft and 6,050 ft above mean sea level.

Access to certain OU12 IHSSs may be limited due to physical obstructions or security provisions. Much of OU12 is located in highly developed areas restricted by buildings, overhead lines, and underground utilities. The OU12 IHSSs contain a variety of chlorinated solvent and acid spills; impoundments that once held chromium, lithium, or solvent solutions; and possible radioactive contamination resulting from releases of stored material or process wastes. The 10 OU12 IHSSs are listed in Table 2.2 along with brief site descriptions, compounds reported or suspected at the site based on information in the HRR, and the anticipated current location of suspect compounds. In addition to the OU12 IHSSs, potential under-building contamination (UBC) exists within OU12 in the 400 and 800 building areas. Several previously unrecognized Potential Areas of Concern (PAC) have also been recently identified in the HRR (EG&G, 1992c). None of the UBCs or PACs are addressed in this work plan pending formal inclusion of PACs and UBCs into the RI/RFI process per the requirements of the IAG.

The following sections provide available historical descriptions of the OU12 IHSSs, UBCs, and PACs. The IHSS discussions are organized by geographic location, with IHSSs in the 400 building area described first, followed by those in the 600 building area and, finally, the single OU12 IHSS in the 800 building area. These historical descriptions are derived primarily from the HRR (EG&G, 1992c), supplemented with the CEARP IHSS summaries.

2.1.1 West Loading Dock Building 447 (IHSS 116.1)

The west loading dock, IHSS 116.1, is a staging and storage area associated with Building 447. The west loading dock, which has been in operation since 1956, is located on the north side of Building 447 and is west of Building 444 as shown in Figures 2-2 and 2-3. Figure 2-3 indicates the extent of paved areas, concrete pads, and soil or gravel covered areas. A photograph of IHSS 116.1 is presented in Figure 2-4. The location from which the photograph was taken and the direction towards which the camera was oriented are shown in Figure 2-3. The location of the west loading dock presented in the IAG agrees generally with the location determined in the HRR. However, low-level oblique photographs clearly show that the dock situated along the north side of Building 447 extends farther to the west than originally proposed (Norton, 1984).

Building 444 was put into use in 1953 for the manufacturing of depleted and enriched uranium components. Beryllium component manufacturing operations began in approximately 1958. Also, some normal uranium fabrication was performed in the early years of operation. Major processes conducted in the building included machining, welding, and cleaning. There is also a foundry and a laboratory in which parts can be etched, electroplated, and coated. Building 447 was put into service in 1956 and houses both assembly-related processes and waste-related processes. In Building 447, metal parts from Buildings 444 and 460 are cleaned, leak-tested, welded, and heat treated. The heat

MAY 27 1994

treatment process is designed to relieve stress and machining damage in the parts. In the past, a chip roaster was operated to convert depleted uranium chips from Building 444 to uranium oxide.

No details are documented concerning releases from the west loading dock. Drums containing nonradioactive solvents may have been stored on the dock (DOE, 1987). Dark staining of soil from spills and leaks of oil stored in drums near Building 453, located immediately north of the loading dock, have been documented and are being investigated in OU10. Spills and leaks may have contaminated soil and ground water beneath the dock (EG&G, 1992c). The nature of contamination for IHSS 116.1 is discussed in Section 2.4.

Two potentially contaminated sites that are not within OU12 are immediately adjacent to or overlap IHSS 116.1 boundaries. These sites are IHSS 208, which is the inactive 444/447 hazardous waste storage area, and PAC 400-801, where an electrical transformer may have leaked. IHSS 208 is identified as a temporary storage area for metal plating solutions in a 20 ft by 8 ft cargo container. There are no documented leaks from the cargo container. As agreed upon in the IAG, IHSS 208 is to be studied as part of Operable Unit 10. PAC 400-801 is identified as a transformer, formerly located on the roof of Building 447, which may have released polychlorinated biphenyl (PCB) contaminated runoff that infiltrated soils adjacent to Building 447. PCB investigations are typically not included in the OU12 RFI/RI and are likely to be addressed in another program for PCBs. Due to the proximity of IHSS 116.1 to the former transformer, and the potential for runoff to have infiltrated soils in the area, samples collected at IHSS 116.1 will be analyzed for PCBs as described in Section 6.0.

2.1.2 South Loading Dock Building 444 (IHSS 116.2)

The south loading dock, which has been in operation since 1953, is located on the south side of Building 444 as shown on Figure 2-2. The location of the south loading dock (IHSS 116.2) is shown in Figures 2-3 and 2-5, and a photograph of IHSS 116.2 is presented in Figure 2-6. The IAG located the south loading dock west of the plenum, which is south of Building 444. Low-level oblique photographs clearly indicate that the dock is east of this plenum as shown in Figure 2-6.

Many incidents have contributed to possible contamination in the south loading dock area:

- In 1953, high winds blew the lids off drums stored in this area, releasing uranium onto the dock, sidewalks, and driveways;
- On August 30, 1954 while vacuuming in a centrifuge, the motor of a portable vacuum shorted out. When the chips in the vacuum receptacle ignited, the receptacle was taken to the dock (known then as Dock No. 2). To extinguish the fire, the bag's contents were transferred to a steel drum and Metal-X powder was added. The explosive nature of the burning material released airborne uranium contamination to the outside atmosphere and covered the dock and the adjacent areaway with uranium oxide. The areaway is the pit entrance to the basement that is used to store cyanide and graphite storage drums. After the vacuum incident, the dock was cleaned, but there is no record that the pit inside the areaway was decontaminated.
- In October 1955, a 55-gallon drum of perclene (tetrachloroethylene) still bottoms and nitric acid stored on the dock burst and released contamination to the area; and
- Until 1970, chlorinated hydrocarbon solvents used to rinse beryllium parts were disposed of on the ground outside Room 106 which opens to the dock.

Details regarding the nature of contamination for IHSS 116.2 are presented in Section 2.4.

2.1.3 Cooling Tower Pond West of Building 444 (IHSS 136.1)

Two former cooling tower ponds have been identified in the vicinity of Buildings 444 and 447 as described in this and the following subsection. IHSS 136.1 is the cooling tower pond west of Building 444, used between 1956 and 1969, to hold blowdown from the cooling tower in Buildings 447 and possibly Building 444.

The location of IHSS 136.1 is shown in Figure 2-7. A 1965 historical photograph of IHSS 136.1 is presented in Figure 2-8. Although reference to three cooling water ponds in the vicinity of Building 444 was made in the CEARP Phase I report (DOE, 1986), documentation examined during the HRR search supported the existence of only two ponds (EG&G, 1992c). The pond located west and north of Building 447 (IHSS 136.1) can be seen clearly in an aerial photograph taken in 1965 (RFP Photograph 10620-17). It is located north and west of the location described in the IAG as IHSS 136.3. As indicated in Table 2.1, IHSS 136.3 identified in the IAG is the same as IHSS 136.1 identified in the HRR. The nature of contamination at IHSS 136.1 is discussed in Section 2.4. As shown in Figure 2-7, the former pond location is now partially or completely covered by Building 460, above ground tanks, and pavement.

2.1.4 Cooling Tower Pond East of Building 444 (IHSS 136.2)

The location map and 1969 historical photograph for IHSS 136.2 appear in Figures 2-9 and 2-10, respectively. Every document found addressing the location of cooling tower ponds in the 400 area describes one as being "due east of Building 444" or "east of the Building 444 exclusion fence," which is assumed to be IHSS 136.2. The pond was reportedly utilized on May 25, 26, and 27, 1956 by an outside contractor (Dowell) to collect the various solutions used during cleaning of the Building 444 cooling tower. Typical solutions used to clean cooling towers are acidic or contain chromate as described in Section 2.4. In

September 1956, when the liquid had evaporated and percolated away, the pond was backfilled. On December 2, 1958 cooling water from Building 447 was reportedly pumped to a surface ditch and allowed to flow across plant site (PAC 000-502). Previous to 1958, drainage and flushing of the cooling water had been diverted to the cooling tower blowdown pond east of Building 444, not to a surface ditch making the 1958 documentation unclear. The several references to a pond east of Building 444 may have been referring to the pond used by Dowell in 1956, or other standing water observed in the same relative location in later photographs.

The exact location of IHSS 136.2 is unclear based on maps and text in the HRR. The pond may have been the standing water observed in aerial photographs (Figure 2-10) although the date of the photograph is documented to be later than the date the pond was backfilled. This location best fits the description of the pond used during the Dowell operation, however, and it is also close to the cooling tower which is immediately east of Building 444. The probable use of this general area as a cooling tower blowdown pond is substantiated by interviews conducted during the HRR with a retired RFP employee. Another interview conducted during the HRR indicated an oily sheen visible on the surface of the pond. The nature of contamination for IHSS 136.2 is discussed in Section 2.4.

2.1.5 Radioactive Site South Area (IHSS 157.2)

The radioactive site south area (IHSS 157.2) is located within a secured area at RFP, and includes the soil and paved area surrounding Buildings 444, 447, 440, and 439. Prior to 1973, soils in the vicinity were reported to contain low levels of uranium and chemical contamination. Buildings 439 and 440 also had possible infiltration of hydraulic oil and carbon tetrachloride originating from the uranium machine tool storage area (DOE, 1987). A uranium machine tool storage area was documented to be in the present location of

Building 460 as shown in Figure 2-11. The western boundary of IHSS 157.2 has been extended to the west in the HRR from what was presented in the IAG to encompass the former uranium machine tool storage area, south to include the northern portions of Buildings 440 and 439, and east in an arc that follows the railroad spur. The extension of the boundaries is intended to include other activities that took place from 1953 to the present in the general area included within this site. IHSS 157.2 also includes contamination beneath Building 444 (EG&G, 1992c), which is described in Section 2.1.9, Under-Building Contamination. Figure 2-11 illustrates the present configuration of IHSS 157.2 including paved areas. Figure 2-12 contains a historical photograph dated June 5, 1969 of the entire IHSS 157.2 area.

Several operations associated with Building 444 may have contributed to potential contamination in the area. Probably the most significant event occurred near the south dock (IHSS 116.2) where solvents, used to rinse beryllium parts, were disposed of onto the ground. Details of activities on this dock are described in Section 2.1.2. Soil sampling conducted twice in 1954 indicated radioactivity levels two and three times that of background in a ditch south of Building 444 (EG&G, 1992c). Neither the sample locations nor radioactivity results were documented in the HRR.

An ingot open storage area east of Building 444, a metal storage area to the south of the building, and a uranium machine tool storage area to the west may have contributed to low-level soil contamination. As mentioned previously, the uranium machine tool storage area is under Building 460 and cannot be investigated in this plan. The other areas will be investigated in IHSS 157.2. There have also been cooling tower ponds in the area, previously described under IHSSs 136.1 and 136.2, Sections 2.1.1 and 2.1.2, respectively.

Numerous incidents are mentioned in documents found during the HRR search that indicate potential contaminant releases to the IHSS 157.2 area; however, most of them provide few details. The reported incidents are discussed below. Potential contaminants are discussed in Section 2.4.

- In May 1960, a vacuum collector fire in Building 447 resulted in the release of approximately 44 microCuries of depleted uranium. The depleted uranium was deposited on the roof of the building.

- In December 1962, a uranium and beryllium release from Building 444 occurred through an unfiltered hood that vented to the exterior of the building.

- In June 1966, a process waste line broke to the north of Building 444.

- On November 11, 1974, approximately 170 square feet (ft^2) of road south of Building 444 (probably Cedar Avenue) was contaminated when a barrel containing uranium chips was dropped during transfer.

- Low-level oblique photographs taken in 1965 indicate drum storage west of Building 444 in a location that is now covered by Building 460 (EG&G, 1992c). Similar photographs taken in 1969 indicate a drum storage area at the southeast corner of Building 444, Figure 2-10 in this report (RFP Photograph 13677-08, 1969). The contents of these drums is not known; however, drums containing cyanide and graphite were known to be stored downstairs through an areaway adjacent to the south loading dock.

- Near the southeast corner of Building 444, very close to the railroad tracks, a small building can be seen in the 1969 RFP photographs. The ground around this building is covered with a white substance that is related to sandblasting operations (PAC 400-807). Also, just west of Building 445 in the ditch near the railroad tracks, there was a pool of water which may have been the cooling water pond identified in the HRR as IHSS 136.2 (RFP Photograph 13676-10, 1969), Figure 2-10 in this report.

- RFP photographs taken in 1978 show poor housekeeping in the area of Building 440. The area is littered with miscellaneous materials such as pallets,

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open paint cans, and machinery. There are also cargo containers located north of the building (RFP Photographs 22923-22927, est. 1979).

- On February 23, 1978 a fire in the air plenum south of Building 444, which services the beryllium machining operations in Room 107, resulted in the release of an estimated 14.5 grams of beryllium. There was a large cleanup attempt after the Building 444 plenum fire. Firemen responding to the alarm began spraying the exterior of the plenum with water where the paint had started to blister and other areas around the plenum to settle the contaminated dust. Temporary dams were established in the ditches south and east of the building and samples were taken of the firewater impounded there. Laboratory analysis revealed 1.6 milligram per liter (mg/l) beryllium in the east ditch and 4.3 mg/l in the south ditch, respectively. These values compare to 0.0024 mg/l mean background concentration for surface water samples reported in the Background Geochemical Characterization Report (EG&G, 1990a). This water was sent to Building 774 for processing. Personnel who were in the building at the time of the fire were sent to Building 881 for showers. The shower water was retained until analytical results indicated that there was no beryllium present.

- An incident occurred on November 4, 1985 involving pressurization of a process line in Building 447. The incident report for the spill is in Appendix B (Ref. 1600551). The pressure forced liquid through a floor drain and up the vent pipe onto the roof where it ran into the gutter and onto the ground below. The location of the vent pipe was in Room 502, although the specific area of the release onto the ground was not provided in the incident report. Documented radioactive contamination levels were as high as 10,000 counts per minute (cpm) beta activity. The area affected by the process waste overflow was decontaminated to below 250 cpm or else painted to contain the radioactivity. The drain that was involved was to have been relocated and a ball check valve installed on the vent pipe.

- While transferring three drums across the plant site on November 30, 1990 one drum containing beryllium ingots was discovered to be radioactive. All areas were smeared along the path the barrels had been taken, and high smears (more than 25 cpm/ft^2) were found just outside the Building 444 beryllium machine shop at the exit/entrance door. The path of the drums is not documented in the HRR and the extent to which it is within OU12 cannot be determined.

Little documentation has been found that specifically indicates cleanup of these incidents, except where noted in the discussion. The nature of the contamination resulting from these reported releases is discussed in Section 2.4.

2.1.6 Sulfuric Acid Spill (IHSS 187)

The sulfuric acid spill (IHSS 187) occurred on September 11, 1970 from an aboveground 3,000 gallon tank located approximately 30 ft east of Building 443. About 1,500 gallons of acid spilled from the tank and drained eastward, where the acid was captured in an earthen pit and neutralized with lime. The location of IHSS 187 is shown on Figure 2-13 and is located east of Building 443, extending into an area now occupied by Building 452. Figure 2-14 is a schematic drawing of the path that the acid flowed in 1970, the earthen pits, and where the neutralized acid was temporarily stored. Figures 2-15, 2-16, and 2-17 are photographs taken from various locations within IHSS 187. Much of the area has been graded and buildings, tanks, and sidewalks are now present at the previous spill location. Documentation regarding the spill and cleanup activities is in Appendix B.

Building 443 was placed in service in 1953 and houses the steam generation plant. Water is softened and transferred to boilers to make steam for use in process heating and cleaning operations. The steam boilers are normally operated using natural gas, although Number 6 diesel fuel is used as a backup fuel. This fuel is stored in two large aboveground tanks that are located about one block east of Building 443. Aboveground tanks containing sulfuric acid and sodium hydroxide are located on the east side of the building. These materials are used for boiler descaling and neutralization.

The 3,000-gallon acid tank associated with IHSS 187 was salvaged from Building 881 where it had been stored an estimated eight to ten months after decontamination. At the time of

installation, the drain line was equipped with a nonstandard valve and flange. The piping system was hydrostatically tested on July 2, 1970. The tank was filled with water and left for three weeks and was determined to have no leaks. After the water was drained from the tank, the valves and gaskets were changed.

From the drain valve of the acid tank, a pipe extended to a 200 gallon mixing tank situated over a 7,000 gallon concrete, PVC-lined neutralizing tank inside Building 443. Figure 2-18 is a schematic drawing of the acid tank and neutralizing process, and indicates neutralizing tank effluent is discharged to the sanitary sewer system. Prior to filling the acid tank, it was verified that the tank was empty by opening all valves and noting that no drainage occurred to the mixing tank. The tank was filled with acid on September 3, 1970. During filling, it was discovered that the level indicator was not functioning which resulted in an overflow of approximately 1/2-gallon of sulfuric acid. Another spill occurred when the transfer hose was removed and was allowed to drain onto the ground. Both spills were neutralized with caustic. The tank was then locked out.

On September 11, 1970 a sulfuric acid stream about 1/4 inch in diameter was found spraying out about 4 ft from the flange above the drain valve. After discovery of the leak, the fire department began spraying the tank and the surrounding area with water. High winds were carrying the acid and fumes to the south and east; therefore, this procedure was curtailed. Lime was added to neutralize the sulfuric acid.

The lockout chain was cut and the acid allowed to drain to the mixing tank inside Building 443. The mixing tank was adapted with a flexible hose which would let the acid drain into the neutralizing tank. Approximately nine hours after the leak was detected, the tank was completely emptied.

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Because the tank was not equipped with secondary containment, the acid emanating from the flange drained through a culvert under Fifth Street and along a ditch south of Building 442. The acid continued to flow northward along a north-south ditch east of Building 442 and west to ponds that were constructed to contain the acid. One pond measured roughly 75 ft by 25 ft and the other was about 25 ft by 25 ft.

On September 12, 1970, it was discovered that the neutralization tank inside Building 443 was leaking from the drain valve into the sanitary sewer line and into the sewage treatment plant (Building 995). The acid was transferred from the neutralization tank to 24 polyethylene-lined barrels that were placed near the earthen pits in Figure 2-14. The investigative report on this incident states that the drums were surrounded by a dike, but photographs taken on September 14, 1970 do not show a dike (RFP Photograph 14686, 1970).

The drain valve on the neutralization tank had not been inspected since its installation in 1966. Dirt was found on the acid tank which may have contributed to the inadequate closure of the neutralization tank valve.

No documentation was found which detailed the removal of contaminated soil. However, photographs indicate excavation of soils immediately adjacent to the tank. The nature of potential contamination resulting from the spill is discussed in Section 2.4.

2.1.7 Fiberglassing Areas North of Building 664 (IHSS 120.1)

The fiberglassing area referred to as IHSS 120.1 is located north of Building 664. A fiberglass panel shed is located within the IHSS, and the area is fenced. The IHSS 120.1 location and photograph are shown in Figures 2-19 and 2-20, respectively.

The fiberglassing area described in this and the next subsection were used during the period between 1972 and 1979 to fiberglass waste packing boxes. The fiberglassing process may have resulted in spills of polyester resin, peroxide catalyst materials, and cleaning solvents, although no documentation of spills was indicated in HRR research. The nature of any contaminants resulting from the fiberglassing area IHSSs is discussed in Section 2.4.

2.1.8 Fiberglassing Area West of Building 664 (IHSS 120.2)

The location and photograph for IHSS 120.2 are shown in Figures 2-21 and 2-22, respectively. Building 664 became operational in 1972 and is used for storage, staging, loading, and shipping of radioactive wastes. Building 664 contains a fiberglass application operation and a Real Time Radiography unit.

The fiberglassing area west of Building 664 (IHSS 120.2) is fully encompassed by IHSS 161, which is to be investigated as part of OU14. IHSS 161 may contain low-level residual plutonium and uranium contamination resulting from punctured or leaking drums and boxes of solid and liquid wastes. In accordance with the IAG, IHSS 161 will be investigated as part of OU14. However, the radiological survey and surficial sampling to be undertaken at IHSS 120.2 within OU12, will provide preliminary information on the extent of contamination at IHSS 161. Activities planned at IHSS 120.2 are described in Section 6.0, Field Sampling Plan.

2.1.9 Nitric Acid Tanks (IHSS 189)

This IHSS was originally identified as Multiple Acid Spills, 800 area. However, specific information from the CEARP is vague regarding location. Interviewees for CEARP Phase I indicated that the "nitric acid receiving area (218) located north of Building 881" was the location of numerous small spills during acid transfer and operation. Other interviewees for

the same document indicated the nitric acid farm west of Building 881 was the location of spills which were rinsed off onto the ground. These interviewees defined the IHSS as multiple acid spills north and west of Building 881.

IHSS 189 has been mapped in the location of the 218 Acid Tanks as indicated on Figures 2-23 and 2-24. Two, approximately 10,000 gallon, storage tanks are located adjacent to the railroad tracks east of Building 444 and south of Cottonwood Avenue. The tanks have been used for the storage of nitric acid since 1952 and are assigned the facility number 218. The tanks supply acid to Building 771 and Building 883. The tanks are within concrete containment structures, but it is not known if these structures were there historically. Numerous spills of unknown volume were reported during the filling and transfer of nitric acid from these tanks, but only the following specific incidents from the HRR were documented (EG&G, 1992c). Documentation of spills at the nitric acid tanks is included in Appendix B.

On October 27, 1982, a brown cloud was observed coming from the Building 218 nitric acid tank during loading from an acid transport truck. The incident was reported to RFP environmental personnel. On September 24, 1985, an unspecified volume spill of nitric acid occurred during a vendor tank filling operation. The spill was neutralized with two containers of unknown size of sodium bicarbonate. On June 28, 1986, approximately one gallon of nitric acid spilled on the ground at the acid storage tank, apparently caused by failure of the automatic shutoff system. The release was neutralized with an application of sodium bicarbonate, and the incident was reported. It should be noted that, at one time, there were overhead acid pipelines between the 218 tanks and the northwest side of Building 881. It is not unlikely that the lines were hit by vehicular traffic at times causing the acid to spill on the ground, which may have been the source of releases identified in the

CEARP as north and west of Building 881. The nature of contamination resulting from these releases is discussed in Section 2.4.

2.1.10 Process Waste Line Leaks (IHSS 147.1)

Process waste line leaks (147.1) were reported to have occurred in the approximate location of IHSS 147.1 on Figure 2-25. Several other leaks have been documented at multiple areas in the Original Process Waste Lines (OPWL) system. Figure 2-28 shows the original process waste lines located in OU12. The lines themselves are part of the OPWL system, designated as OU9, as are most of the reported spill locations. Originally IHSS 147.1 was to be investigated in OU12. Due to the nature of the spill at this location however, this IHSS has been transferred to OU9 for investigation. No further discussion of IHSS 147.1 is presented in this work plan.

2.1.11 Building 881 Conversion Activity (IHSS 147.2)

Persons interviewed during preparation of the CEARP Phase I document stated that low-level radioactive contamination was thought to exist north of Building 881 due to leaks in the process waste lines; however there are no process waste lines in the area of IAG IHSS 147.2. This suspected low-level radioactive contamination may be associated with the storage of items from Building 881 conversion activities, which occurred between 1964 and 1966. No documentation could be found in HRR research that indicates a release due to conversion activities in the location given in the IAG. The HRR recommended relocating IHSS 147.2 to the conversion activity storage area shown in aerial photographs. The site is located approximately 150 feet south of Building 865, about 250 ft east of Building 883 and 450 ft south of Central Avenue. It measures approximately 50 ft by 150 ft (EPA Photograph VB BL 3-7 1964). The location and a photograph of IHSS 147.2 appear in Figures 2-26 and 2-27, respectively.

Building 881 was placed into service in 1953 as an enriched uranium components production building. The building also contained a laundry, an analytical laboratory, and facilities for chemically recovering enriched uranium from manufacturing wastes. In the mid-1960's, all enriched uranium manufacturing activities ceased and Building 881 was converted to a nonradioactive metals fabrication facility.

No documentation was found which detailed when items were first stored south of Building 881. Interviews with former RFP employees indicate that miscellaneous equipment was stored in this area such as lathe and rolling mill parts. Aerial photographs show items in this area as early as 1964 (EPA Photograph VB BL 3-7, 1964) and again in 1966 (EPA Photograph AIN IKK 154, 1968). By 1969, the area had been covered by a parking lot. Figure 2-26 shows that currently IHSS 147.2 is partially covered by pavement. The nature of potential contamination associated with IHSS 147.2 is discussed in Section 2.4.

2.1.12 Under-Building Contamination (UBC-439, 447, 881, 883, and 889, 400 & 800 Areas)

The following buildings in the 400 and 800 areas within the OU12 boundaries have been identified as potential areas of concern (PAC) due to the possibility of contamination occurring beneath existing structures:

- Building 444 (UBC-discussed as IHSS 157.2);
- Building 447 (UBC-447);
- Building 881 (UBC-881);
- Building 883 (UBC-883); and
- Building 889 (UBC-889).

The PAC reference number for these sites is UBC followed by the building number. No UBC-PACs have been identified within the 600 area. UBC-PACs within OU12 are not in the IAG, and are therefore outside the scope of this investigation.

Soil and/or ground water beneath the identified buildings may have become contaminated because of the nature of the activities within these buildings. Numerous indoor unplanned events and routine operations may have led to under-building contamination. These events are not all similar in nature or scope. Some of these unplanned events have involved extremely small spills of hazardous materials while others have been major industrial accidents. In addition to these identifiable events, there is also the possibility of routine operations contributing to under-building contamination. For example, leaking process waste lines could contribute to under-building contamination. Leakage from such lines is generally cleaned up upon its identification, but at times the affected environment is under a building and is not remediated. Tanks associated with these buildings may have leaked or may have been overfilled causing a release to the environment. Building sumps, floors, and foundation walls may have cracks or be otherwise unsealed and have created a pathway for contamination of the environment beneath the building.

Some of the events that may have led to under-building contamination within OU12 are listed below. These events include several spills which may have migrated to soils beneath the building via floor drains, joints, or cracks. This list is not intended to be complete, but is representative of the types of events that may have led to under-building contamination.

UBC-439, 444, 447	A vacuum collector fire in Building 447 in May 1960 and a uranium/beryllium release through an exterior vented hood in December 1962 from Building 444 may have dispersed airborne uranium and beryllium throughout portions of the 400 Area.

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Building 439, Building 444, and Building 447 are suspected to be radioactively contaminated to some degree including the footings and foundations of these buildings.

UBC-444

This building houses general fabrication operations. These operations include machining, casting, and other related operations. Use of this building began in 1953.

The sewage treatment plant received a greenish substance which was traced back to Building 444 and an incident involving the overflow of a chromic acid solution from a hazardous waste tank. Chromic acid solution overtopped a plating bath, emptied into a trough leading to a RCRA tank, overtopped into the secondary containment berm, then spilled onto the floor and into a sump and building footing drains. The footing drains empty to the sewage treatment plant, where the green substance was observed. This incident, which occurred on February 22, 1989, resulted in the filing of a RCRA Contingency Plan Implementation Report (89-001) which is included in Appendix B. There is no information to determine if chromic acid migrated below Building 444 or its footing drains.

A continuous flow fabric filter in Room 1 of Building 444 overflowed, spilling low-level radioactively contaminated liquid onto the floor in the area of the filter. This incident occurred on July 7, 1989, and resulted in the filing of a RCRA Contingency Plan Implementation Report (89-010). This report is included in Appendix B.

A 65-gallon spill of process waste water occurred in Room 1 at a temporary bypass for a filter. This incident occurred on September 29, 1989, and resulted in the filing of a RCRA Contingency Plan Implementation Report (89-014), included in Appendix B.

Approximately 2,000 gallons of process waste water leaked from a fume scrubber tank in Room 204 on October 25, 1989. This

incident resulted in the filing of a RCRA Contingency Plan Implementation Report (89-017), which is included in Appendix B.

Water used in the suppression of a fire in Room 245 flooded the floor and several baths containing gold cyanide plating solution, sulfuric acid, hydrochloric acid, and nickel. The water flowed through floor drains and overflowed waste tanks in rooms 9, 10, and 11. This incident occurred on May 21, 1990 and a RCRA Contingency Plan Implementation Report (90-005) was filed.

UBC-881 Building 881 currently houses primarily laboratory and office support operations. Various other operations have been conducted in this building such as uranium recovery, machining, and fabrication. Use of this building began in 1953. Waste lines have been broken with possible infiltration of the underlying soil.

UBC-883 This building houses general rolling, forming, and forging operations. Use of this building began in 1957. On October 27, 1989, process waste water was noted to be overflowing from a tank in Room 139 and some of the water flowed under the wall. This incident resulted in the filing of a RCRA Contingency Plan Implementation Report (89-018), which is included in Appendix B.

In addition to the information available on specific events in or near buildings that may have led to under-building contamination, there are also data that indicate the presence of contamination under Building 444. As part of routine footing drain and event-related sampling programs, footing drain and building sump samples have been collected. These samples have historically been analyzed for total dissolved solids, conductivity, nitrate, nitrogen, pH, gross alpha activity, gross beta activity, and tritium activity. Buildings in OU12 that have footing drains include Buildings 444, 883, and 881. Engineering drawings showing footing drain locations and footing drain sample analysis results obtained during finalization of this work plan are in Appendix C. Elevated concentrations of some contaminant or indicator parameter have been noted at least once in building sump BS 444-2 (EG&G,

1992c). Building sump locations are shown in Figure 2-28. Additionally, buried process waste lines, pipes, and other materials may be contaminated even though the use of the building has changed and these pipes and other materials may no longer be in use. As part of the OU12 field sampling plan, additional footing drain analytical data will be obtained, reviewed, and the need for additional sampling evaluated.

2.2 PREVIOUS INVESTIGATIONS AND OTHER OPERABLE UNIT IMPACTS

The following sections discuss prior investigation activities which have been conducted within OU12, and describe the potential impacts of activities planned for other OUs.

2.2.1 Previous Investigations

Investigation of OU12 is required according to the IAG which was drafted on January 22, 1991, since no specific OU12 IHSS investigations have been conducted. Many of the IHSSs contained within OU12 were previously identified during plant-wide investigations discussed in Section 1.3.2. The CEARP Phase I investigation identified 12 IHSSs (originally referred to as Solid Waste Management Units) in OU12. The more recent HRR has researched and refined the specific locations of the 10 remaining IHSSs described in Section 2.1. Previous site-wide monitoring programs have resulted in the installation of numerous soil borings throughout the industrial area, including OU12. Many of these borings have been completed as piezometers or monitoring wells. The latest RCRA Monitoring Report (EG&G, 1992g) addresses ground water quality upgradient and downgradient of OU12. Available geologic and ground water data from these wells are presented and discussed in Section 2.3. RFP has also been the subject of numerous radiometric surveys, many of which were conducted in the OU12 area. A site-wide assessment of PCB releases has recently been conducted (EG&G, 1991h) which includes the OU12 area. The following sections discuss radiometric surveys, the HRR, PCB assessment, and the RCRA Monitoring Report.

2.2.1.1 Radiometric Surveys

Numerous radiometric surveys have been conducted at the RFP. The radiometric data that were collected during the time period 1977 to 1984 included in Appendix D, evolved from the use of Field Instrument for Detecting Low Energy Radiation (FIDLER) type research instruments designed to identify methods to evaluate contamination in soil. Experimental instruments were being used at the RFP as early as 1971 or 1972. A plant-wide survey begun in 1977 and completed in September 1984 accomplished its purpose of locating abnormal radiation levels in the soil of the RFP and confirmed that large areas of the plant have higher than environmentally acceptable levels of radioactive contamination. Appendix D contains the results of this survey as they apply to OU12.

2.2.1.2 Historical Release Report (HRR)

The purpose of the HRR is to provide information on existing and potentially new IHSSs at RFP. The scope of the HRR is derived from the IAG, which stipulates that the HRR will provide a complete listing of all spills, releases, and incidents involving hazardous substances occurring since the inception of the RFP. The HRR project was structured to provide a reasonable and diligent effort towards meeting this goal, focusing on incidental releases that took place outdoors or had an immediate impact on the out-of-building environment, and on waste management practices that have been discontinued due to environmental concerns. In addition, the HRR addresses the potential cumulative effects of inside-building releases on the environment beneath the buildings, and discusses known and potential environmental releases outside the RFP boundaries due to RFP activities.

2.2.1.3 PCB Assessment

A site-wide assessment conducted in 1991 has identified 35 documented or potential PCB contaminated sites at RFP (EG&G, 1991h). Thirteen of the identified sites fall within or

close to OU12 boundaries. The assessment was based on document and record review, personnel interviews, and sampling and analysis. DOE has proposed to the agencies that PCB sites will be investigated under the Toxic Substance Control Act (TSCA) not in the RFI/RI. However, PCBs are included in the analytical suite for samples collected at OU12 IHSSs in which PCB-contaminated runoff may have infiltrated soils.

2.2.2 Impacts from Other Operable Units

Some of the OU12 IHSSs located in the 400, 600, and 800 building areas may be impacted not only by events identified for that IHSS, but also by activities occurring at nearby or overlapping IHSSs contained in other OUs. The following sections describe the other OUs in the area. The primary OUs of concern include OU9 (Original Process Waste Lines), OU10 (Other Outside Closures), OU13 (the 100 Area), and OU14 (Radioactive Sites). Historical information and investigations planned for IHSSs that are in other OUs and are near to or overlap OU12 IHSSs have been considered in developing the OU12 Field Sampling Plan to avoid duplication of effort, or to alter the OU12 analytical suite, if necessary. In the event IHSSs from other OUs commence field activities prior to OU12, FSP data needs will be conveyed to the other OU in an effort to combine activities and/or streamline the schedule. Similarly, if OU12 commences field activities first, OU12 will evaluate data needs at overlapping IHSSs from other OUs, and attempt to similarly accommodate data needs.

2.2.2.1 OU9 (Original Process Waste Lines)

Numerous OPWLs and the associated IHSSs contained in OU9 exist within the boundaries of OU12. Figure 2-28 shows the OPWL system located within the OU12 area. Specific impacts of OU9 have been identified. These include multiple releases from the OPWL

pipeline at IHSS 147.1 which has been transferred to OU9 and suspected uranium and beryllium contamination around Building 444 and Building 447 (IHSS 157.2).

2.2.2.2 OU10 (Other Outside Closures)

OU10 has four IHSSs located within the OU12 boundaries: IHSS 182, IHSS 205, IHSS 207, and IHSS 208. The Final Phase I RFI/RI Work Plan for OU10 was submitted in May, 1992. The OU10 work plan contains details of the planned investigation activities, which are scheduled to begin after work plan approval and reported in a Draft Phase I RFI/RI Report on August 25, 1994. The final OU10 work plan (May 1992) has been reviewed with respect to OU12 IHSSs.

2.2.2.3 OU13 (100 Area)

OU13 contains several IHSSs immediately north of OU12, one of which actually overlaps the location of OU12 IHSS 187 presented in the HRR. The OU13 IHSS that overlaps IHSS 187 is IHSS 157.1, Radioactive Site North.

The Final Phase I RFI/RI Work Plan for OU13 will be submitted on October 19, 1992. The RFI/RI Draft Report for OU13 will be submitted on August 8, 1994. Details of investigation activities required at OU13 are outlined in the IAG and will be outlined in the OU13 Work Plan.

2.2.2.4 OU14 (Radioactive Sites)

OU14 has one IHSS located in the 600 building area (IHSS 160) which completely overlaps the OU12 IHSS 120.1, and another (IHSS 161) which completely overlaps OU12 IHSS 120.2. The Final Phase I RFI/RI Work Plan for OU14 is due on October 19, 1992, and the Draft RFI/RI Report for OU14 is due on December 20, 1994. Sampling plans

developed for OU12 IHSSs will be conveyed to OU14 personnel to coordinate the two investigations and minimize duplication of effort. Details of planned activities at OU14 may be found in the IAG and the OU14 work plan.

2.3 GEOLOGY AND HYDROLOGY

The following sections on the geology and hydrology of the site are based primarily on the Final Geologic Characterization Report (EG&G, 1991c) and on information presented in the 1991 RCRA Ground Water Monitoring Report (EG&G, 1992g). Geologic characterization is ongoing, and under constant re-evaluation as new data are developed. The bedrock lithology data presented in the Final Geologic Characterization Report have been used in conjunction with available borehole logs for the OU12-specific interpretations presented herein regarding the cross-sections and bedrock geology.

Appendix E contains borehole logs for all soil boring and well locations used for the preparation of this work plan. Locations of wells are shown in Figure 2-29. Some of the wells shown have since been abandoned, as indicated in the figure.

2.3.1 Geology

The following discussion addresses the surficial and bedrock geology of the site area. An alluvial thickness (isopach) map is presented in Figure 2-30. A bedrock geology map appears in Figure 2-31, which also shows locations for cross sections A-A' and B-B', which are shown in Figures 2-32 and 2-33, respectively.

The surficial geologic unit at the site is the Quaternary Rocky Flats Alluvium. The Rocky Flats Alluvium is the oldest and topographically highest alluvial deposit at RFP, and was formed by a series of coalescing alluvial fans deposited by braided streams. The unit is an

unconsolidated deposit composed of poorly sorted, angular to subrounded cobbles, angular to rounded coarse gravels, coarse sands, and gravelly clays. Generally, it is coarser grained to the west and becomes finer grained toward the east. The colors of the Rocky Flats Alluvium matrix range from light brown to dark yellowish orange and grayish orange to dark gray. Bedding has been identified only in a gravelly sand in the East Trenches area (EG&G, 1991c).

The amount of caliche [calcium carbonate ($CaCO_3$)] mineralization in the interstices (pore spaces) of the alluvium ranges from zero to almost 100 percent. In areas where caliche has been defined as "abundant," the amount of caliche in the interstices is greater than 25 percent over a 1 to 2 ft interval (EG&G, 1991c). It is believed that in OU12, the amount of caliche generally increases as the thickness of the Rocky Flats Alluvium decreases. The amount of caliche may have hydrogeologic significance and is discussed further in the following Section 2.3.2, Hydrology.

Figure 2-30 indicates that, in the immediate vicinity of OU12, the alluvial unit ranges in thickness from 10 to almost 50 ft, with the greater thickness occurring to the west. The alluvial thickness within the OU12 boundary is an average of 20 ft.

Many areas in OU12 have been disturbed by building and road construction. Consequently, much of the Rocky Flats Alluvium on the plant site has been removed and/or reworked during plant construction activities. Disturbed ground is generally described as unconsolidated clay, silt, sand, gravel, and pebbles. The materials are very poorly sorted with fragments of claystone and display no bedding. The color ranges from olive to reddish brown to yellowish gray and gray to yellowish orange. Angular to subangular gravels and pebbles of granite and quartzite are commonly found in areas of disturbed Rocky Flats

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Alluvium or disturbed colluvium. Sand, where present, varies from fine-grained to coarse-grained and is very poorly sorted.

There is an area of artificial fill mapped around Building 881, a portion of which has been included within OU12. Material excavated for the Building 881 multi-story foundation was spread over a large area generally south of the building. The very poorly sorted and unconsolidated artificial fill was derived from Rocky Flats Alluvium, colluvium, and fragments of claystone and concrete rubble. It is predominantly composed of sandy clay with some gravelly zones. Sand and gravel fill material is expected to have been backfilled in some of the tank and pipe excavations. The fill is generally brown to gray in color with occasional zones of moderate yellowish brown staining.

The youngest bedrock geologic unit beneath the alluvium in the site area is the Upper Cretaceous Arapahoe Formation (Arapahoe Formation). The Arapahoe Formation at RFP has recently been interpreted as being 15 to 25 ft in thickness and consisting of claystone and silty claystone interbedded with a medium-grained to conglomeratic frosted sandstone (EG&G, 1992b). The Arapahoe Formation is underlain by the Cretaceous Laramie Formation (Laramie Formation) which contains lithologies very similar to those in the Arapahoe Formation making the two formations difficult to differentiate in the field. The two formations may attain a thickness of 600-800 ft and dip gently to the east at about one to two degrees (EG&G, 1991c). The contact with the overlying surficial deposits generally parallels surface topography.

The Arapahoe and Laramie Formation have been interpreted as fluvial deposits comprised of channel-fill, point bar, and over-bank deposits (EG&G, 1991c). Claystones and silty claystones represent over-bank deposits, while most of the sandstones represent channel-fill

and point bar deposition from a meandering stream system flowing generally west to east. Contacts between various lithologies are both gradational and sharp. Weathering is observed to penetrate up to approximately 30 to 40 ft into the bedrock on the basis of iron-oxide staining. Open and healed fractures have been observed as deep as 220 ft. Healed fractures commonly occur in siltstones and very fine-grained sandstones and have less than one millimeter of bedding offset. The fractures are generally less than one millimeter wide and are cemented with host rock argillaceous cement and matrix material (EG&G, 1991c). Several large slump features have recently been discovered during the construction of the 881 Hillside french drain.

The Arapahoe and Laramie claystones and silty claystones are massive and blocky, containing occasional thin laminae and stringers of sand, silt, and coal. Unweathered claystones and silty claystones are light to medium olive gray and occasionally olive black. Weathered claystones appear dark yellowish orange and yellowish brown. The color difference is the result of iron-oxide staining, which is common at depths from 1 to 20 ft below the base of the surficial material. Leaf fossils and black organic matter occur throughout the claystones.

Most of the Arapahoe sandstones are poorly to moderately sorted, subangular to subrounded, silty, clayey, quartzitic, and very fine-grained to medium-grained. The Arapahoe sandstones are moderately to well-sorted and very-fine-grained to medium-grained and, compositionally, have a higher percentage of chert and rock fragments than do the underlying Laramie sandstones (EG&G, 1992b). Laramie sandstones also do not exhibit the roundness found in Arapahoe sandstones and also have a slightly lower porosity (EG&G, 1992b). The contact between the two formations is defined by a lithologically distinctive medium-grained to conglomeratic frosted sandstone marker bed at the base of

the Arapahoe Formation. Unweathered sandstones of both formations are light gray to olive gray, while weathered sandstones appear pale orange, yellowish gray, and dark yellowish orange, as the result of iron-oxide staining. Cementation generally increases with depth as weathering decreases. Cementing agents in the sandstones are predominantly argillic with minor amounts of $CaCO_3$ and silica. Trough and planar cross-stratification are common sedimentary structures (EG&G, 1991c). Individual sandstones have lenticular geometries and contain thin beds or laminae of silt and clay. The Arapahoe sandstone was encountered as the surface bedrock lithology in boreholes 19689 and 13589 in OU12, as shown in Figure 2-31.

The bedrock geology shown in Figure 2-31 illustrates three separate mappable units of the Arapahoe formation including sandstone, silty claystone, and claystone. The silty claystones and claystones have been mapped separately to illustrate the transitional nature between the units. Silty claystone surrounds the two subcrops of sandstone along the southern boundary of OU12, and also occurs less extensively along the northern portion of the mapped area. Most of the bedrock in the OU12 area is claystone.

2.3.2 Hydrology

Surface water drainage in OU12 is controlled for the most part by water diversion works such as ditches, pavements, gutters, drains, and culverts. Surface water drainage patterns throughout RFP were presented in Figures 1-3 and 1-4. The largest of the runoff control ditches is the Central Avenue Ditch. This ditch runs eastward along Central Avenue and discharges to South Walnut Creek which flows to the northeast, then into the B-series ponds. The other major runoff control ditch is the South Interceptor Ditch which prevents runoff from the south side of the RFP main production area from entering Woman Creek; the

ditch discharges to Pond C-2 (Rockwell, 1988). Pond C-2 waters are directed to the Broomfield Diversion Ditch.

The discharges from the ponds are monitored to document compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements. In addition to NPDES monitoring requirements, all off-site pond discharges are monitored for concentrations of plutonium, americium, uranium, and tritium (Rockwell, 1988).

Unconfined ground water occurs in OU12 in the Rocky Flats Alluvium, the disturbed ground, and artificial fill. Where the Arapahoe sandstone subcrops directly beneath the surficial material, it is in hydraulic connection with the Rocky Flats Alluvium. The Arapahoe sandstone geometry is lenticular and laterally discontinuous, and the Arapahoe sandstone subcrops frequently throughout the RFP area and acts as an unconfined aquifer for a substantial portion of its occurrence (EG&G, 1991c).

Surficial deposits on the RFP site generally are recharged by infiltration of incidental precipitation and by seepage from ponds, ditches and creeks, although the situation in OU12 probably differs from undeveloped areas because of the greater amount of paved and covered surfaces. Large water table fluctuations have been observed in response to seasonal recharge (Hurr, 1976). An investigation of ground water flow mechanisms of an evaporation spray field east of RFP in the buffer zone indicated a fluctuation range of eight feet, with the low occurring in late March and the high occurring in late June (Koffer, 1989). As a result of water table fluctuations, the extent of saturated surficial deposits fluctuates. The shallow ground water system discharges in streams, ditches and at seeps along slopes at the alluvium/bedrock contact.

Generally, unconfined ground water flows along the contact of the surficial material and the underlying Arapahoe Formation claystones in a downgradient direction to the east. The alluvial aquifer, as well as the bedrock aquifers, exhibit a highly variable range of hydraulic conductivity values. As shown in Table 2.3, hydraulic conductivity values reported for the Rocky Flats Alluvium range from 1 x 10^{-2} centimeter per second (cm/s) (Hurr, 1976) to 4 x 10^{-8} cm/s (DOE, 1988). This wide range of hydraulic conductivity values for the Rocky Flats Alluvium is due to its heterogeneity and vertical and lateral variability. The most recent hydrogeologic investigation suggests the hydraulic conductivity of the Rocky Flats Alluvium and the Arapahoe sandstone is approximately 6 x 10^{-5} cm/s whereas the Arapahoe Formation claystones have a lower hydraulic conductivity on the order of 1 x 10^{-7} cm/s (EG&G, 1991c). This effectively constrains much of the flow within the alluvial aquifer to the more permeable surficial material. Table 2.3 presents a comparison of hydraulic conductivities for RFP area deposits from a variety of sources.

As previously noted in Section 2.3.1, the amount of caliche mineralization in the Rocky Flats Alluvium tends to increase as the thickness of the alluvium decreases. There are some areas where the amount of caliche in the interstices of the surficial material approaches 100 percent. The presence of caliche may prove to be useful in determining localized changes in hydraulic conductivities and ground water flow directions. Due to insufficient data on caliche in RFP surficial deposits, the extent to which this may be helpful is unknown at this time.

Confined ground water is present in the sandstone units of the Arapahoe Formation throughout most of OU12. Ground water recharge to the Arapahoe Formation occurs as infiltration of alluvial ground water and as infiltration of precipitation where the bedrock outcrops in the western portion of the RFP (EG&G, 1991c). The confining layers are the

relatively impermeable claystones and silty claystones of the Arapahoe Formation. Ground water in the sandstone of the Arapahoe Formation occurs typically under confined conditions throughout most of RFP. Exceptions to this are the local occurrence of ground water in subcropping sandstone units directly beneath the surficial material.

The Laramie sandstones have a hydraulic conductivity of approximately 10^{-6} cm/s (EG&G, 1991c). An overall downward vertical gradient has been identified but due to lack of data, has not been quantified. The existence of a vertical gradient is evidenced in the overall decrease in static water levels in monitoring wells with depth (EG&G, 1991c). Generally, both confined and unconfined ground water flow is toward the east. Much of the ground water within the bedrock aquifer becomes surface water as it leaves the ground water system as seeps along slopes and in stream drainages. However, none of these slope or drainage areas are present within OU12.

Industrialization of OU12 has significantly affected the hydrogeology of the site. Heightened awareness and understanding of the synthetic conditions will facilitate a more accurate site characterization. One pivotal construction effect on the alluvial aquifer is the creation of potential preferred migration pathways. These potential preferred migration pathways are in filled trenches from buried utilities, such as storm sewers, sanitary sewers, electrical lines, building foundations, and footing drains, in addition to both abandoned and active process waste pipes and tanks. Footing drains and building sumps are known to exist under Buildings 444, 883, and 881, as shown in the engineering drawings included in Appendix C. Available analytical data collected during site-wide monitoring of these and other footing drains and sumps will be obtained during the RFI/RI and evaluated. The extent to which these trenches provide preferred migration pathways will be considered when evaluating OU12 hydrogeology during the RFI/RI.

Available information on ground water relative to OU12 comes from investigations of the 881 Hillside located southeast of OU12, the West Spray Field, and the Solar Ponds. As previously mentioned, ground water occurs in both unconfined and confined conditions throughout most of OU12. Figure 2-34 presents a water table contour map for OU12 for April, 1991, and Figure 2-35 presents a water table contour map for October, 1991. Available water quality data are discussed in Section 2.4.2, under Nature of Contamination.

Based on the water table contour maps of the site area, the unconfined ground water generally flows easterly, as well as northeast towards North Walnut Creek and southeast towards Woman Creek. The main plant area is on an east-west trending ground water divide which lies approximately beneath Central Avenue. Ground water flow appears to be topographically controlled, flowing to the east-northeast coincident with the site-wide gradient. Ground water also flows to the south following the mesa slope.

2.4 NATURE OF CONTAMINATION

This description of the nature of contamination has been derived primarily from the HRR (EG&G, 1992b). The historical descriptions of each site have been presented in Section 2.1. This section presents the type of contaminants which have been released. In most instances, however, descriptions of the nature of contamination associated with OU12 IHSSs are limited to historical documentation of the type of materials released to the environment.

The following sections address the nature of potential contamination at each specific IHSS, as well as generally for all of the OU12 site area for ground water, surface water, soils, and sediments.

2.4.1 OU12 IHSSs

The nature of contamination at the following individual IHSSs is based on historical information presented in the HRR (EG&G, 1992b).

2.4.1.1 West Loading Dock (IHSS 116.1)

No documentation was found detailing releases on the west loading dock itself; however, there is record of significant oil staining around Building 453 which is located just north of the dock and was used to store oil (IHSS 182 in OU10). There is a possibility that solvents were stored at the west loading dock and hydrocarbons may also be present in the soils due to leaks and spills (DOE, 1987). A radiometric survey was performed in the vicinity of the west loading dock as part of a site-wide survey in April and May 1984. Areas south and west of Building 447 and areas north of Building 453 were identified as areas which could not be surveyed for plutonium due to high-level background radioactivity.

2.4.1.2 South Loading Dock (IHSS 116.2)

Drums containing perclene (tetrachloroethene) still bottoms and nitric acid were stored on the south dock. In October 1955, one 55-gallon drum leaked and sprayed its contents onto two workers who were in the areaway adjacent to the dock. No discussion of cleanup in the reference pertaining to the perclene drum leak in 1955 has been located; however, the leaks were plugged and the drum moved. The contents of the drum were transferred to a stainless steel drum and treated with caustic. Removal of soils in this area was being considered in 1975, but it is not known if removal was accomplished.

Until 1970, chlorinated hydrocarbon solvents used to rinse beryllium parts were typically disposed of onto the ground outside Room 106, which opens to the south dock. Analytical results of soil samples taken at two to four inches below ground surface revealed 350 to

1000 micrograms (μg) of beryllium per gram (g) of soil due to this solvent disposal. Normal beryllium concentrations are 0.01 to 2 μg/g of soil (Putzier, 1975). Personnel conducted air sampling in the area of solvent disposal dumping from June through September 1977. The average concentration of beryllium in air was 0.0009 μg per cubic meter (m^3), which was 9 percent of the EPA standard. Soil removal was not deemed necessary.

Constituents which may have contaminated surfaces around the south dock include enriched and depleted uranium, beryllium, and chlorinated solvents. Direct uranium activity readings as high as 7,500 disintegrations per minute (dpm)/100 square centimeters (cm^2), and smear readings with a maximum of 350 dpm, were detected around the south dock. Following the release, the dock and sidewalks were cleaned and the driveway coated. Air count results during the vacuum fire extinguishing operations (Section 2.1.2) were as high as 33,000 percent of the maximum permissible limit (MPL) for airborne radioactivity. Direct counts in the dock area were as high as 1,372 dpm.

2.4.1.3 Cooling Tower Pond West of Building 444 (IHSS 136.1)

The main purpose of the former cooling tower pond was to hold blowdown from the Building 444 and Building 447 cooling towers. Recycled water in the cooling tower is periodically released (referred to as blowdown) and fresh water added to the tower to control levels of total dissolved solids. Blowdown liquid probably contained hexavalent chromium since chromium residue was found when the cooling towers were dismantled in 1975. Cooling tower industry maintenance documentation indicates that lithium chromate and lithium dichromate are commonly used in cooling towers as corrosion inhibitors and chloride or chlorine containing compounds are used to control biological growth (Marley, 1990). Industry documentation indicates acids are used to clean scale off the tower, and there is no indication organic solvents would be used for cleaning cooling towers. According

to the HRR, a pond was used in 1956 to catch solutions during a cleaning operation of the Building 444 cooling tower; however, it is not known which pond is referred to. Liquids were allowed to evaporate and percolate into the soil; the pond was later backfilled. The pond may have also been used to dispose of lithium. In addition, small amounts of depleted uranium may have been buried at this IHSS according to the HRR.

2.4.1.4 Cooling Tower Pond East of Building 444 (IHSS 136.2)

The east cooling tower pond was also potentially used to hold blowdown from the Building 444 and 447 cooling tower. Historical records indicate it was used for only a few days by Dowell, then backfilled, although standing water is observed in this location in historical photos after Dowell reportedly backfilled the ponds. The pond may have contained liquids with lithium chromate, acids, and chloride, and the soils may contain lithium and uranium.

2.4.1.5 Radioactive Site South Area (IHSS 157.2)

The principal materials that have contributed to contamination in the radioactive area around Building 444 are depleted and enriched uranium, beryllium, chlorinated hydrocarbon solvents including carbon tetrachloride, and hydraulic oil. There may also be lithium and chromium in the sediments due to the presence of cooling tower ponds (IHSS 136). Numerous incidents are mentioned in documents found during the HRR search that indicate releases to the area.

2.4.1.6 Sulfuric Acid Spill (IHSS 187)

A sulfuric acid spill in September, 1970 released approximately 1,500 gallons of 94 percent sulfuric acid to the 400 Area. Approximately 32,000 pounds of lime was added to neutralize the acid. It was common practice at RFP for acid spills to be neutralized with a caustic such

as lime. The CEARP Phase I document (DOE, 1986) considered that this procedure would create by-products that were benign and highly mobile and, therefore, no environmental hazard should remain.

Assuming that the acid tank was filled to capacity (3,000 gallons), approximately 200 gallons of acid are unaccounted for in the description of the incident. Approximately 1,500 gallons are reported to have been released from the leaking flange directly to the ground. An additional 1,300 gallons were recovered from the neutralization tank. The remaining 200 gallons likely leaked from the neutralization tank into the sanitary sewer system. The Building 995 sewage treatment plant and its effluent were monitored to assess the impact of the 1970 spill. On September 12, the pH of Building 995 influent was as low as 1.8. On September 13, the effluent had a pH of 2.2 with a sulfate concentration of 1120 ppm. It is probable the sulfuric acid leak into the sanitary sewer system contributed to the acidic treatment plant water. Documentation related to the acid spill is in Appendix B.

2.4.1.7 Fiberglassing Area North of Building 664 (IHSS 120.1)

No documentation detailing discrete releases or detailed response actions in the fiberglassing area was found. Potential residues from spills of polyester resin, peroxide catalyst and unspecified cleaning solvents may exist. Higher than background levels of gamma radiation and americium were detected by an Aerial Radiological Measurements System survey (RFP Photograph 21644-01, 1977). No documentation was found which provided an explanation for the origin of the elevated readings. Building 664 is currently used for radioactive waste storage, but it is not known whether stored waste was responsible for the historically elevated readings.

2.4.1.8 Fiberglassing Area West of Building 664 (IHSS 120.2)

As with IHSS 120.1, no documented releases are known at this IHSS. A similar history of potential residue from spills of polyester resin, peroxide catalyst, and cleaning solvents may exist. Unlike IHSS 120.1, this area is paved with asphalt.

2.4.1.9 Nitric Acid Tanks (IHSS 189)

Small volumes of nitric acid were released to the environment in each of three documented occurrences. As identified in the CEARP Phase I (DOE, 1986), the routine response to spills was to rinse the acid spill on the ground. In two of the documented releases, the nitric acid was neutralized with sodium bicarbonate. Documentation of nitric acid spills are included in Appendix B.

2.4.1.10 Building 881 Conversion Activity Contamination (IHSS 147.2)

Potential contaminants include beryllium, and enriched or depleted uranium. Based on interviews with former RFP employees conducted during the preparation of the HRR and on the historical use of Building 881, some of the equipment stored in this IHSS may have been contaminated with beryllium, enriched uranium, or depleted uranium. Radioactivity levels associated with this stored equipment would not be anticipated to be high with respect to background.

2.4.1.11 Under-Building Contamination (UBC-439, 444, 447, 881, 883, and 889, 400 and 800 Areas)

The soils beneath OU12 buildings may be contaminated with radionuclides, nitrate, solvents, acids, and hydrocarbons. The most likely contaminants in soils beneath any particular building can be identified through knowledge of the operations conducted in that building and the raw and waste materials associated with those operations. Suspected contamination

under a building depends on the overall history of the building, not just the current operations. For instance, Building 881 currently houses various technical support, analytical, plant support, and administrative functions. However, in the past the building was an enriched uranium components production facility, and was later converted to a nonradioactive metals fabrication facility. The uranium machine tool storage area, historically located where Building 460 now stands, may require that a UBC for Building 460 be added.

A number of RCRA Contingency Plan Implementation Reports have been made in response to releases inside buildings that could contribute to under building contamination. These reports are numbered in a manner that gives the year and a sequential number for the RCRA Contingency Plan Implementation Reports of that year. The RCRA Contingency Plan Implementation Reports addressing indoor building events applicable to OU12 are: 89-001, 89-010, 89-013, 89-014, 89-017, 89-018. These are contained in Appendix B.

Inside building events have largely been cleaned-up or otherwise addressed without noticeable impacts on the outdoor environment. However, due to the long time frame, history of operations, and difficulty in detecting soil contamination beneath buildings, the soils beneath the identified OU12 UBCs should be considered in the field investigations.

2.4.2 Operable Unit 12 Site Area

The nature of contamination in the OU12 area is based on a limited amount of soil, ground water, and surface water data from several sources. This information and a comparison of the data to background data is discussed in the following sections.

2.4.2.1 Discussion of Existing Data

Existing soil boring, ground water, and surface water analytical data from locations in or adjacent to OU12 have been summarized on Tables 2-4 through 2-9. Analytical data including metals, radionuclides, volatile organic compounds, and major ions, were evaluated and significant constituents are presented on the tables. Most of the analytical data were properly validated. The selection of the constituents was based on past IHSS history and the requirements of the IAG for field sampling. The complete listing of the data set used to develop these tables is presented in Appendix A. Each of the environmental media is discussed below.

Soil

Based on the IAG requirements and past OU12 history, three metals of potential concern in shallow soil were researched: beryllium, chromium, and lithium. A summary of the concentrations of these select metals in shallow soils (0 to 7 ft) from 15 existing soil borings within or adjacent to OU12 is presented on Table 2.4. A graphical representation of the data from soil samples collected from zero to three feet in depth is shown on Figure 2-37. Concentrations of beryllium ranged from less than 0.15 to 2.0 milligrams per kilogram (mg/kg) in shallow OU12 soils. Chromium concentrations ranged from 5.5 mg/kg to 34 mg/kg. The results of the analysis for lithium indicate that lithium is present at or below detection limits of approximately 20 mg/kg at most locations. Lithium was reliably detected only at location number 17989 at a concentration of 14 mg/kg.

Beryllium, chromium, and lithium results for soils sampled below 7 ft were similar to those for the shallower soils. In general, at the majority of locations, similar or slightly higher concentrations were observed in soils at depths greater than 3 ft.

Existing analytical data for selected radionuclides in soil samples from 11 borings at depths of 0 to 7 ft are presented on Table 2.5. Gross alpha, gross beta, plutonium-239/240, uranium-233/234, uranium-238, and tritium results have been included. In general, the highest radionuclide concentrations were detected in the 0- to 3-ft depth, surface samples. The shallow soil data are graphically presented on Figure 2-38. Radionuclide concentrations in soil samples collected at depths greater than 7 ft were similar to concentrations detected in the 3 to 7 ft samples.

Volatile organic compounds were detected in soil samples from 11 borings within and near OU12 at depths of 0 to 6 ft. A summary of these volatile organic detections is presented on Table 2.6 and is shown on Figure 2-36. Acetone and methylene chloride were detected in almost every soil boring. However, these compounds were also frequently detected in the associated blank samples, suggesting laboratory contamination. 1,1,1-Trichloroethane (TCA) was detected in 13489 at 11 micrograms per kilogram (μg/kg). Tetrachloroethene and trichloroethene (TCE) were detected in soil samples from 0187 at greater than 100 μg/kg. Bis (2-ethylhexyl) phthalate (a common laboratory contaminant) was also detected in shallow soils from this location. Other volatile organic constituents detected in only a few of the soil borings included carbon disulfide, 2-butanone, benzene, ethylbenzene, and toluene.

Volatile organic compound results for soils at depths greater than 6 ft are similar to those for the shallower soils. Acetone and methylene chloride were detected frequently; however, these compounds were also detected in the blank samples. TCA was only detected in soil from location 13489. Other volatile organic compounds were only detected in a few of the samples at low concentrations of typically less than 30 μg/kg.

The existing database for soils within and near OU12 is not sufficient to adequately determine the nature and extent of radionuclides, metals or volatile organic constituents. Additional soil analysis will be conducted in the RFI/RI, and a detailed evaluation of all data will be made following the sampling effort.

Ground Water

Alluvial ground water quality data were only available for two monitoring wells in the vicinity of OU12. Several wells shown in Figure 2-29 actually function as piezometers and are used for water level information only. Because OU12 is located in the industrial area at the RFP which is primarily paved with asphalt or concrete, infiltration into the shallow soils is prevented. As a result, most of the monitoring wells in OU12 are dry. Monitoring well 17989 is located east of OU12, while monitoring well 0187 is located immediately south of the OU12 boundary in OU1. These two wells have been sampled one or more times and analyzed for a range of parameters. Analytical results for selected metals, radionuclides, volatile organic compounds (0187 only), and major ions from these wells are presented in Tables 2.7 and 2.8. Volatile organic compounds were not reliably detected in well 17989. These results are discussed in the following paragraphs.

Concentrations of radionuclides in the single August 1990 sampling event from monitoring well 17989 were elevated, while those observed in samples from monitoring well 0187 were not. However, radionuclide levels in monitoring well 17989 cannot be directly attributed to activities associated with OU12 IHSSs. Concentrations of the selected metals were elevated in ground water from both monitoring wells. Volatile organic constituents detected in ground water samples from monitoring well 0187 consisted of trace concentrations of TCA and TCE which were detected during a few of the sampling events. However, in the most recent December 1991 sampling event, TCA and TCE were not detected.

Analytical data for several major ions are also presented in Tables 2.7 and 2.8. Bicarbonate, chloride, and sulfate concentrations were elevated in both monitoring well 17989 and 0187. Fluoride and nitrate/nitrite concentrations were elevated in well 17989 but not in well 0187. Elevated concentrations of these major ions, as well as radionuclides, in well 17989 are consistent with the release of process wastes liquids in the area. Total dissolved solids concentrations in 0187 were greater than 500 mg/l and in 17989 were greater than 1,000 mg/l.

Water quality data are available for other areas of the RFP, as part of the site-wide RCRA ground water monitoring program (EG&G, 1992f). The nearest upgradient and downgradient monitoring wells to OU12 were located at the West Spray Field (OU11) and the Solar Ponds (OU4), respectively. Wells B410689, B410789, and B110889, installed to monitor ground water at the West Spray Field, were selected as the nearest water quality monitoring wells upgradient of OU12. Wells P207489 and 2486, installed in the vicinity of the Solar Ponds, were selected as the nearest water quality monitoring points downgradient of OU12. Because of the distance between these wells and OU12, as interpreted by the maps included in Appendix F, they may not be representative of actual water quality conditions immediately upgradient and downgradient of OU12. Several other OUs lying within the upgradient and downgradient well may also be contributing to variations in the ground water quality. The analytical results for these selected wells are presented in tabular form in Appendix F. The results are discussed below.

Volatile organic compounds have been detected at low levels in Wells B410689 and B110889, including trichloroethene, 4-methyl-2-pentanone, carbon disulfide, acetone, and methylene chloride. According to EG&G (1992f), statistical analysis of wells across the West Spray Field shows no significant increases in volatile organic concentration due to

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spray field activities. Detections of U-233/234 and U-238 in wells B410789 and B110889 indicate an impact to water quality at the spray field. Metals were detected at levels consistent with background ranges (EG&G, 1992f). Water quality parameters have also been monitored and data are included in Appendix F. These results may be indicative of upgradient water quality conditions, west of OU12.

Downgradient of OU12, volatile organic compounds were detected at very low levels in well P207489. No volatiles were detected in well 2486. Radionuclides, including U-233/234, U-238, tritium, and gross beta activity, were detected in well P207489. Water quality parameters including chloride, fluoride, nitrate/nitrite, sulfate, bicarbonate, and total dissolved solid were elevated above the same values in the upgradient wells.

Calcium, magnesium and strontium also appear to be elevated above the upgradient values. These water quality data may in part reflect ground water conditions downgradient of OU12, but may be more representative of the activities related to the Solar Ponds.

The existing ground water analytical database for the IHSSs within OU12 is not adequate to determine the nature and extent of ground water contamination in OU12. IHSS-specific ground water data will be collected in this FSP, with provisions for installation of additional monitoring wells, after soil data evaluation.

Surface Water

Analytical data from only one surface water sampling location, SW125, was available. This location is indicated on Figure 2-29. The analytical results for selected radionuclides, metals, and ions are summarized on Table 2.9. Concentrations of radionuclides, metals, and ions were relatively low and consistent with those detected at other surface water monitoring

stations at RFP. Provisions for collecting surface water samples are included in the FSP after evaluation of results from sediment and soil sampling activities.

2.4.2.2 Site Background Comparison

Shallow soil and ground water analytical data from several borings and two monitoring wells within or adjacent to OU12 were compared to site-wide background chemical data presented in the Background Geochemical Characterization Report (EG&G, 1990a). Data presented in the background report are currently being revised. The following discussion is based on the 1990 version and may change as a result of EPA comments and concerns. Background data on radionuclides, metals, major anions, and indicator parameters were obtained from samples collected at stations located in buffer zone areas west, north, and south of the main plant.

The background data for alluvial soil and ground water samples are compared in the following discussions to analytical results for select compounds in soil and ground water presented in Tables 2.4 through 2.8. Comparisons were made to tolerance limits used to characterize background concentrations, which were presented in the background geochemical report where sufficient data permitted calculation of these limits (EG&G, 1990a). The three metals and six radionuclides of potential concern identified based on past history of the facility and the requirements of the IAG are:

- Metals: beryllium, chromium, and lithium; and
- Radionuclides: gross alpha, gross beta, plutonium-239/240, uranium-233/234, uranium-238, and tritium.

Concentrations of the three select metals in soils within and near OU12 were typically less than upper tolerance limits or maximum concentrations in background soils. Beryllium concentrations, which ranged from less than 0.15 to 2.0 mg/kg, in soils within and near OU12 were less than half of the upper tolerance level of 4.7 mg/kg calculated from background soil samples.

Chromium was detected in all but two samples within and near OU12 at concentrations less than the upper tolerance limit of 20 mg/kg calculated for the background soil samples. The two exceptions of 27 and 34 mg/kg were detected at locations 13489 and 14289, respectively. The only reliable lithium detection of 14 mg/kg at location 17989 was above the upper tolerance limit of 8.1 mg/kg calculated from background samples south of RFP; however it was below the minimum concentration of 16 mg/kg observed in background samples collected north of the RFP.

Gross alpha concentrations in soils within and near OU12 were less than the upper tolerance limit of 38 pCi/g calculated for gross alpha concentrations detected in background soils. Gross beta concentrations in OU12 soils and in soils nearby were within the range of background concentrations of 3 to 42 pCi/g. Three detections were above, but close to, the upper tolerance limit of 37 pCi/g. The highest plutonium-239/240 concentration detected in soils within and near OU12 was 15.86 pCi/g. A background concentration for plutonium-239 is available but not applicable for a comparison because it is only for one isotope. Concentrations of uranium-233/234 and uranium-238 were typically greater than upper tolerance limits of 0.66 and 0.68 pCi/g calculated for each of these compounds, respectively, from concentrations in background soils. However, the concentrations of uranium-233/234 and uranium-238 in soils within and near OU12 were within the range of concentrations observed in background soils. The majority of tritium concentrations for soils within and

near OU12 were less than the calculated upper tolerance limit of 410 pCi/g and were within the range of tritium concentrations detected in background soils. Exceptions were in soils at 13689 and 14689 located in the northeast portion of OU12 and north of OU12, respectively.

Ground Water

As stated in the previous section, alluvial ground water data near OU12 were limited to two monitoring wells, one east and one south of the OU12 boundary (Table 2.7 and 2.8). Metals concentrations in ground water samples from these wells were generally greater than calculated upper tolerance limits and maximum concentrations detected in alluvial ground water samples from background locations (EG&G, 1990a). Exceptions include mercury which was not detected in background samples above a detection limit of 0.0002 mg/l and was only detected during one sampling event in well 0187 at 0.00028 mg/l. Selenium and strontium were also detected at low concentrations in well 0187 close to or below, respectively, the detection limits of 0.05 and 1.0 mg/l, used for the background samples. Zinc was detected in ground water from well 0187 at concentrations within the range of observed background concentrations from the alluvial ground water samples.

The radionuclides, gross alpha, gross beta, uranium-233/234, uranium-235/236, and uranium-238 were detected in wells 0187 and 17989 at concentrations greater than the calculated upper tolerance limit or the maximum concentration detected in background water samples. The other select radionuclides analyzed in ground water from well 0187 were detected within or below concentration ranges observed in background alluvial ground water samples.

The major ions bicarbonate, chloride, nitrate/nitrite, and sulfate were analyzed in both ground water from wells 0187 and 17989 and in background well locations. Concentrations of these ions in well 17989 and in well 0187, with the exception of nitrate/nitrite, were greater than the upper tolerance limit calculated from the background ground water samples. Nitrate/nitrite concentrations in well 0187 were below this limit and also were within the range of concentrations detected in the background samples. Total dissolved solids (TDS) concentrations in 17989 were greater than those observed in background samples. TDS concentrations in 0187 were within the range of background TDS concentrations.

2.5 SITE CONCEPTUAL MODEL

On the basis of the known site physical conditions and the potential contamination sources described in the preceding sections, a conceptual model of exposure pathways for OU12 has been developed for use in the evaluation of the potential risks presented to human health and the environment.

The primary purpose of a conceptual model is to aid in identifying exposure pathways by which human and biotic receptors may be exposed to site contaminants. The EPA defines an exposure pathway as "...a unique mechanism by which a population may be exposed to chemicals at or originating from the site..." (EPA, 1989b). As shown in Table 2.10, an exposure pathway includes a contaminant source, a release mechanism, a transport medium or migration pathway, an exposure route, and a receptor. An exposure pathway is not complete unless all of these elements are present. Each individual element is described in more detail in the individual sections referenced below:

- Contaminant Source (Section 2.5.1) - For the OU12 conceptual model, the contaminant sources are the media potentially impacted by historical releases of chemicals from each IHSS. These are secondary source media and may include soil, sediment, vadose water, and ground water throughout OU12.

- Release Mechanism (Section 2.5.2) - A release mechanism is a physical and/or chemical process by which contaminants are released from the source. The conceptual model for OU12 identifies historical mechanisms which released contaminants directly from historical sources at the time of the actual spills or releases; and primary release mechanisms which release contaminants directly from the current contamination (or secondary) sources. Secondary mechanisms which release contaminants from one transport media to another are also identified. Primary release mechanisms for OU12 may include wind erosion, volatile emissions, infiltration, dissolution, leaching, tracking, bioaccumulation/ bioconcentration, and storm water runoff. Secondary mechanisms may include percolation, recharge, discharge, seepage, pumpage, irrigation volatilization, and dry deposition.

- Transport Medium (Section 2.5.3) - A transport medium is the environmental medium into which contaminants are released from the source, and from which contaminants are in turn released via an exposure route. Potential transport media for OU12 include flora, fauna, vadose water, ground water, surface water, and air.

- Exposure Route (Section 2.5.4) - Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor. Exposure routes for receptors at OU12 include ingestion, direct dermal contact, and inhalation.

- Receptor (Section 2.5.5) - Receptors are human or environmental populations that are exposed to the contamination released from a site. Environmental receptors include biota (both flora and fauna) that may be indigenous to the primarily industrial OU12 area.

The conceptual model shown in Figure 2-39 provides a contaminant source characterization and an overview of all the potential exposure pathways that may exist at OU12. The pathways are shown pictorially in Figure 2-40. Some pathways have a higher potential for occurrence than others; more likely exposure pathways are identified in Table 2-10 and

discussed by evaluating the fate and mobility of the source contaminants in the various transport media. For the OU12 area, many IHSSs have been isolated from transport media by concrete or asphalt pavement, which may effectively eliminate any exposure to re-suspended dust or volatile organic compounds. In areas where infiltration is possible, sparingly soluble compounds, such as plutonium and trivalent chromium [Cr (III)], will remain bound to soils, rather than being mobilized by infiltration and transported in ground water. Similarly, some ground water originating in the OU12 area may be intercepted by the Building 881 Hillside French drain, which is currently under construction, or the interceptor trenches at the Solar Ponds (OU4).

2.5.1 Contaminant Source

As shown in Figure 2-39, the primary sources of contamination at OU12 are considered to be the potential or documented releases that occurred at an IHSS. For the purpose of the conceptual site model for OU12, the 10 IHSSs are considered one historical source because of their proximity and overlapping boundaries, the similar nature and small size of many of the reported releases, and the surficial or shallow nature of the impacts. The potential impacted media include air, surface water, sediment, ground water, and soil. Since the historical release events, contaminants released to air and surface water have dissipated. Soil and sediment are, therefore, considered the current, or secondary, contaminant sources in the OU12 model. The following sections describe the characteristics of the historical and current contaminant sources.

2.5.1.1 Historical Source Characterization

The 10 IHSSs that comprise OU12 have been described in detail in Section 2.1. To summarize the discussion presented in that section, the 10 IHSSs include:

- Loading docks at Buildings 447 and 444 (IHSSs 116.1 and 116.2) where solvents and uranium wastes were stored;
- Fiberglass application areas in the vicinity of Building 664 (IHSSs 120.1 and 120.2);
- A storage area related to the conversion of Building 881 from enriched uranium components production to a non-radioactive metals fabrication facility (IHSS 147.2);
- General soils contamination in the 400 area, referred to as the Radioactive Site South Area (IHSS 157.2);
- A sulfuric acid spill adjacent to Building 443 (IHSS 187);
- The area adjacent to two nitric acid storage tanks (IHSS 189), east of Building 444, where nitric acid spills have been documented; and
- Cooling water ponds located in the vicinity of Building 444 (IHSSs 136.1 and 136.2) which contained cooling tower blowdown from Buildings 444 and 447.

Each of these sites has been identified because of documented or suspected spills or leaks of contaminants during storage or during normal operations. In each documented case, the spills or leaks were generally limited in extent. The documented or suspected releases occurred over an approximate 40 year period, and may have potentially impacted soils, sediments and ground water remaining within the OU12 area. Most of the spills or leaks are thought to have impacted sediments and surface and shallow soils. The cooling water ponds have impacted shallow subsurface soils. Although surface water and air were also potentially impacted by historical releases, they are not considered as current sources, but instead as transport media and migration pathways.

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2.5.1.2 Current Contaminant Source Characteristics

The historical releases described above have impacted soils and sediments within OU12. As shown in Figure 2-39, these media are considered the current contaminant sources. The physical and chemical characteristics of the contamination in these media have been discussed in detail in Section 2.4. The contaminants comprise five general types: radioactive materials, including depleted uranium and plutonium; chlorinated organic solvents used for cleaning parts and components; metals, including lithium, beryllium, and chromium; acid and/or neutralized acid byproducts; and chemicals such as polyester resin related to fiberglassing operations. The behavior of these contaminant types is described below. No analytical results are available specifically for the OU12 IHSSs because no previous sampling has been conducted. Section 6.3 provides the media sampling and analysis rationale for the OU12 Field Sampling Plan.

Radionuclides present in the OU12 area include both naturally occurring and man-made isotopes. These elements may be of concern due to both their radioactivity and chemical toxicity. The uranium isotopes occur naturally in soils and sediments, and exist in economically recoverable quantities near the Rocky Flats Plant. Their mobility is variable and is based primarily on environmental oxidation-reduction and pH conditions.

The valence states of uranium, U(IV) and U(VI), are stable under naturally occurring environmental conditions. The U(IV) valence state is relatively insoluble under slightly acidic to basic pH, and is stable under reducing conditions. The U(VI) valence state predominates under oxidizing conditions and is relatively soluble. Uranium released in its elemental form or as U(IV) oxides will be associated with soils or sediments and transported as particulates. Oxidation of U(IV) over time may result in conversion to the soluble U(VI) and subsequent mobilization and transport in surface and ground water.

Plutonium is a transuranic actinide element, and does not occur naturally in the environment. Sensitive analytical techniques allow measurement of background concentrations of these elements which are the result of atmospheric testing of nuclear weapons. Plutonium forms insoluble hydroxide and oxide solids under neutral to basic pH conditions, limiting its mobility in the subsurface. Similar to the transition metals, however, plutonium may be transported in association with particulates in surface water or air, or possibly as colloids in ground water.

The chlorinated organic solvents are generally characterized by relatively high solubility and volatility, and relatively low affinity for solids. Therefore, these chlorinated solvents are generally readily mobilized from shallow soil by volatilization and infiltration. In cases where soils contain significant levels of organic carbon, or are high in clay, chlorinated compounds can be sorbed to these soils. If dissolved in surface water or ground water, these compounds are readily transported. In surface water systems, these solvents are volatilized to the atmosphere where they are photo-oxidized. Although the volatilization process is relatively rapid, potential transport distances may still be significant in most streams.

Lithium is an alkali metal which occurs naturally in the environment. Soil particles exhibit a lesser affinity for lithium than for other common alkali or alkaline earth elements. Once released in surface or ground water, lithium tends to remain in solution and be transported in the dissolved phase.

Beryllium is an alkaline earth element which occurs naturally in the environment. Beryllium oxide and hydroxide compounds have very low solubilities and dissolved ions are strongly adsorbed by mineral surfaces. In natural environments, beryllium will be transported as particulate matter in wind or surface water runoff rather than in the dissolved phase.

Chromium (Cr) has two stable valence states in natural systems: Cr(III) and Cr(VI). Behavior of this transition element is strongly influenced by valence state, which in turn is a function of oxidation reduction and pH conditions. Under strongly oxidizing, moderate to low pH conditions, Cr(VI) will predominate. Cr(VI) is highly soluble, and displays only a weak affinity for solid surfaces. As a result, Cr(VI) is preferentially transported in surface and ground water. Under moderately oxidizing to reducing conditions, relatively insoluble Cr(III) will predominate. Cr(III) displays a strong attraction for soil and sediment, and is transported as suspended particulates in surface water and air. Under conditions common in most soils, Cr(VI) is readily transformed to Cr(III).

Sulfuric and nitric acids will tend to be neutralized by carbonate and aluminosilicate minerals present in soil and sediment. The resulting neutralized solutions will contain dissolved sulfate and nitrate, respectively, as anionic species. Sulfate and nitrate are both highly soluble, and are readily leached from soils and transported in surface and ground water.

No information was found during preparation of this work plan to describe the behavior of unsaturated polyester resins such as those used in fiberglassing operations. However, their high molecular weight and resistance to water suggests that these compounds would be relatively strongly adsorbed and bound to soil and sediment.

2.5.2 Release Mechanisms and Transport Media

The historical release mechanisms identified in the OU12 site conceptual model include spills and releases from stored drums, tanks, work areas, stored machinery, and ponds. These releases potentially impacted soils and sediment in the vicinity of each IHSS, with the contaminants described in the preceding section. These impacted media are considered the

current contaminant source, since the original sources of spills or releases at most IHSSs are no longer present. The primary release mechanisms from the current source materials to the transport media, and the potential secondary release mechanisms from the transport media are discussed in the following sections.

2.5.2.1 Primary Release Mechanisms

Based on the contaminant source characteristics and the fate and transport process discussed above, primary release mechanisms for OU12 have been identified. These include: wind erosion of contaminated soil into the air as fugitive dust; vapor emissions of volatile organic compounds from soils and sediment; suspension and transport of contaminated soil and sediment via surface water runoff; tracking of contaminated soil; leaching of contaminants by infiltrating precipitation; and transport downward into ground water and bioaccumulation of contaminants in flora and fauna. However, over much of the OU12 area, surface soil contamination has been isolated by concrete or asphalt pavement. In these paved areas, the primary release mechanisms are severely constrained or inactive.

2.5.2.2 Secondary Release Mechanisms

After the contaminants become entrained in the transport media, the potential exists for interaction between the individual transport media. In the OU12 conceptual model, these secondary release mechanisms include percolation of vadose water and recharge of ground water; discharge and seepage of ground water; recharge of ground water by surface water; pumpage of ground water; volatilization from surface water; and deposition of dust from the air.

2.5.3 Exposure Routes and Receptors

As illustrated in Figures 2-39 and 2-40, contaminants released from OU12 can affect potential receptors through inhalation of airborne particles or vapors, and through ingestion of or dermal contact with contaminated source or transport media.

2.5.4 Exposure Pathway Summary

The primary goal of the OU12 RFI/RI is to gather data to define the nature and extent of contamination which supports a Baseline Risk Assessment. The Baseline Risk Assessment evaluates the potential risks of OU12 contamination to human health and the environment. The OU12 site conceptual model developed in the preceding sections identifies potential completed exposure pathways resulting from OU12 releases. Data necessary to evaluate each of these pathways will be collected during the OU12 RFI/RI as listed below:

- Soils/Sediment → Ingestion, Inhalation, or Direct Contact;
- Wind-Blown Dust/Volatile Emissions → Inhalation;
- Surface Runoff/Surface Water/Sediments;
- Infiltration/Percolation/Ground Water → Ingestion or Direct Contact; and
- Bioaccumulation/Bioconcentration → Ingestion or Direct Contact.

TABLE 2.1

OU12 IAG AND HRR IHSS COMPARISON

IAG IHSS Number	IAG IHSS Title	HRR IHSS Number	HRR IHSS Title	Discrepancies	IHSS Investigated in OU12
400 Area					
116.1	Multiple Solvent Spills at West Loading Dock	116.1	West Loading Dock - Building 447	HRR IHSS 116.1 is in the same location as IAG IHSS 116.1, but orientation is changed to extend further west based on low-level oblique photographs.	HRR IHSS 116.1
116.2	Multiple Solvent Spills at South Loading Dock	116.2	South Loading Dock - Building 444	HRR IHSS 116.2 is in a different location than IAG IHSS 116.2. The South Loading Dock is located east of the Building 444 plenum based on low-level oblique photographs, not west of the building plenum as indicated in the IAG.	HRR IHSS 116.2
136.1	Cooling Tower Pond Northeast of Building 460	—	—	No documentation was found during HRR research to support the IAG pond location.	No investigation
136.2	Cooling Tower Pond South of Building 460	136.2	Cooling Tower Pond East of Building 444	HRR IHSS 136.2 is in a different location and is larger than IAG IHSS 136.2. Documentation found during HRR supports pond location east of Building 444. No cooling tower ponds are located in the IAG that are south of Building 460, as the title infers.	HRR IHSS 136.2
136.3	Cooling Tower Pond West of Building 460	136.1	Cooling Tower Pond West of Building 444	HRR IHSS 136.1 is in the same general location as IAG IHSS 136.3. Pond north and west of Building 444 seen in 1965 aerial photographs. Corresponds to mapped location of IAG IHSS 136.3, but does not match title of IAG IHSS 136.3.	HRR IHSS 136.1/aka IAG IHSS 136.3
157.2	Radioactive Site South Area	157.2	Radioactive Site South Area	HRR 157.2 boundary extended west, south, and east to include activities in this area not identified in IAG.	HRR IHSS 157.2
187	Acid Leaks(2)	187	Sulfuric Acid Spill	Location of IHSS 187 not provided in IAG.	HRR IHSS 187

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TABLE 2.1

OU12 IAG AND HRR IHSS COMPARISON

IAG IHSS Number	IAG IHSS Title	HRR IHSS Number	HRR IHSS Title	Discrepancies	IHSS Investigated in OU12
600 Area					
120.1	Building 664 Fiberglassing Area	120.1	Fiberglassing Area North of Building 664	No discrepancies.	IAG IHSS 120.1
120.2	Building 664 Fiberglassing Area	120.2	Fiberglassing Area West of Building 664	No discrepancies.	IAG IHSS 120.2
189	Multiple Acid Spills	189	Nitric Acid Tanks	Location of IHSS 189 not provided in IAG. Location was defined only as north and west of Building 881.	HRR IHSS 189
700 Area					
147.1	Process Waste Line Leak: Maas Area	147.1	Process Waste Line Leaks	IHSS 147.1 location is the same in both the IAG and HRR. IHSS 147.1 will be investigated in OU9.	Not Investigated in OU12
800 Area					
147.2	Process Waste Line Leak: Owen Area	147.2	Building 881 Conversion Activity Contamination	HRR IHSS 147.2 located north and east of IAG 147.2 location. History of site provided in HRR and eluded to in IAG does not address a process waste line leak, but a storage area for equipment during conversion of Building 881 from beryllium and uranium manufacturing to nonradioactive uses.	HRR IHSS 147.2

TABLE 2.2

OU12 IHSS SUMMARY

IHSS #	TITLE	HISTORICAL ACTIVITY DESCRIPTION	SUSPECT COMPOUNDS	SUSPECT LOCATION
400 Area				
116.1	West Loading Dock Building 447	Uranium and beryllium transfer and storage area (1956 - present); Possible nonradioactive solvent storage; Oil surfacing nearby around Building 453; Adjacent PACs contain a PCB transformer and were used for hazardous waste storage	Uranium, Beryllium, Solvents, Oil PCBs	Surface from spills and leaks; Subsurface from infiltration
116.2	South Loading Dock Building 444	Uranium and beryllium transfer and storage area (1953 - present); Nearby pit entrance to basement storage of cyanide- and graphite-containing drums; Wind dispersion of uranium from drums (1953); Airborne release of uranium oxide from vacuum fire extinguishing activity (1954); Dumping of solvent rinse from cleaning beryllium parts on adjacent ground (until 1970); Leaking of drums containing perclene still bottoms and nitric acid onto dock and nearby soil	Uranium, Beryllium, Cyanide, Graphite, Perclene, Nitric Acid, Chlorinated Hydrocarbon Solvents	Surface from spills, leaks, dumping, and airborne releases; Subsurface from infiltration
136.1	West Cooling Tower Pond Building 444	Impoundment for cooling tower blowdown from Buildings 444 and 447 (1956-1969); Possible presence of hexavalent chromium used in cooling tower maintenance; Possible lithium disposal and depleted uranium burial	Hexavalent Chromium, Uranium, Lithium	Subsurface from infiltration and burial
136.2	East Cooling Tower Pond Building 444	Impoundment for cooling tower blowdown from Buildings 444 and 447 (1956-1969); Possible containment of cooling tower cleaning solution (1956) and subsequent backfilling following evaporation and infiltration; Possible presence of hexavalent chromium used in cooling tower maintenance; Possible lithium disposal and depleted uranium burial	Hexavalent Chromium, Uranium, Lithium	Subsurface from infiltration and burial
157.2	Radioactive Site South Area	Transfer, storage, and fabrication area (1953 - present); Includes activities described for IHSS 116.1, 116.2, 136.1, and 136.2; Also includes ditch south of Building 444 which contained wash water from docks; ingot, metal, and drum storage areas; uranium machine tool storage area with infiltration of hydraulic oil and carbon tetrachloride; and potential contamination under Building 444; Numerous incidents of releases to soil and air	Uranium, Beryllium, Hydraulic Oil, Carbon Tetrachloride, Chlorinated Hydrocarbon Solvents	Surface from spills, leaks, dumping, and airborne releases; Subsurface from infiltration and burial
187	Sulfuric Acid Spill Building 443	1,500-gallon 94.1% sulfuric acid spill from 3,000-gallon aboveground tank captured in earthen pit and neutralized with lime (1970)	Sulfuric Acid, Sulfates	Surface from spill; and neutralization Subsurface from infiltration

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TABLE 2.2

OU12 IHSS SUMMARY

IHSS #	TITLE	HISTORICAL ACTIVITY DESCRIPTION	SUSPECT COMPOUNDS	SUSPECT LOCATION
600 Area				
120.1	Fiberglassing Area North of Building 664	Fiberglassing operations for waste packing boxes (1972-1979); Possible spills of polyester resin, peroxide catalyst, and cleaning solvents; adjacent storage site for radioactive wastes (IHSS 161); Aerial radiological measurements of elevated gamma radiation and americium	Radioactive Waste, Polyester Resin, Peroxide Catalyst Materials, Solvents, Americium	Surface from spills and leaks; Subsurface from infiltration
120.2	Fiberglassing Area West of Building 664	Fiberglassing operations for waste packing boxes (1972-1979); Possible spills of polyester resin, peroxide catalyst, and cleaning solvents; adjacent storage site (IHSS 161) for radioactive wastes; Aerial radiological measurements of elevated gamma radiation and americium	Radioactive Waste Polyester Resin, Peroxide Catalyst Materials, Solvents, Americium	Surface from spills and leaks; Subsurface from infiltration
189	Nitric Acid Tanks	Nitric acid storage and transfer area (1952- present); Numerous reported spills during filling and transfer from two, 10,000-gallon aboveground tanks; Recent spills of 1-3 gallons	Nitric Acid	Surface from spills and leaks
800 Area				
147.2	Building 881 Conversion Activity Contamination	Storage yard for machining equipment possibly during Building 881 conversion (1964-1966); Equipment possibly contaminated with beryllium and/or enriched or depleted uranium 1964-1966	Uranium, Beryllium	Surface from storage of contaminated equipment

TABLE 2.3
COMPARISON OF HYDRAULIC PROPERTIES

Source	Formation	Hydraulic Conductivity (cm/s)
Ground Water Assessment Plan Addendum - Draft	Valley Fill	9×10^{-5}
	Alluvium	5.3×10^{-4} - 2.1×10^{-5}[a]
EG&G, 1990	Bedrock	5.4×10^{-7} - 4×10^{-8}
Hydrogeological Characterization of the Rocky Flats Plant	Alluvium	1×10^{-3}[b]
	Arapahoe Sandstone[e]	4×10^{-5}
Hydro-Search, 1985	Arapahoe Claystone[e]	3×10^{-7}
Section E Ground Water Protection	Rocky Flats Alluvium	7×10^{-5}[c]
	Walnut Creek Alluvium	3×10^{-5}
Rockwell International, 1986	Woman Creek Alluvium	3×10^{-3}
	Arapahoe Sandstone[e]	2×10^{-6}
	Weathered Arapahoe Claystone[e]	5×10^{-7}
	Unweathered Arapahoe Claystone[e]	1×10^{-7}
	Qal (Valley Fill)	2×10^{-4}
Draft Final Ground Water Protection and Monitoring Plan	Rocky Flats Alluvium Arapahoe Sandstone No. 1	6×10^{-5}[a]
	Arapahoe Sandstones Nos. 3, 4, 5[e]	10^{-6}
EG&G, 1991	Basal Arapahoe Sandstone[e]	10^{-6}
	Arapahoe Claystone[e] (Weathered & Unweathered)	10^{-7} - 10^{-8}
RCRA Part B Permit Application	Rocky Flats Alluvium	7×10^{-5}[c]
	Valley Fill	3×10^{-3}
DOE, 1987	Arapahoe Formation[e]	2×10^{-6} - 1×10^{-7}

TABLE 2.3
COMPARISON OF HYDRAULIC PROPERTIES

Source	Formation	Hydraulic Conductivity (cm/s)
Hydrology of a Nuclear-Processing Plant Site	Rocky Flats Alluvium	1×10^{-2} [d]
	Valley Fill	NA
Hurr, 1976	Arapahoe Formation[c]	1×10^{-4}
RCRA Post-Closure Care Permit Application	Rocky Flats Alluvium	9×10^{-6} - 4×10^{-8} [c]
	Valley Fill	5×10^{-6}
DOE, 1988	Arapahoe Formation[c]	NA

Source: Draft Final Rocky Flats Plant Geologic Characterization Report (EG&G, 1991c)

[a] Averages of measurements in wells at three RFP RCRA-regulated units (West Spray Field, Solar Evaporation Ponds, and Present Landfill)

[b] Estimate based on drawdown-recovery tests on three RFP wells and on observed physical properties of Rocky Flats Alluvium

[c] Average of measurements from monitoring wells at various locations within RFP

[d] Estimate, apparently based on physical properties of Rocky Flats Alluvium and infiltration rate calculated from one or more RFP monitoring wells

[e] Arapahoe sandstones 2 through 5 and interbedded claystones are considered part of the Laramie Formation based on the Phase II Geologic Characterization, Data Acquisition.

TABLE 2.4
CONCENTRATIONS OF SELECT METALS (mg/kg) IN SHALLOW SOILS (0 to 7 feet)

Location	Depth	Beryllium	Chromium	Lithium
12489	0-3	<1.1	11.6	<21.2
13489	0-3	<0.41	12.3	13.5B
	3-7	<0.42	27.4	5.1B
13589	0-3	<1.0	13.6	<20.4
	4-8	<0.98	5.5	<19.7
13689	0-3	<1.1	9.8	<22.4
	3-7	1.1	17.1	<22.9
14089	0-3	<1.2	10.8	<23.2
	3-7	1.6	11.6	<23.6
14289	0-3	<0.43	15.3	9.9B
	3-7	1.6	33.7	<22.6B
14689	0-3	<0.86	8.4	<17.3
	3-6	<1.1	5.7	<22.2
14789	0-3	<0.85	12.6	<16.9
	3-7	1.2	13.0	<18.7
14889	0-3	1.2	11.7	<22.6
	3-6	<1.0	7.5	<20.9
15489	0-3	2.0	17.5	<19.4
	3-6	1.8	9.5	<21.0
15589	0-3	<1.1	10.6	<21.1
	3-6	<0.96	10.0	<19.1
15989	0-3	<1.0	10.3	<20.2
	3-7	1.1	14.5	<18.2
16889	0-2	<1.0	8.7	<20.3
	3-5	<1.1	11.2	<23.0

TABLE 2.4
CONCENTRATIONS OF SELECT METALS (mg/kg) IN SHALLOW SOILS (0 to 7 feet)

Location	Depth	Beryllium	Chromium	Lithium
17989	0-3	<0.44	9.1	14.2
	3-6	<0.39	10.6	15.5B
0187	1	0.8J	14	--
	4	0.8J	12	--

J = Reported value is less than the contract required detection limit but greater than the instrument detection limit.
B = Compound detected in blank sample.
-- Not reported.

TABLE 2.5
CONCENTRATIONS OF SELECT RADIONUCLIDES (pCi/g) IN SHALLOW SOILS (0 to 7 feet)

Location	Depth	Alpha	Beta	Plutonium 239/240	Uranium 233/234	Uranium 238	Tritium (pCi/l)
13489	0-3	20.7±3.5	29.1±5.2	15.860±0.28	0.27±0.14	0.23±0.14	-220±270
	3-7	9.6±2.9	23.0±4.9	0.024±0.011	0.19±0.20	0.42±0.27	-160±260
13689	0-3	24.2±3.9	39.4±5.5	1.756±0.082	1.17±0.32	0.82±0.27	3260±430
	3-7	12.3±3.2	31.4±5.2	0.066±0.015	1.01±0.36	1.82±0.34	1000±40
14289	0-3	6.7±2.4	19.0±4.7	0.096±0.026	1.66±0.48	1.20±0.42	70±280
	3-7	1.09±3.4	32.4±5.2	0.023±0.014	0.71±0.33	1.32±0.42	190±330
14689	0-3	17.6±4.8	28.9±4.9	0.031±0.015	0.69±0.28	0.84±0.31	620±310
	3-6	17.0±4.5	30.9±4.9	0.018±0.011	0.64±0.28	0.39±0.12	-140±260
14789	0-3	18.3±4.7	26.4±4.8	0.090±0.021	0.80±0.34	0.73±0.31	-70±270
	3-7	7.1±3.8	29.1±4.9	0.022±0.011	0.38±0.2	0.43±0.2	-130±250
14889	0-3	17.0±3.5	35.3±5.3	0.022±0.015	1.16±0.36	0.80±0.31	-50±280
	3-6	11.4±3.1	34.4±5.2	0.025±0.012	0.71±0.27	0.52±0.25	230±280
15489	0-3	20.1±4.6	31.5±5.1	0.030±0.01	1.27±0.28	1.00±0.25	380±330
	3-6	24.1±5.2	28.9±5.0	0.014±0.009	0.72±0.27	0.99±0.32	200±300
15589	0-3	13.6±3.0	33.4±5.3	0.031±0.013	1.10±0.44	0.90±0.38	130±440
	3-6	8.2±2.7	26.6±5.0	0.030±0.014	0.85±0.43	0.80±4.1	210±280
15989	0-3	19.8±3.4	35.6±5.1	0.012±0.007	0.85±0.27	0.85±0.27	50±290
	3-7	17.2±3.4	37.5±5.3	0.013±0.008	0.91±0.33	0.88±0.33	-110±300
16889	0-2	18.1±3.6	42.2±5.8	0.13±0.032	0.95±0.33	1.01±0.35	-80±290
	3-5	14.8±3.1	36.0±5.5	0.005±0.013	0.62±0.33	0.31±0.27	-80±310

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TABLE 2.5
CONCENTRATIONS OF SELECT RADIONUCLIDES (pCi/g) IN SHALLOW SOILS (0 to 7 feet)

Location	Depth	Alpha	Beta	Plutonium 239/240	Uranium 233/234	Uranium 238	Tritium (pCi/l)
0187	1	24±10	24±6	0.06±0.11	0.42±0.13	0.35±0.12	--
	4	22±10	19±6	-0.03±0.07	0.87±0.23	0.58±0.19	--

Error corresponds to the radioactive potential disintegration process counting error at the 95% confidence level, 1.96σ. Variability larger than concentration results in an apparent negative concentration.
-- Not reported.

TABLE 2.6
CONCENTRATIONS OF SELECT VOLATILE ORGANIC COMPOUNDS[a] (ug/kg) IN SHALLOW SOILS (0 to 6 feet)

Location	Depth (ft)	Acetone	1,1,1-Trichloroethane	Methylene Chloride	Carbon Disulfide	2-Butanone	Benzene	Toluene	Ethyl-benzene
11589	0-2	<11	<6	6	<5	<10	<5	<5	<5
	0-2 (DUP)	59	<6	4J	<6	<11	<6	<6	<6
	4-5	45	<5	<5	<5	<10	<5	<5	<5
	5-6	10J	<6	3J	<6	<12	<6	<6	<6
13489	0-2	18B	11	9B	<6	<11	<6	<6	<6
	2-4	75B	9	7B	<6	<11	<6	<6	<6
13589	0-2	19	<6	11	<6	<11	<6	<6	<6
	2-3	<11	<6	4J	<6	<11	<6	<6	<6
	4-6	<12	<6	17	<6	<12	<6	2J	<6
13689	0-2	55	<6	27B	<6	<12	<6	<6	<6
	2-4	200	<6	13B	<6	43	<6	<6	<6
	4-6	130	<6	16B	<6	<11	<6	<6	<6
14089	0-2	<11	<5	9B	<5	<11	<5	<5	<5
	2-4	<12	<6	12B	<6	<12	<6	<6	<6
	4-6	<12	<6	41B	<6	<12	<6	<6	<6
14289	0-2	14B	<5	7B	<5	<10	<5	<5	<5
	2-4	14B	<6	8B	<6	<12	<6	<6	<6
	4-6	46B	<6	7B	<6	<13	<6	<6	<6

TABLE 2.6
CONCENTRATIONS OF SELECT VOLATILE ORGANIC COMPOUNDS[a] (ug/kg) IN SHALLOW SOILS (0 to 6 feet)

Location	Depth (ft)	Acetone	1,1,1-Trichloroethane	Methylene Chloride	Carbon Disulfide	2-Butanone	Benzene	Toluene	Ethyl-benzene
14689	0-2	<11	<6	16B	<6	<11	<6	<6	<6
	2-4	<12	<6	12B	<6	<12	<6	<6	<6
	4-6	<11	<5	13B	13	<11	5	16	1J
14789	0-2	<11	<5	11B	<5	<11	<5	2JB	<5
	2-4	<11	<5	8B	<5	<11	<5	<5	<5
	4-6	<11	<6	13B	<6	<11	<6	<6	<6
14889	0-2	53	<6	13B	<6	<11	<6	<6	<6
	2-4	<17	<9	17B	<9	<17	<9	3JB	<9
	5-6	34	<5	15B	1J	<11	<5	<5	<5
15489	0-2	6J	<5	17B	<5	<10	<5	2J	<5
	2-4	11J	<6	19B	<6	<12	<6	<6	<6
	4-6	<10	<5	18B	<5	<10	<5	1J	<5
15589	0-2	5J	<6	6B	<6	<11	<6	<6	<6
	2-4	38	<7	9B	<7	<13	<7	<7	<7
	4-6	76B	<6	15B	<6	<11	<6	<6	<6
15989	0-2	<11	<6	5JB	<6	6J	<6	<6	<6
	2-4	100	<6	<6	<6	<6	<6	<6	<6
	4-6	25	<5	5B	<5	<11	<5	<5	<5
16889	0-2	<11	<5	15B	<5	<11	<5	<5	<5
	3-5	4J	<6	15B	10	<12	<6	<6	<6

TABLE 2.6
CONCENTRATIONS OF SELECT VOLATILE ORGANIC COMPOUNDS[a] (ug/kg) IN SHALLOW SOILS (0 to 6 feet)

Location	Depth (ft)	Acetone	1,1,1-Trichloroethane	Methylene Chloride	Carbon Disulfide	2-Butanone	Benzene	Toluene	Ethyl-benzene
17989	0-2	37B	7B	6B	<6	<13	<6	<6	<6
	2-4	19B	<6	7B	<6	<12	<6	<6	<6
	4-6	18B	4JB	4JB	<6	<12	<6	<6	<6
0187	1	400B	<25	10JB	<25	120B	<25	<25	<25
	4	400B	<25	12JB	<25	120B	<25	<25	<25

B = Compound detected in blank sample.
J = Reported value is less than the contract required detection limit but greater than the instrument detection limit.
[a] Only volatile organic compounds detected in soil samples from a depth of 0 to 6 feet are listed. At 0187, tetrachloroethene and trichloroethene were also detected at concentrations of 190 and 120 ug/kg, respectively, in a 4-foot sample; and bis (2-ethylhexyl) phthalate was detected at 880 and 1100 ug/kg in a 1-foot and 4-foot sample, respectively.

TABLE 2.7
CONCENTRATION OF SELECT CONSTITUENTS IN GROUND WATER FROM WELL NO. 17989

Constituent	Mar 90	May 90	Aug 90	Dec 90
RADIONUCLIDES (pCi/l)				
Gross Alpha	--	--	108±27	--
Gross Beta	--	--	40.5±10.2	--
Uranium-233/234	--	--	49±5.7	--
Uranium-235/236	--	--	1.57±0.43	--
Uranium-238	--	--	37.2±4.4	--
Tritium	--	--	--	244.9±210J
METALS (μg/l)				
Calcium	80700	--	--	--
Magnesium	70600	--	--	--
Sodium	284000	--	--	--
Strontium	1610	--	--	--
MAJOR IONS (mg/l)				
Bicarbonate	330	312	--	300
Chloride	130	128	--	170
Fluoride	5.9	5	--	6.8
Nitrate/Nitrite	54	<0.1*	--	4.2
Sulfate	650	638	--	650
TDS	1500	1620	--	1600
TSS	--	<5	--	16

-- = Not tested.
* = Nitrite only.
TDS = Total Dissolved Solids.
TSS = Total Suspended Solids.
J = Value reported is less than the contract required detection limit but greater than the instrument detection limit.

TABLE 2.8
CONCENTRATIONS OF SELECT CONSTITUENTS IN GROUND WATER FROM WELL NO. 0187

Constituent	Feb. 88	June 89	Aug. 89	Oct. 89	Feb. 90	July 90	Oct. 90	Aug. 91	Dec. 91
RADIONUCLIDES (pCi/l)									
Americium-241	0.03±0.25	0±0.04	0±0.1	--	--	--	--	--	--
Gross Alpha	15±11	31±12	28±17	17.7±3	--	9.74±5.77	16.34±8.88	4.95±3.27	--
Gross Beta	15±30	15±6	17±8	--	--	10.34±3.33	8.23±2.72	7.5±2.22	--
Plutonium-239/240	0±0.26	0.01±0.02	0±0.01	--	--	--	--	--	--
Strontium	--	--	--	0.31±0.62	--	--	--	--	--
Tritium	--	--	280±200	--	--	277±219	--	65.28±189	--
Uranium, Total	14.24	20.8	--	--	--	--	--	--	--
Uranium-233/234	8.4±0.7	12±1	13±1	3.98±1.08	--	14.74±2.38	9.69±1.88	8.48±1.71	--
Uranium-235	0.34±0.11	0.2±0.1	0.6±0.2	0.37±0.33	--	0.21±0.19	0.15±0.18	0.10±0.15	--
Uranium-238	5.5±0.5	8.6±0.7	9±0.7	3.17±0.97	--	10.67±1.86	6.4±1.4	4.741±1.16	--
METALS (μg/l)									
Barium	--	264	244	<200	--	281	--	<200	<200
Calcium	--	162000	144000	84100	--	150000	--	78300	98500
Copper	--	<25	<25	<25	--	<25	--	27.9	37.1
Iron	--	5820	2190	18.9	--	1060	--	734	974
Magnesium	--	40100	36400	21800	--	41000	--	19700	26300
Manganese	--	3330	1730	707	--	1190	--	623	446
Mercury	--	<0.2	<0.2	0.28	--	<0.2	--	<0.2	<0.2
Nickel	--	<40	<40	<40	--	229	--	<40	104
Selenium	--	<5	<5	<5	--	5.6	--	<5	<5
Sodium	--	10400	91300	70500	--	117000	--	89100	89100
Strontium	--	943	<1000	518	--	993	--	540	735
Zinc	--	73.5	<20	87.5	--	126	--	46.9	95.9
Silicon	--	--	--	--	--	5130	--	--	--

TABLE 2.8
CONCENTRATIONS OF SELECT CONSTITUENTS IN GROUND WATER FROM WELL NO. 0187

Constituent	Feb. 88	June 89	Aug. 89	Oct. 89	Feb. 90	July 90	Oct. 90	Aug. 91	Dec. 91
MAJOR IONS (mg/l)									
Bicarbonate	--	640	600	320	630	600	420	340	410
Chloride	--	59	51	23	55	55	34	31	32
Fluoride	--	--	--	--	<0.5	0.6	0.6	0.8	0.9
Nitrate/Nitrite	--	0.14	0.55	<0.05	0.06	<1/<1	--	--	0.8
Sulfate	--	110	120	84	96	110	100	140	110
TDS	--	810	830	460	740	930	670	620	620
TSS	--	50	14	41	--	4	34	360	49
VOLATILES (μg/l)									
1,1,1-Trichloroethane	<5	<5	<5	130	16	3J	<5	<5	<5
Trichlorethene	<5	<5	<5	<10	18	7	2J	2J	<5

-- Not reported.
J = Value reported in less than the contract required detection limit, but greater than the instrument detection limit.

TABLE 2.9

CONCENTRATIONS OF SELECT CONSTITUENTS IN SURFACE WATER FROM LOCATION SW125 DECEMBER 1990

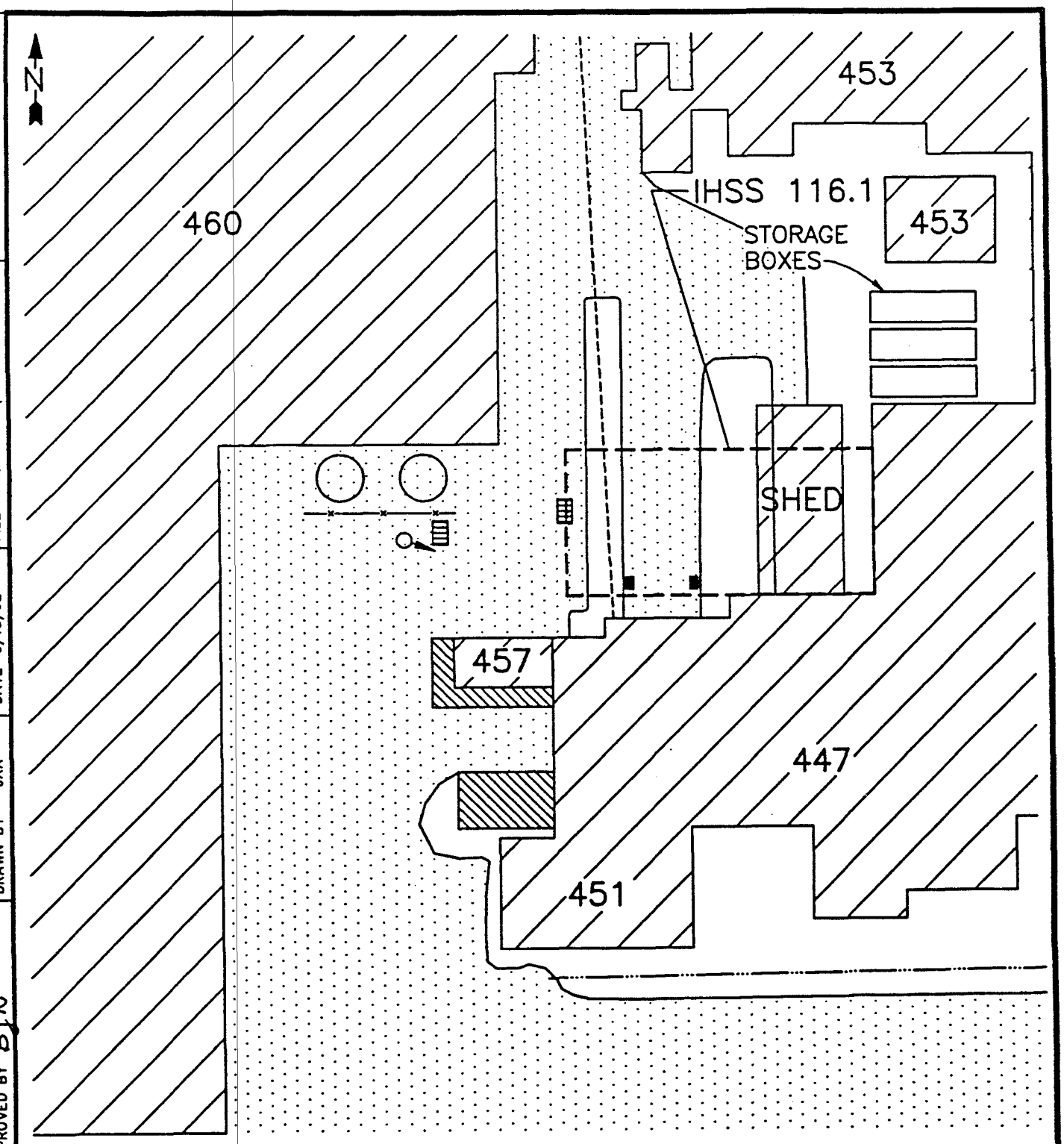
CONSTITUENT	CONCENTRATION	DUPLICATE CONCENTRATION
RADIONUCLIDES (pCi/l)		
Gross Alpha	4.300	
Gross Beta	5.900	
Uranium-234	2.600	
Uranium-238	1.600	
METALS (μg/l)		
Aluminum	<200	261
Calcium	38400	38400
Iron	<100	234
Lead	<3	<3
Magnesium	9660	9620
Sodium	17300	16900
Zinc	<20	22
Strontium	240	239
MAJOR IONS (mg/l)		
Bicarbonate	170	
Fluoride	1.1	
Nitrate/Nitrite	0.38	
Phosphate	0.065	
Silica	7	
Sulfate	42	
TDS	270	
TSS	16	

TDS = Total Dissolved Solids.
TSS = Total Suspended Solids.

TABLE 2.10

GENERAL ENVIRONMENTAL PATHWAY MODEL

CONTAMINANT SOURCE	→ RELEASE MECHANISM	→ TRANSPORT MEDIA	→ EXPOSURE ROUTE	→ RECEPTOR
Surface soil/sediment	---	---	Direct contact/ingestion	Site workers/public
	Re-suspension	Air	Inhalation	Site workers/public
	Volatilization	Air	Inhalation	Site workers/public
	Re-suspension	Surface water	Direct contact/ingestion	Extra-OU surface water users
Subsurface soil	Volatilization	Air	Inhalation	Site workers/public
	Dissolution	Vadose and ground water	Direct contact/ingestion	Extra-OU ground water users
Ground Water	Discharge/Seepage	Surface water	Direct contact/ingestion	Extra-OU ground water users
Vadose Water	Discharge/Seepage	Ground and surface water	Direct contact/ingestion	Extra-OU ground water users



EXPLANATION

- BUILDING
- PHOTO VANTAGE POINT
- IHSS BOUNDARY
- OVERHEAD PIPING
- DRAIN
- DRAINAGE
- FENCE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL

25 0 25 50 FEET

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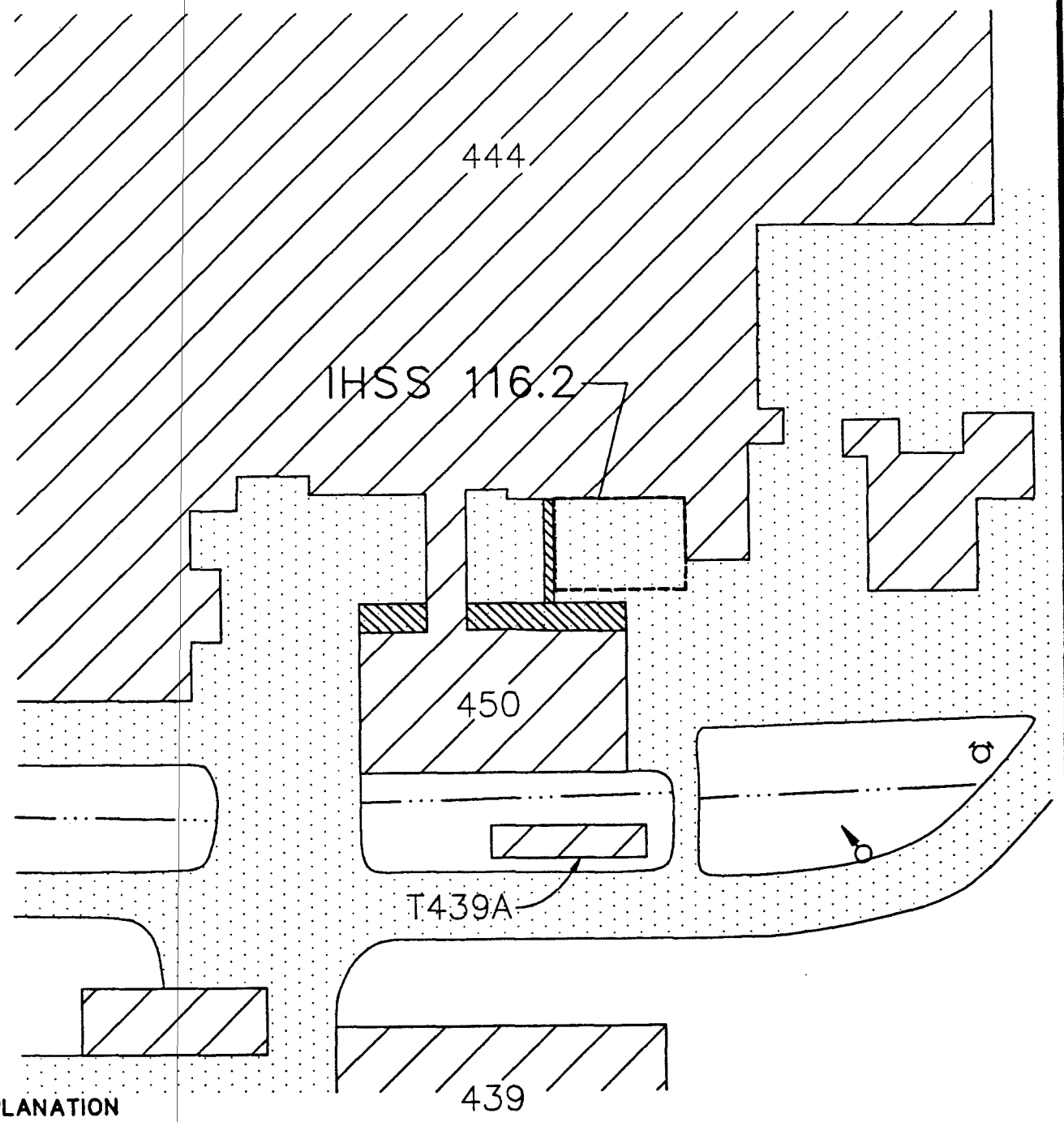
GOLDEN, COLORADO

FIGURE 2-3
LOCATION OF IHSS 116.1
WEST LOADING DOCK
BUILDING 447

REVISION NO. 0 | FILE NAME 40103\F01-203.DWG | DATE ~~9/15/92~~ | DRAWN BY JAA | APPROVED BY BIN | CHECKED BY BIN

MAY 27 1994



EXPLANATION

- BUILDING
- PHOTO VANTAGE POINT
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- WATER HYDRANT

25 0 25 50 FEET

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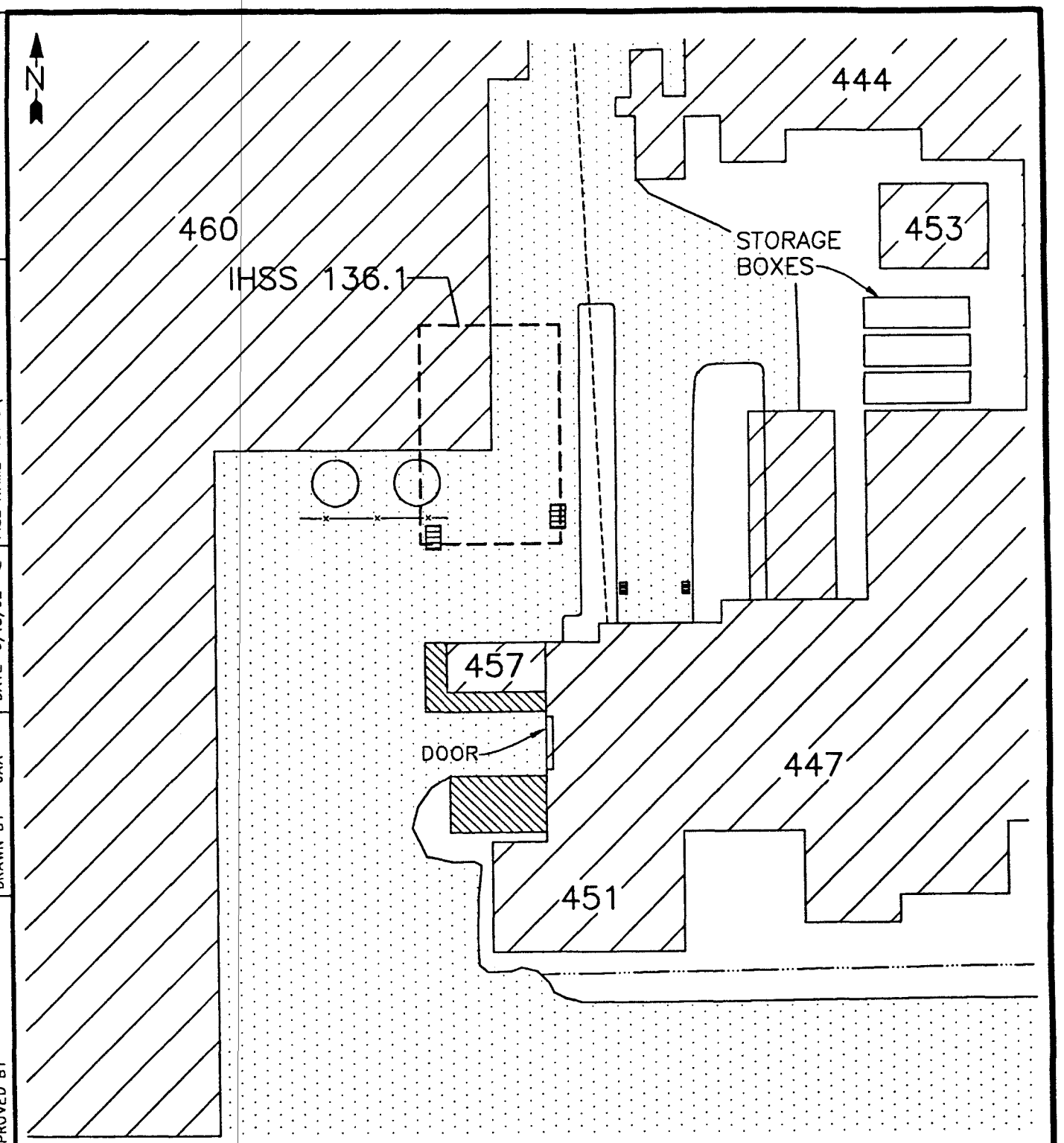
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 2-5

LOCATION OF IHSS 116.2
SOUTH LOADING DOCK
BUILDING 444

REVISION NO. 0 | FILE NAME 40103\F01-205.DWG | DATE ~~9/15/92~~ | DRAWN BY JAA | APPROVED BY BJN | CHECKED BY BJN

MAY 27 1994



EXPLANATION

- BUILDING
- IHSS BOUNDARY
- OVERHEAD PIPING
- DRAIN
- DRAINAGE
- FENCE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL

25 0 25 50 FEET

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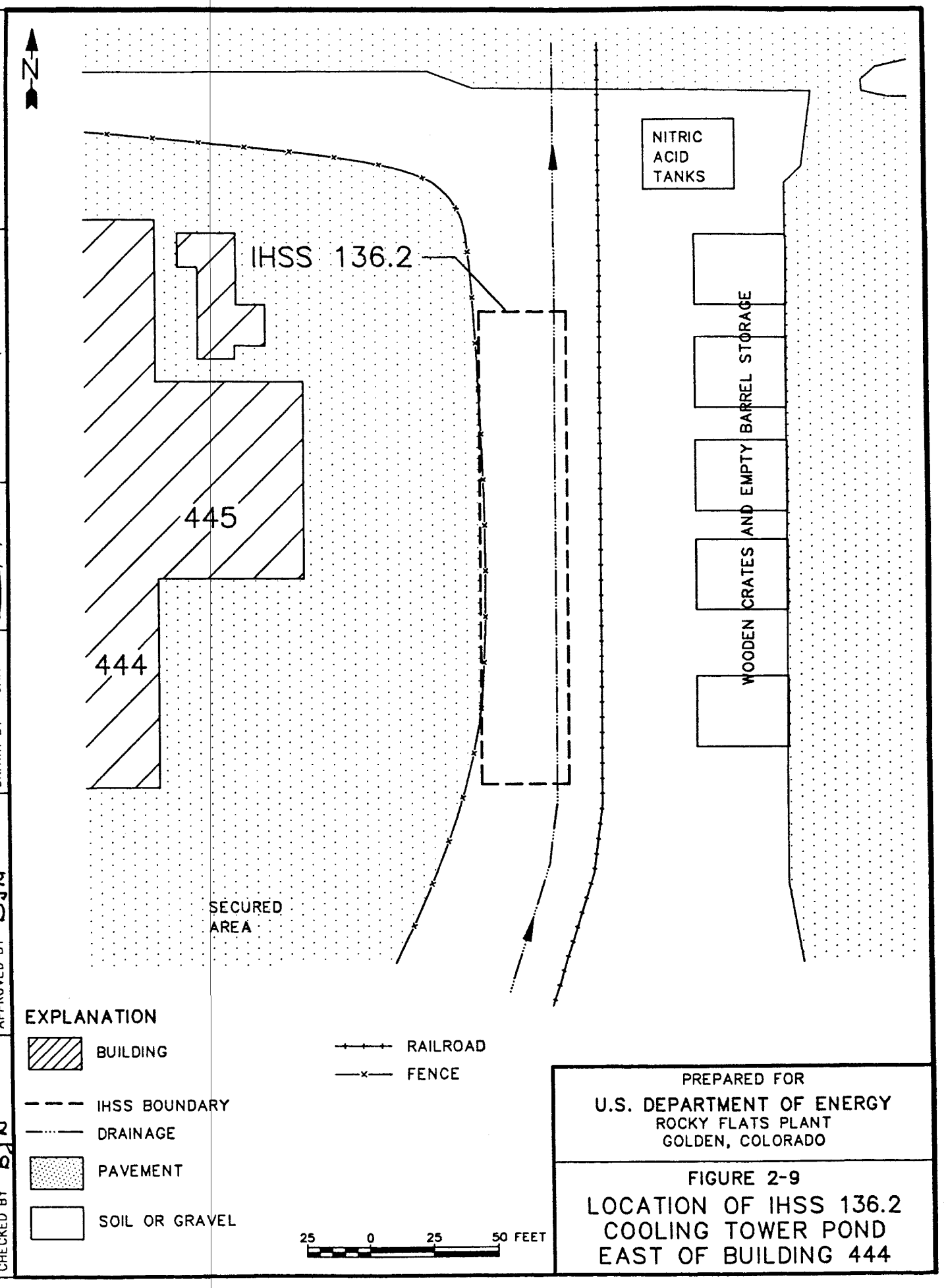
FIGURE 2-7
LOCATION OF IHSS 136.1
COOLING TOWER POND
WEST OF BUILDING 444

REVISION NO. 0
FILE NAME 40103\F01-207.DWG
DATE ~~9/15/92~~
DRAWN BY JAA
APPROVED BY
CHECKED BY

MAY 27 1994


N
NITRIC ACID TANKS
IHSS 136.2
445
444
WOODEN CRATES AND EMPTY BARREL STORAGE
SECURED AREA
EXPLANATION
BUILDING
IHSS BOUNDARY
DRAINAGE
PAVEMENT
SOIL OR GRAVEL
RAILROAD
FENCE
25 0 25 50 FEET
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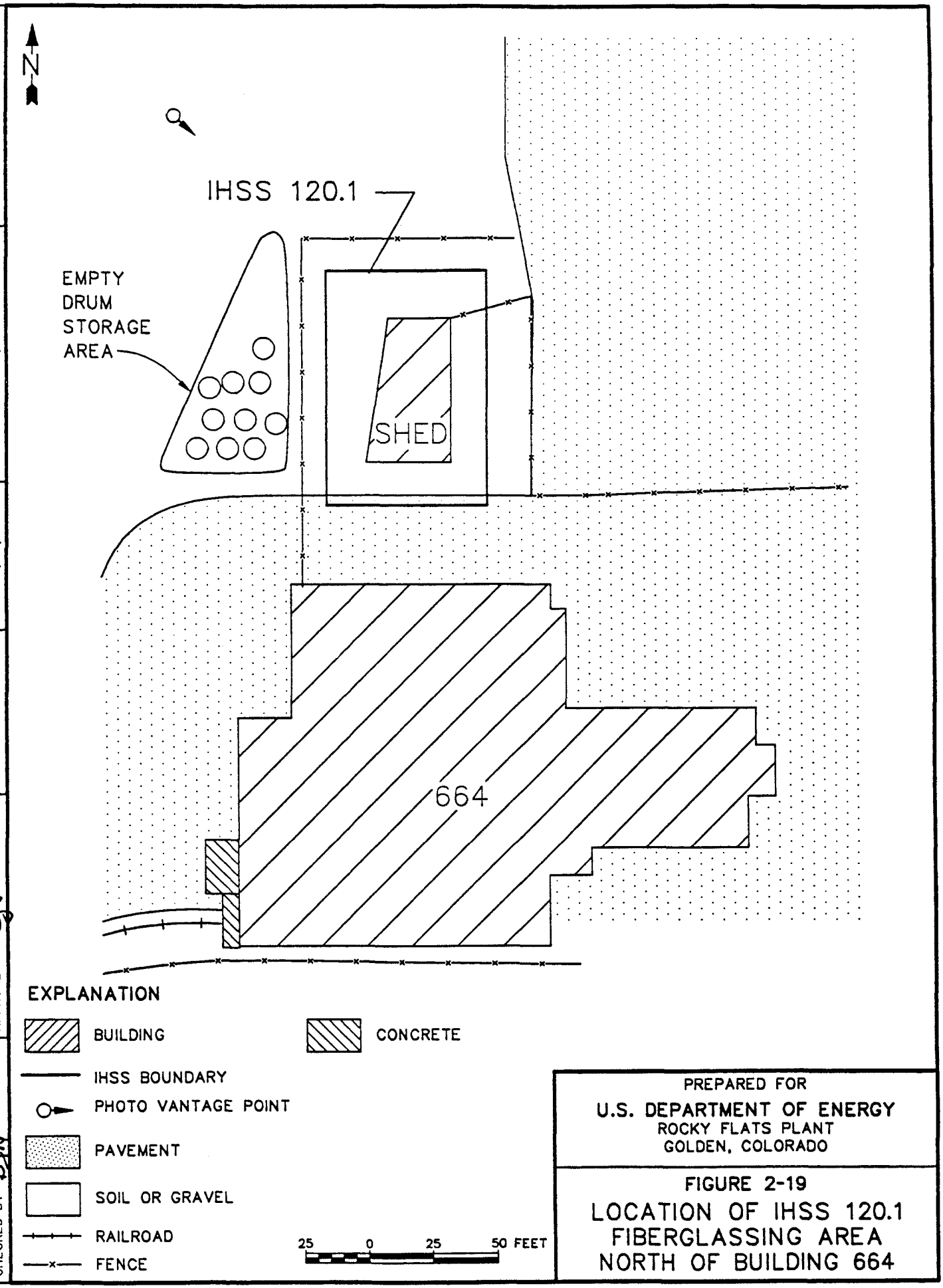
GOLDEN, COLORADO
FIGURE 2-9
LOCATION OF IHSS 136.2
COOLING TOWER POND
EAST OF BUILDING 444
REVISION NO. 0
FILE NAME 40103\F01-209.DWG
DATE 9/15/92
DRAWN BY JAA
APPROVED BY BJN
CHECKED BY BJN
MAY 27 1994


N
IHSS 120.1
EMPTY
DRUM
STORAGE
AREA
SHED
664
EXPLANATION
BUILDING
CONCRETE
IHSS BOUNDARY
PHOTO VANTAGE POINT
PAVEMENT
SOIL OR GRAVEL
RAILROAD
FENCE
25 0 25 50 FEET
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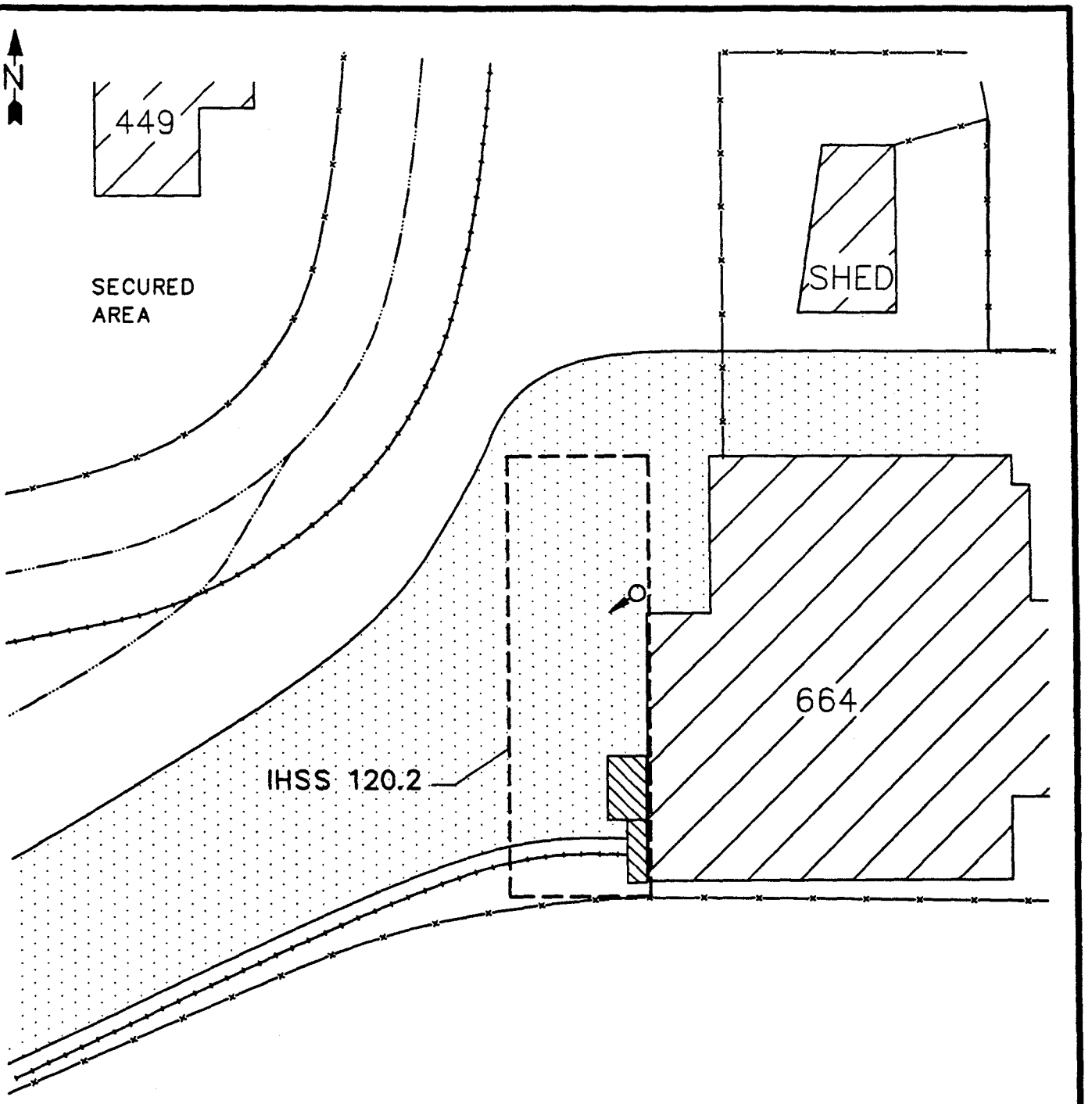
GOLDEN, COLORADO
FIGURE 2-19
LOCATION OF IHSS 120.1
FIBERGLASSING AREA
NORTH OF BUILDING 664
REVISION NO. 0
FILE NAME 40103\F02-219.DWG
DATE 4/29/92
DRAWN BY JAA
APPROVED BY BJN
CHECKED BY BJN
MAY 27 1994



EXPLANATION

- BUILDING
- CONCRETE
- PHOTO VANTAGE POINT
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- SOIL OR GRAVEL
- RAILROAD
- FENCE

25 0 25 50 FEET

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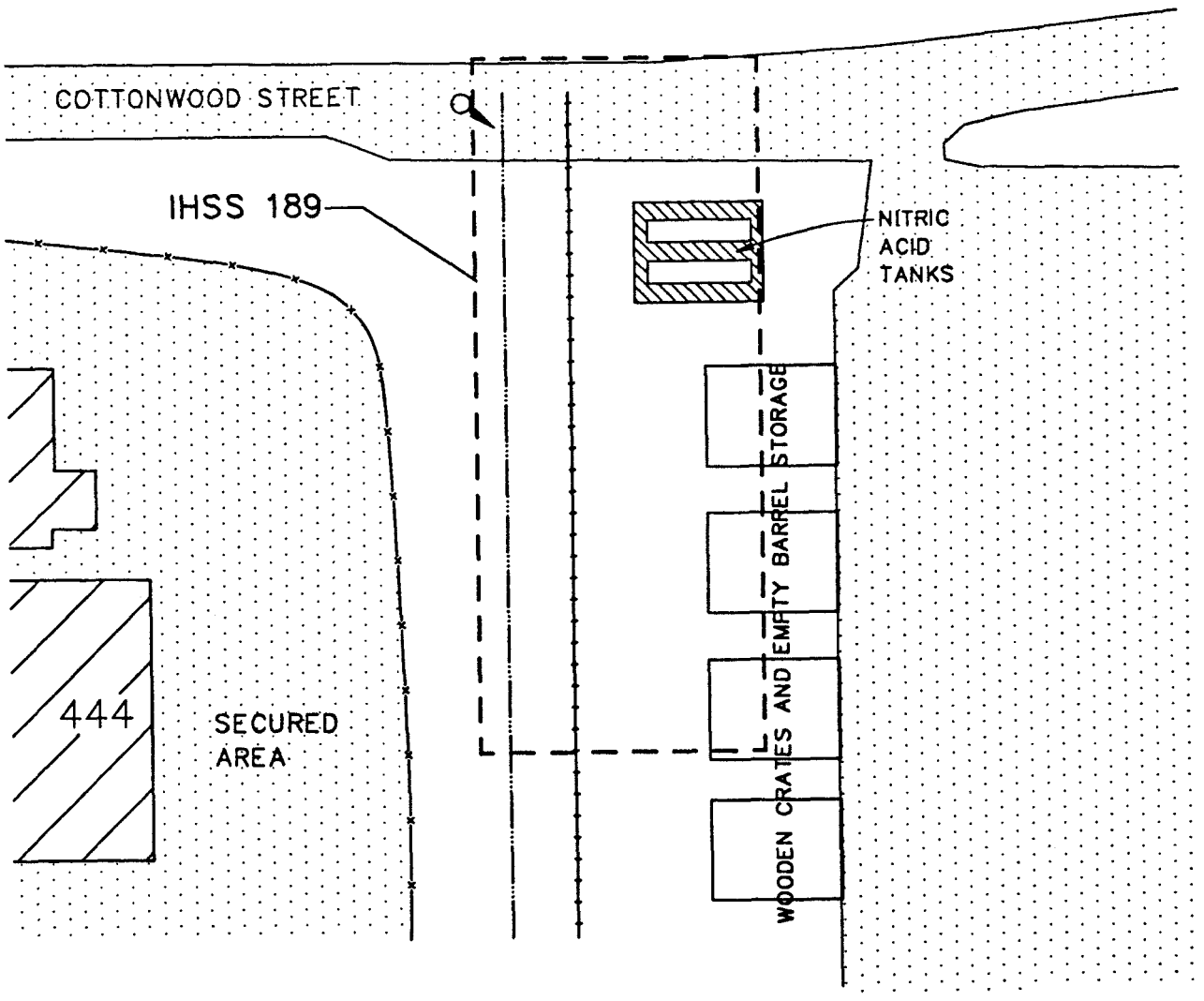
FIGURE 2-21
LOCATION OF IHSS 120.2
FIBERGLASSING AREA
WEST OF BUILDING 664

REVISION NO. 0
FILE NAME 40103\F01-221.DWG
DATE ~~9/16/92~~
DRAWN BY JAA
APPROVED BY BN
CHECKED BY BN

MAY 27 1994



EXPLANATION

- BUILDING
- PHOTO VANTAGE POINT
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- RAILROAD
- FENCE
- CONCRETE
- SOIL OR GRAVEL

25 0 25 50 FEET

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FIGURE 2-23
LOCATION OF IHSS 189
NITRIC ACID TANKS

REVISION NO. 0
FILE NAME 40103\F01-223.DWG
DATE ~~4/29/92~~ 2c
DRAWN BY JAA
APPROVED BY BJN
CHECKED BY BJN
MAY 27 1994

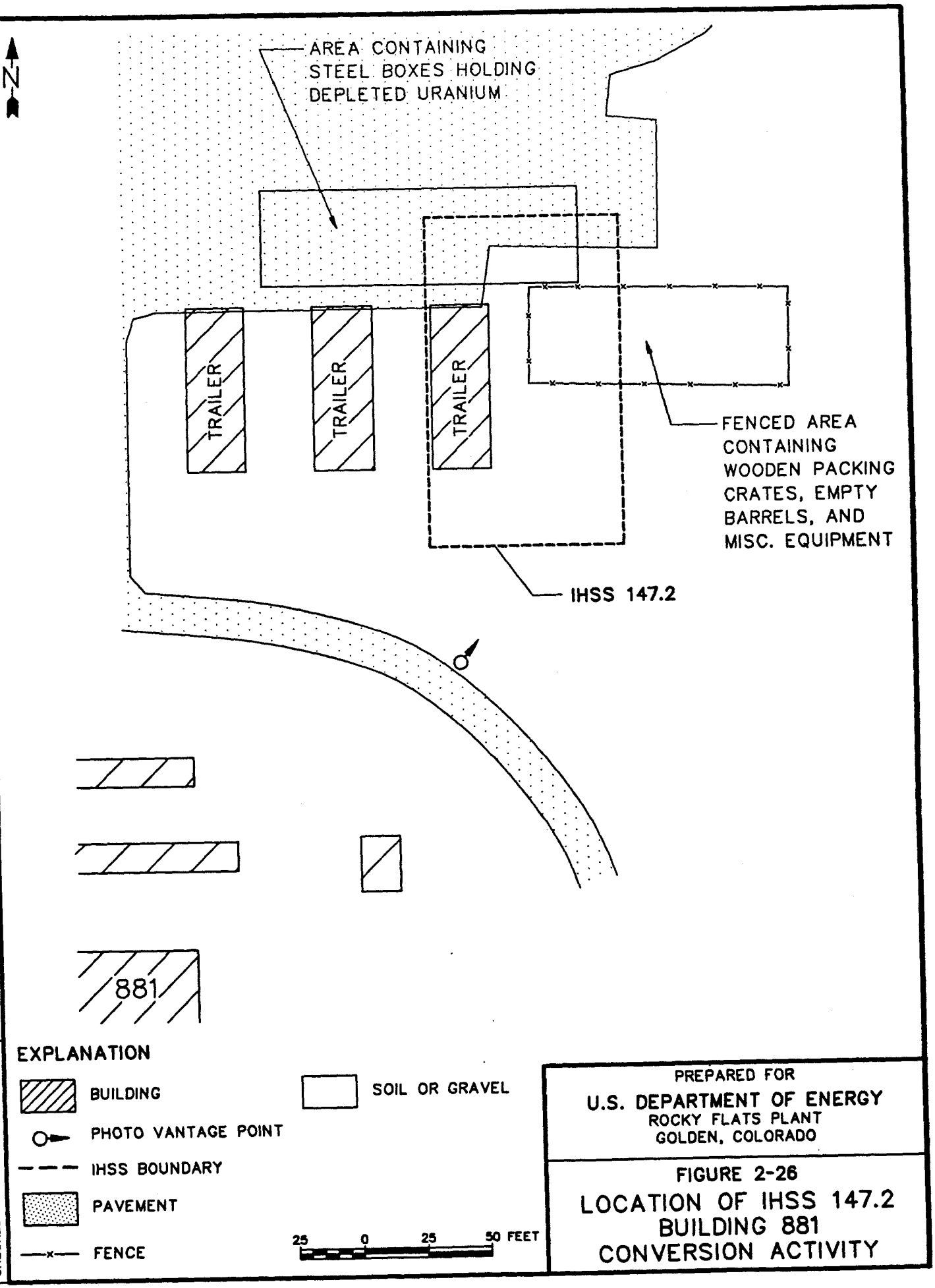

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FIGURE 2-26
LOCATION OF IHSS 147.2
BUILDING 881
CONVERSION ACTIVITY

REVISION NO. 0
FILE NAME 40103\F01-226.DWG
DATE 4/29/92
DRAWN BY JAA
APPROVED BY
CHECKED BY

MAY 27 1994

Approved by:

Manager, Remediation Programs 2/18/94

RI Project Manager 2/18/94

3.0 CHEMICAL SPECIFIC BENCHMARKS (CSBs)

Rocky Flats Plant Chemical Specific Benchmarks (CSBs) (EG&G terminology) included in this section were provided by EG&G and are in lieu of Applicable or Relevant and Appropriate Requirements (ARARs). The CSBs were developed for the entire Rocky Flats Plant site and are not specific to OU12. Site-specific ARARs will be developed as the initial step of the Corrective Measures Study/Feasibility Study (CMS/FS) for OU12. Preliminary remediation goals (PRGs) will also be developed in the CMS/FS. Tables 3.1 through 3.4 provide a preliminary identification of potential CSBs for ground water and surface water at the Rocky Flats Plant. CSBs for soil have not been developed at this time. EPA analytical methods and detection limits have been specified for soil analyses to obtain data of the highest quality with the lowest possible detection limits. As validated data become available from OU12 RFI/RI activities, the CSBs will be reevaluated in accordance with Chapter Three, Part 15 of the IAG (DOE, 1991a). The sitewide CSBs included in this work plan are not intended for use in establishing clean-up goals, however, they will be used to establish RFI/RI analytical detection limits. Clean-up activities for OU12 will be site specific and shall be based on results of an environmental and human-based Risk Assessment.

Sitewide CSBs represented in Tables 3.1 through 3.4 were developed from the following sources:

DOCUMENT CLASSIFICATION REVIEW WAIVER
PER R.B. HOFFMAN, CLASSIFICATION OFFICE
JUNE 11, 1991

- Colorado Department of Health (CDH), Water Quality Control Commission (WQCC), groundwater standards (EG&G, 1991e);
- Safe Drinking Water Act (SWADA), Maximum Contaminant Levels (MCLs), surface water and groundwater (EG&G, 1991e);
- Clean Water Act (CWA), Ambient Water Quality Criteria (AWQC), potentially applicable to surface water and groundwater (EG&G, 1991e);
- RCRA, Subpart F, Groundwater Concentration Limits (40 CFR 264.94), groundwater standards (EG&G, 1991e); and
- CDH, WQCC proposed statewide and classified groundwater area standards (EG&G, 1991e).

In instances where CSBs have not been proposed for a particular chemical or for a particular type of investigative method, EG&G's General Radiochemistry and Routine Analytical Services Protocol (GRRASP) or other appropriate laboratory procedures will be considered as the practical quantitation limits and will be applied (EG&G, 1991d).

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Bicarbonate	A	10,000		E310.1													
Carbonate	A	10,000		E310.1													
Chloride	A	5,000		E325	250,000 *							250,000					
Chlorine	A	1,000		E4500													
Fluoride	A	5,000		E340	4,000; 2,000*		4,000				4,000		2,000				
N as Nitrate	A	5,000		E353.1	10,000			10,000			10,000						
N as Nitrate+Nitrite	A	5,000		E353.1		10,000		10,000					100,000				
N as Nitrite	A	5,000		E354.1		1,000		1,000			1,000		10,000				
Sulfate	A	5,000		E375.4	250,000*							250,000					
Sulfide	A																
Coliform (total)	B	1		SM9221C	1/100 ml						1/100 ml						
Ammonia as N	C	5,000		E350													
Dioxin	D		0.01(9)	d						0.00000022					0.000000013		
Sulfur	E	100,000		E600													
Dissolved Oxygen	FP	500		SM4500													
pH	FP	0.1		E150.1	6.5-8.5 *							6.5-8.5	6.5-8.5				
Specific Conductance	FP	1		E120.1													
Temperature	FP																
Boron	I	5,000		E6010									750				
Total Dissolved Solids	I	10,000		E160.1	500,000*									400,000 (1)			
Aluminum	M	200		CT		50 to 200*							5,000				
Antimony	M	60		CT													
Arsenic	M	10		CT	50				50		50		100				
Arsenic III	M																
Arsenic V	M																
Barium	M	200		CT	1,000	2,000 (e)		2,000 (e)	1,000		1,000						
Beryllium	M	5		CT									100				
Cadmium	M	5		CT	10	5		5	10		10		10				
Calcium	M	5,000		CT													
Cesium	M	1,000		NC													
Chromium	M	10		CT	50	100		100	50		50		100				

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		FQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Chromium III	M	5		SW8467196													
Chromium VI	M	10		E218.5													
Cobalt	M	50		CT									50				
Copper	M	25		CT	1,000 *			1,300 (f)				1,000	200				
Cyanide	M	10		CT							200						
Iron	M	100		CT	300 *							300	5,000				
Lead	M	5		CT	50			0 (f)	50		50		100				
Lithium	M	100		NC									2,500				
Magnesium	M	5000		CT													
Manganese	M	15		CT	50 *							50	200				
Mercury	M	0.2		CT	2	2		2	2		2		10				
Molybdenum	M	200		NC													
Nickel	M	40		CT									200				
Potassium	M	5000		CT													
Selenium	M	5		CT	10	50		50	10		10		20				
Silver	M	10		CT	50	100 *			50		50						
Sodium	M	5000		CT													
Strontium	M	200		NC													
Thallium	M	10		CT													
Tin	M	200		NC													
Titanium	M	10		E6010													
Tungsten	M	10		E6010													
Vanadium	M	50		CT									100				
Zinc	M	20		CT	5,000 *							5,000	2,000				
2,4,5-TP Silvex	P		0.5	d	10	50		50	10	50							
2,4-Dichlorophenoxyacetic Acid	P		1	d	100	70		70	100	70							
(2,4-D)	P																
Acrolein	P		10														
Aldicarb	P		10			3 (e)		1 (e)		10							
Aldrin	P	0.05	0.1	CP						0.002					0.000074		
Bromacil	P																
Carbofuran	P			d		40		40		36							
Chloranil	P																

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Chlordane (Alpha)	P	0.5	1	CP		2		0		0.03					0.00046		
Chlordane (Gamma)	P	0.5	1	CP		2		0		0.03					0.00046		
Chlorpyrifos	P			E619													
DDT	P	0.1	0.1	CP						0.1					0.000024		
DDT Metabolite (DDD)	P	0.1		CP													
DDT Metabolite (DDE)	P	0.1	0.1	CP						0.1							
Demeton	P																
Diazinon	P																
Dieldrin	P	0.1	0.1	CP						0.002					0.000071		
Endosulfan I	P	0.05		CP													
Endosulfan II	P	0.1		CP													
Endosulfan sulfate	P	0.1		CP													
Endrin	P	0.1	0.1	CP	0.2				0.2	0.2							
Endrin Aldehyde	P		0.1							0.2							
Endrin Ketone	P	0.1		CP													
Guthion	P																
Heptachlor	P	0.05	0.05	CP		0.4		0		0.008					0.00028		
Heptachlor Epoxide	P	0.05	0.05	CP		0.2		0		0.09							
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP						0.006					0.0092		
Hexachlorocyclohexane, Beta	P	0.05	0.1(9)	CP											0.0163		
Hexachlorocyclohexane, BHC	P		0.05														
Hexachlorocyclohexane, Delta	P	0.05		CP											0.0123		
Hexachlorocyclohexane, Tech	P		0.5(9)	f											0.0186		
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	4	0.2		0.2	4.0	0.2							
Malathion	P																
Methoxychlor	P	0.5	0.5	CP	100	40		40	100	40	100						
Mirex	P																
Parathion	P																
PCBs	P	0.5	1	CP		0.5		0		0.005					0.000079		
Simazine	P			e											4		
Toxaphene	P	1	5	CP		3		0	5.0	0.03	5						
Vaponite 2	P																
Aroclor 1016	PP	0.5		CP													
Aroclor 1221	PP	0.5		CP													

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					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Aroclor 1232	PP	0.5		CP													
Aroclor 1242	PP	0.5		CP													
Aroclor 1248	PP	0.5		CP													
Aroclor 1254	PP	1		CP													
Aroclor 1260	PP	1		CP													
Atrazine	PP		1 (9)	e		3		3							3		
Americium (pCi/l)	R															0.05	0.05
Americium 241 (pCi/l)	R	0.01															
Cesium 134 (pCi/l)	R	1								80 (2)						80	80
Cesium 137 (pCi/l)	R	1															
Gross Alpha (pCi/l)	R	2			15 (8)						15(8)					7	11
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)						4 mrem/yr					5	19
Plutonium (pCi/l)	R															0.05	0.05
Plutonium 238+239+240 (pCi/l)	R	0.01								15 (2)							
Radium 226+228 (pCi/l)	R	0.5/1.0 (4)			5					5 (2)							
Strontium 89+90 (pCi/l)	R	1															
Strontium 90 (pCi/l)	R				8 (3)					8 (2)						8	8
Thorium 230+232 (pCi/l)	R									60 (2)							
Tritium (pCi/l)	R				20,000 (3)					20,000 (2)						500	500
Uranium 233+234 (pCi/l)	R																
Uranium 235 (pCi/l)	R	0.6															
Uranium 238 (pCi/l)	R	0.6															
Uranium (Total) (pCi/l)	R															5	10
1,2,4,5-Tetrachlorobenzene	SV		10	b						2							
1,2,4-Trichlorobenzene	SV	10		CS													
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS		600		600		620							
1,2-Diphenylhydrazine	SV			b						0.05							
1,3-Dichlorobenzene (Meta)	SV	10	1	CS						620							
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75		75			75							
2,4,5-Trichlorophenol	SV	50		CS						700							
2,4,6-Trichlorophenol	SV	10	50	CS						2					1.2		
2,4-Dichlorophenol	SV	10	50	CS						21							

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
2,4-Dimethylphenol	SV	10		CS													
2,4-Dinitrophenol	SV	50	50	CS						14							
2,4-Dinitrotoluene	SV	10		CS													
2,6-Dinitrotoluene	SV	10		CS													
2-Chloronaphthalene	SV	10		CS													
2-Chlorophenol	SV	10		CS													
2-Methylnaphthalene	SV	10		CS													
2-Methylphenol	SV	10		CS													
2-Nitroaniline	SV	50		CS													
2-Nitrophenol	SV	10		CS													
3,3-Dichlorobenzidine	SV	20		CS													
3-Nitroaniline	SV	50		CS													
4,6-Dinitro-2-methylphenol	SV	50		CS													
4-Bromophenyl Phenylether	SV	10		CS													
4-Chloroaniline	SV	10		CS													
4-Chlorophenyl Phenyl Ether	SV	10		CS													
4-Chloro-3-methylphenol	SV	10		CS													
4-Methylphenol	SV	10		CS													
4-Nitroaniline	SV	50		CS													
4-Nitrophenol	SV	50		CS													
Acenaphthene	SV	10		CS													
Anthracene	SV	10		CS													
Benzidine	SV		10	d						0.0002	0.1				0.00012		
Benzoic Acid	SV	50		CS													
Benzo(a)anthracene	SV	10		CS													
Benzo(a)pyrene	SV	10		CS													
Benzo(b)fluoranthene	SV	10		CS													
Benzo(g,h,i)perylene	SV	10		CS													
Benzo(k)fluoranthene	SV	10		CS													
Benzyl Alcohol	SV	10		CS													
bis(2-Chloroethoxy)methane	SV	10		CS													
bis(2-Chloroethyl)ether	SV	10		CS						0.03					0.0000037		
bis(2-Chloroisopropyl)ether	SV	10		CS													
bis(2-Ethylhexyl)phthalate	SV	10		CS													

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										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Butadiene	SV																
Butylbenzylphthalate	SV	10		CS													
Chlorinated Ethers	SV																
Chlorinated Napthalenes	SV																
Chloroalkylethers	SV	10		CS													
Chlorophenol	SV										1						
Chrysene	SV	10		CS													
Dibenzofuran	SV	10		CS													
Dibenz(a,h)anthracene	SV	10		CS													
Dichlorobenzenes	SV																
Dichlorobenzidine	SV	20	10(9)	CS											0.01		
Diethylphthalate	SV	10		CS													
Dimethylphthalate	SV	10		CS													
Di-n-butylphthalate	SV	10		CS													
Di-n-octylphthalate	SV	10		CS													
Ethylene Glycol	SV			d						7,000							
Fluoranthene	SV	10		CS													
Fluorene	SV	10		CS													
Formaldehyde	SV																
Haloethers	SV																
Hexachlorobenzene	SV	10	10	CS						6					0.00072		
Hexachlorobutadiene	SV	10	10	CS						1					0.45		
Hexachlorocyclopentadiene	SV	10		CS						49							
Hexachloroethane	SV	10		CS											1.9		
Hydrazine	SV																
Indeno(1,2,3-cd)pyrene	SV	10		CS													
Isophorone	SV	10	10	CS						1,050							
Naphthalene	SV	10		CS													
Nitrobenzene	SV	10	10	CS						3.5							
Nitrophenols	SV																
Nitrosamines	SV		10														
Nitrosodibutylamine	SV			b											0.0064		
Nitrosodiethylamine	SV		10	b											0.0008		
Nitrosodimethylamine	SV		10	b											0.0014		

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										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Nitrosopyrrolidine	SV		10	b											0.016		
N-Nitrosodiphenylamine	SV	10	10(9)	CSb											4.9		
N-Nitroso-di-n-dipropylamine	SV	10		CSb													
Pentachlorinated Ethanes	SV			b													
Pentachlorobenzene	SV		10	b						6 (7)							
Pentachlorophenol	SV	50	50	CS		1 (e)		0 (e)		200							
Phenanthrene	SV	10		CS													
Phenol	SV	10		CS							1						
Phthalate Esters	SV																
Polynuclear Aromatic Hydrocarbons	SV		1 (9)	b											0.0028		
Vinyl Chloride	SV	10	2	CV	2		0			2							
1,1,1-Trichloroethane	V	5	1	CV	200		200			200							
1,1,2,2-Tetrachloroethane	V	5	1 (9)	CV											0.17		
1,1,2-Trichloroethane	V	5	1	CV						3					0.6		
1,1-Dichloroethane	V	5		CV													
1,1-Dichloroethene	V	5	1	CV	7		7			7							
1,2-Dichloroethane	V	5	1	CV	5		0			0.4							
1,2-Dichloroethene (cis)	V		1	a		70		70		70							
1,2-Dichloroethene (total)	V	5		CV													
1,2-Dichloroethene (trans)	V		1	a		100		100		100							
1,2-Dichloropropane	V	5	1	CV		5		0		0.56							
1,3-Dichloropropene (cis)	V	5		CV													
1,3-Dichloropropene (trans)	V	5		CV													
2-Butanone	V	10		CV													
2-Hexanone	V	10		CV													
4-Methyl-2-pentanone	V	10		CV													
Acetone	V	10		CV													
Acrylonitrile	V		15(9)	c											0.058		
Benzene	V	5	1	CV	5		0			1							
Bromodichloromethane	V	5	1	CV						0.3							
Bromoform	V	5	1	CV						4							
Bromomethane	V	10		CV													
Carbon Disulfide	V	5		CV													

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										CDH CWQCC Groundwater Quality Standards (d)							
		PQL MDL								Statewide	Site-Specific (g)						
Parameter	Type (5)	RFP	CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Carbon Tetrachloride	V	5	1	CV	5		0			0.3							
Chlorinated Benzenes	V	10		CV/CS													
Chlorobenzene	V	5	1	CV/CS		100		100		100							
Chloroethane	V	10		CV													
Chloroform	V	5	1	CV	Tot THM <100**					6					0.19		
Chloromethane	V	10		CV													
Dibromochloromethane	V	5	1	CV						14							
Dichloroethenes	V																
Ethyl Benzene	V	5	1	CV		700		700		680							
Ethylene Dibromide	V			d		0.05		0		0.0004							
Ethylene Oxide	V																
Halomethanes	V		1 (9)		100					100					0.19		
Methylene Chloride	V	5		CV													
Pyrene	V	10		CS													
Styrene	V	5		CV		100		100									
Tetrachloroethanes	V	5		CV													
Tetrachloroethene	V	5	1	CV		5		0		5					0.8		
Toluene	V	5	1	CV		1,000		1,000		1,000							
Trichloroethanes	V	5		CV													
Trichloroethene	V	5	1	CV	5		0			5							
Vinyl Acetate	V	10		CV													
Xylenes (total)	V	5		CV		10,000		10,000									

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										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek

EXPLANATION OF TABLE

* = secondary maximum contaminant level
** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

CDH = Colorado Department of Health
CLP = Contract Laboratory Program
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Limit
RCRA = Resource Conservation and Recovery Act
RFP = Rocky Flats Plant
SDWA = Safe Drinking Water Act
TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
CWQCC = Colorado Water Quality Control Commission

(1) TDS standard – see Table 4 in (d); standard is 400 mg/l or 1.25 times the background level, whichever is least restrictive
(2) radionuclide standards – see sec. 3.11.5(c)2 in (d)
(3) If both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(4) MDL for Radium 226 is 0.5; MDL for radium 228 is 1
(5) type abbreviations are: A=anion; B=bacteria; C=cation; D=dioxin; E=element; FP=field parameter; I=indicator; M=metal; P=pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(7) Where standard is below (more stringent than) PQL (CDH), PQL is standard.
(8) Value for gross alpha excludes uranium.
(9) Value is CDH detection level (PQL not available)

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek

(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526; 1/30/1991)
(c) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, August 1988, 40 CFR 264.94.
(d) CDH/Colorado Water Quality Control Commission, The Basic Standards for Ground Water, 3.11.0 (5 CCR 1002-8) 1/5/1987 amended 11/30/1991; statewide radioactive standards listed in 3.11.5(c)(2).
(e) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective January 1, 1993 (56 FR 30266; 7/1/1991)
(f) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/91) effective 12/7/92.
(g) CDH/Colorado Water Quality Control Commission, Classifications and Water Quality Standards for Ground Water, 3.12.0 (9/19/1991).

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Bicarbonate	A	10,000		E310.1									
Carbonate	A	10,000		E310.1									
Chloride	A	5,000		E325	250,000*				860,000(c)	230,000(c)			
Chlorine	A	1,000		E4500					19	11			
Flouride	A	5,000		E340	4,000; 2,000*		4,000					4,000	
N as Nitrate	A	5,000		E353.1	10,000			10,000			10,000		
N as Nitrate+Nitrite	A	5,000		E353.1		10,000		10,000					
N as Nitrite	A	5,000		E354.1		1,000		1,000					
Sulfate	A	5,000		E375.4	250,000*								
Sulfide	A												
Coliform (Fecal)	B	1		SM9221C	1/100 ml								
Ammonia as N	C	5,000		E350					Criteria are pH and temperature dependent – see criteria document				
Dioxin	D			d					0.01	0.00001	0.000000013	0.000000014	
Sulfur	E	100,000		E600									
Dissolved Oxygen	FP	500		SM4500					5,000				
pH	FP	0.1		E150.1	6.5–8.5 *					6.5–9			
Specific Conductance	FP	1		E120.1									
Temperature	FP								SS	SS			
Boron	I	5,000		E6010									
Total Dissolved Solids	I	10,000		E160.1	500,000*				SS	SS	250,000		
Aluminum	M	200		CT		50 to 200*			750	87			
Antimony	M	60		CT					9,000	1,600	146	45,000	
Arsenic	M	10		CT	50						0.0022	0.0175	
Arsenic III	M								360	190			
Arsenic V	M								850	48			
Barium	M	200		CT	1,000	2,000 (f)		2,000 (f)			1,000		
Beryllium	M	5		CT					130	5.3	.0068**	.117**	
Cadmium	M	5		CT	10	5		5	3.9 (3)	1.1 (3)	10		
Calcium	M	5,000		CT									
Cesium	M	1,000		NC									
Chromium	M	10		CT	50	100		100					

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Chromium III	M	5		SW8467196					1,700	210	170,000	3,433,000	
Chromium VI	M	10		E218.5					16	11	50		
Cobalt	M	50		CT									
Copper	M	25		CT	1,000*			1,300 (g)	18 (3)	12 (3)			
Cyanide	M	10		CT					22	5.2	200		
Iron	M	100		CT	300 *					1,000	300		
Lead	M	5		CT	50			0 (g)	82 (3)	3.2 (3)	50		
Lithium	M	100		NC									
Magnesium	M	5000		CT									
Manganese	M	15		CT	50 *						50	100	
Mercury	M	0.2		CT	2	2		2	2.4	0.012	0.144	0.146	
Molybdenum	M	200		NC									
Nickel	M	40		CT					1,400 (3)	160 (3)	13.4	100	
Potassium	M	5000		CT									
Selenium	M	5		CT	10	50		50	20 (d)	5 (d)	10		
Silver	M	10		CT	50	100 *			4.1 (3)	0.12	50		
Sodium	M	5000		CT									
Strontium	M	200		NC									
Thallium	M	10		CT					1,400 (1)	40 (1)	13	48	
Tin	M	200		NC									
Titanium	M	10		E6010									
Tungsten	M	10		E6010									
Vanadium	M	50		CT									
Zinc	M	20		CT	5,000 *				120 (3)	110 (3)			
2,4,5-TP Silvex	P		0.5	d	10	50		50					
2,4-Dichlorophenoxyacetic Acid (2,4-D)	P		1	d	100	70		70					
Acrolein	P		10						68(1)	21(1)	320	780*	
Aldicarb	P		10			3 (f)		1 (f)					
Aldrin	P	0.05	0.1	CP					3.0		0.000074	0.000079	
Bromacil	P												
Carbofuran	P			d		40		40					
Chloranil													

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Chlordane (Alpha)	P	0.5	1	CP		2		0	2.4	0.0043	0.00046	0.00048	
Chlordane (Gamma)	P	0.5	1	CP		2		0	2.4	0.0043	0.00046	0.00048	
Chlorpyrifos	P		0.1	E619					0.063	0.041			
DDT	P	0.1	0.1	CP					1.1	0.0011	0.000024	0.000024	
DDT metabolite (DDD)	P	0.1	0.1	CP					0.06				
DDT metabolite (DDE)	P	0.1	0.1	CP					1,050				
Demeton	P		1							0.1			
Diazinon	P												
Dieldrin	P	0.1	0.1	CP					2.5	0.0019	0.00007	0.000076	
Endosulfan I	P	0.05	0.1	CP					0.22	0.056	74	159	
Endosulfan II	P	0.1	0.1	CP									
Endosulfan Sulfate	P	0.1	0.1	CP									
Endrin	P	0.1	0.1	CP	0.2				0.18	0.0023	1		
Endrin Aldehyde	P		0.1										
Endrin Ketone	P	0.1		CP									
Guthion	P		1.5							0.01			
Heptachlor	P	0.05	0.05	CP		0.4		0	0.52	0.0038	0.00028	0.00029	
Heptachlor Epoxide	P	0.05	0.05	CP		0.2		0					
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP							0.0092	0.031	
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP							0.0163	0.0547	
Hexachlorocyclohexane, BHC	P	0.05	0.05										
Hexachlorocyclohexane, Delta	P	0.05		CP									
Hexachlorocyclohexane, Technical	P		0.2	f							0.0123	0.0414	
Hexachlorocyclohexane, (Lindane) Gama	P	0.05	0.05	CP	4	0.2		0.2	2.0	0.08			
Malathion	P		0.2							0.01			
Methoxychlor	P	0.5	0.5	CP	100	40		40		0.03	100		
Mirex	P		0.1							0.001			
Parathion	P								0.065	0.013			
PCBs	P	0.5	1	CP		0.5		0	2.0	0.014	0.000079**	0.000079**	
Simazine	P			e									
Toxaphene	P	1	5	CP		3		0	0.73	0.0002	0.00071**	0.00073**	
Vaponite 2	P												
Aroclor 1016	PP	0.5		CP									

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Aroclor 1221	PP	0.5		CP									
Aroclor 1232	PP	0.5		CP									
Aroclor 1242	PP	0.5		CP									
Aroclor 1248	PP	0.5		CP									
Aroclor 1254	PP	1		CP									
Aroclor 1260	PP	1		CP									
Atrazine	PP			e		3		3					
Americium (pCi/l)	R												
Americium 241 (pCi/l)	R	0.01											20
Cesium 134 (pCi/l)	R	1											900
Cesium 137 (pCi/l)	R	1											1000
Gross Alpha (pCI/l)	R	2			15 (10)							15	
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)								
Plutonium (pCi/l)	R												
Plutonium 238+239+240 (pCi/l)	R	0.01											20
Radium 226+228 (pCi/l)	R	0.5/0.1 (9)			5							5	60
Strontium 89+90 (pCi/l)	R	1											500
Strontium 90 (pCi/l)	R				8 (6)							8	500
Thorium 230+232 (pCi/l)	R												30
Tritium (pCi/l)	R				20,000 (6)								1000000
Uranium 233+234 (pCi/l)	R												300
Uranium 235 (pCi/l)	R	0.6											300
Uranium 238 (pCi/l)	R	0.6											300
Uranium (total) (pCi/l)	R												
1,2,4,5-Tetrachlorobenzene	SV		10	b							38	48	
1,2,4-Trichlorobenzene	SV	10		CS									
1,2-Dichlorobenzene (Ortho)	SV	10	10	CS		600		600					
1,2-Diphenylhydrazine	SV			b					270 (1)				
1,3-Dichlorobenzene (Meta)	SV	10	1	CS									
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75		75						
2,4,5-Trichlorophenol	SV	50		CS							2,800		

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
2,4,6-Trichlorophenol	SV	10	50	CS						970 (1)	1.2 **	3.6 **	
2,4-Dichlorophenol	SV	10	50	CS					2,020 (1)	365 (1)	3,090		
2,4-Dimethylphenol	SV	10	50	CS					2,120 (1)				
2,4-Dinitrophenol	SV	50	50	CS									
2,4-Dinitrotoluene	SV	10	10	CS							0.11 **	9.1 **	
2,6-Dinitrotoluene	SV	10	10	CS					330 (1)	230 (1)	70	14,300	
2-Chloronaphthalene	SV	10		CS									
2-Chlorophenol	SV	10	50	CS					4,360 (1)	2,000 (1)			
2-Methylnaphthalene	SV	10		CS									
2-Methylphenol	SV	10		CS									
2-Nitroaniline	SV	50		CS									
2-Nitrophenol	SV	10		CS									
3,3-Dichlorobenzidine	SV	20	10	CS							0.01	0.02	
3-Nitroaniline	SV	50		CS									
4,6-Dinitro-2-methylphenol	SV	50	50	CS									
4-Bromophenyl Phenylether	SV	10		CS									
4-Chloroaniline	SV	10		CS									
4-Chlorophenyl Phenyl Ether	SV	10		CS									
4-Chloro-3-methylphenol	SV	10	50	CS					30 (1)				
4-Methylphenol	SV	10		CS									
4-Nitroaniline	SV	50		CS									
4-Nitrophenol	SV	50		CS					230 (1)	150 (1)			
Acenaphthene	SV	10	10	CS					1,700 (1)	520 (1)			
Anthracene	SV	10	1	CS									
Benzidine	SV		1	d					2,500		0.00012	0.00053	
Benzoic Acid	SV	50		CS									
Benzo(a)anthracene	SV	10	10	CS									
Benzo(a)pyrene	SV	10	10	CS									
Benzo(b)fluoranthene	SV	10	10	CS									
Benzo(g,h,i)perylene	SV	10	10	CS									
Benzo(k)fluoranthene	SV	10	10	CS									
Benzyl Alcohol	SV	10		CS									
bis(2-Chloroethoxy)methane	SV	10		CS									

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
bis(2-Chloroethyl)ether	SV	10	10	CS							0.03**	1.36 **	
bis(2-Chloroisopropyl)ether	SV	10	10	CS							34.7	4,360	
bis(2-Ethylhexyl)phthalate	SV	10	10	CS							15,000	50,000	
Butadiene	SV												
Butylbenzylphthalate	SV	10	10	CS									
Chlorinated Ethers	SV												
Chlorinated Napthalenes	SV								1,600 (1)				
Chloroalkylethers	SV	10		CS					238,000 (1)				
Chlorophenol	SV		50										
Chrysene	SV	10	10	CS									
Dibenzofuran	SV	10		CS									
Dibenz(a,h)anthracene	SV	10	10	CS									
Dichlorobenzenes	SV		1						1,120 (1)	763 (1)	400	2,600	
Dichlorobenzidine	SV	20	10	CS							0.01	0.02	
Diethylphthalate	SV	10	10	CS							350,000	1,800,000	
Dimethylphthalate	SV	10	10	CS							313,000	2,900,000	
Di-n-butylphthalate	SV	10	10	CS									
Di-n-octylphthalate	SV	10		CS									
Ethylene Glycol	SV			d									
Fluoranthene	SV	10	10	CS					3,980 (1)		42	54	
Fluorene	SV	10	10	CS									
Formaldehyde	SV												
Haloethers	SV								380 (1)	122 (1)			
Hexachlorobenzene	SV	10	10	CS							0.00072**	0.00074**	
Hexachlorobutadiene	SV	10	10	CS					90 (1)	9.3 (1)	0.45**	50 **	
Hexachlorocyclopentadiene	SV	10	10	CS					7 (1)	5.2 (1)	206		
Hexachloroethane	SV	10	10	CS					980 (1)	540 (1)	1.9	8.74	
Hydrazine	SV												
Indeno(1,2,3-cd)pyrene	SV	10	10	CS									
Isophorone	SV	10	10	CS					117,000 (1)		5,200	520,000	
Naphthalene	SV	10	10	CS					2,300 (1)	620 (1)			
Nitrobenzene	SV	10	10	CS					27,000 (1)		19,800		
Nitrophenols	SV								230 (1)	150 (1)			

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Nitrosamines	SV								5,850 (1)				
Nitrosodibutylamine	SV		10	b							0.0064	0.587	
Nitrosodiethylamine	SV		10	b							0.0008	1.24	
Nitrosodimethylamine	SV		10	b							0.0014	16	
Nitrosopyrrolidine	SV		10	b							0.016	91.9	
N-Nitrosodiphenylamine	SV	10	10	b							4.9 **	16.1 **	
N-Nitroso-di-n-dipropylamine	SV	10	10	b									
Pentachlorinated Ethanes	SV			b					7,240 (1)	1,100 (1)			
Pentachlorobenzene	SV		10	b							74	85	
Pentachlorophenol	SV	50	50	CS		1 (f)		0 (f)	20 (4)	13 (4)	1,010		
Phenanthrene	SV	10	10	CS									
Phenol	SV	10	50	CS					10,200 (1)	2,560 (1)	3,500		
Phthalate Esters	SV			e					940 (1)	3 (1)			
Polynuclear Aromatic Hydrocarbons	SV		10	b							0.0028**	0.0311**	
Vinyl Chloride	SV	10	2	CV	2		0				2 **	525 **	
1,1,1-Trichloroethane	V	5	1	CV	200		200				18,400	1,030,000	
1,1,2,2-Tetrachloroethane	V	5	1	CV						2,400	0.17**	10.7 **	
1,1,2-Trichloroethane	V	5	1	CV						9,400	0.6**	41.8 **	
1,1-Dichloroethane	V	5		CV									
1,1-Dichloroethene	V	5	1	CV	7		7						
1,2-Dichloroethane	V	5	1	CV	5		0		118,000	20,000	0.94**	243 **	
1,2-Dichloroethene (cis)	V		1	a		70		70					
1,2-Dichloroethene (total)	V	5		CV									
1,2-Dichloroethene (trans)	V	5	1	a		100		100					
1,2-Dichloropropane	V	5	1	CV		5		0	23,000	5,700			
1,3-Dichloropropene (cis)	V	5	1	CV					6,060	244 (1)	87	14,100	
1,3-Dichloropropene (trans)	V	5	1	CV					6,060	244 (1)	87	14,100	
2-Butanone	V	10		CV									
2-Hexanone	V	10		CV									
4-Methyl-2-pentanone	V	10		CV									
Acetone	V	10		CV									
Acrylonitrile	V		5	c					7,500	2,600	0.058	0.65	

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Benzene	V	5	1	CV	5		0		5,300		0.66**	40 **	
Bromodichloromethane	V	5	1	CV									
Bromoform	V	5	1	CV									
Bromomethane	V	10	1	CV									
Carbon Disulfide	V	5		CV									
Carbon Tetrachloride	V	5	1	CV	5		0		35,200 (1)		0.4**	6.94 **	
Chlorinated Benzenes	V	10		CV/CS					250 (1)	50 (1)			
Chlorobenzene	V	5	1	CV/CS		100		100					
Chloroethane	V	10		CV									
Chloroform	V	5	1	CV	Tot THM<100 (2)				28,900 (1)	1,240 (1)	0.19 **	15.7 **	
Chloromethane	V	10	1	CV									
Dibromochloromethane	V	5	1	CV									
Dichloroethenes	V		1						11,600 (1)		0.033**	1.85 **	
Ethyl Benzene	V	5	1	CV		700		700	32,000 (1)		1,400	3,280	
Ethylene Dibromide	V			d		0.05		0					
Ethylene Oxide	V												
Halomethanes	V				100				11,000 (1)		0.19**	15.7 **	
Methylene Chloride	V	5	1	CV									
Pyrene	V	10	10	CS									
Styrene	V	5		CV		100		100					
Tetrachloroethanes	V	5	1	CV					9,320 (1)				
Tetrachloroethene	V	5	1	CV		5		0	5,280 (1)	840 (1)	0.80**	8.85 **	
Toluene	V	5	1	CV		1,000		1,000	17,500 (1)		14,300	424,000	
Trichloroethanes	V	5	1	CV					18,000 (1)				
Trichloroethene	V	5	1	CV	5		0		45,000 (1)	21,900 (1)	2.7 **	80.7 **	
Vinyl Acetate	V	10		CV									
Xylenes (total)	V	5		CV		10,000		10,000					

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L

EXPLANATION OF TABLE

* = secondary maximum contaminant level

** = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10-5 risk level.

AWQC = Ambient Water Quality Criteria
CLP = Contract Laboratory Program
CWA = Clean Water Act
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SDWA = Safe Drinking Water Act
SS = Species Specific
TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis

(1) criteria not developed; value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7.8 pH used)
(5) standard is not adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(6) if both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(7) type abbreviations are: A=anion; B=bacteria; C=cation; D=dioxin; E=element; I=indicator; FP=field parameter; M=metal; P=pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(8) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TIC in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(9) MDL for radium 226 is 0.5; MDL for radium 228 is 1.0
(10) Value for gross alpha excludes uranium

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990).
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142 and 143, Final Rule, effective July 30, 1992 (56 Federal Register 3526; 1/30/1991).
(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986
(d) EPA, National Ambient Water Quality Criteria for Selenium – 1987
(e) EPA, National Ambient Water Quality Criteria for Chloride – 1988
(f) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, and 143, Final Rule (56 FR 30266; 7/1/1991) effective 1/1/1993.
(g) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/1991) effective 12/7/91.
(h) NRC Effluent Water Concentrations – 10 CFR 20 Appendix A, Table 2, Column 2 "Effluent Concentrations for Water" (56 FR 23412 – 23464, May 21, 1991) effective 6/20/91.

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
							Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
									Aquatic Life					
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Human Health Carcinogens/ Noncarcinogens (2) (8) Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Bicarbonate	A	10,000		E310.1										
Carbonate	A	10.000		E310.1								250,000		
Chloride	A	5,000		E325					19	11				
Chlorine	A	1,000		E4500								2,000		
Fluoride	A	5,000		E340							100,000	10,000		
N as Nitrate	A	5,000		E353.1							100,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353.1					SS	SS	10,000	1,000		
N as Nitrite	A	5,000		E354.1								250,000		
Sulfate	A	5,000		E375.4						2		50		
Sulfide	A													
Coliform (Fecal)	B	1		SM9221C								2000/100 ml		
Ammonia as N	C	5,000		E350					620	60		500		
Dioxin	D			d	0.00000022	0.000000013	0.01	0.00001						
Sulfur	E	100,000		E600					5,000	5,000	3,000	3,000		
Dissolved Oxygen	FP	500		SM4500					6.5-9.0	6.5-9.0		5.0-9.0		
pH	FP	0.1		E150.1										
Specific Conductance	FP	1		E120.1					30 degrees	30 degrees				
Temperature	FP										750			
Boron	I	5,000		E6010										
Total Dissolved Solids	I	10,000		E160.1										
Aluminum	M	200		CT					750	87				
Antimony	M	60		CT								14		
Arsenic	M	10		CT					360	150	100	50		
Arsenic III	M													
Arsenic V	M											1,000		
Barium	M	200		CT							100	0.0076		
Beryllium	M	5		CT					TVS	TVS	10	10		
Cadmium	M	5		CT										
Calcium	M	5,000		CT										
Cesium	M	1,000		NC										
Chromium	M	10		CT										

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Chromium III	M	5		SW8467196					TVS	TVS	100	50		
Chromium VI	M	10		E218.5					16	11	100	50		
Cobalt	M	50		CT										
Copper	M	25		CT					TVS	TVS	200	1,000		
Cyanide	M	10		CT					5	5	200	200		
Iron	M	100		CT						1,000		300 (dis)		
Lead	M	5		CT					TVS	TVS	100	50		
Lithium	M	100		NC										
Magnesium	M	5000		CT										
Manganese	M	15		CT						1,000	200	50 (dis)		
Mercury	M	0.2		CT					2.4	0.1		2.0		
Molybdenum	M	200		NC										
Nickel	M	40		CT					TVS	TVS	200			
Potassium	M	5000		CT										
Selenium	M	5		CT					135	17	20	10		
Silver	M	10		CT					TVS	TVS		50		
Sodium	M	5000		CT										
Strontium	M	200		NC										
Thallium	M	10		CT						15		0.012		
Tin	M	200		NC										
Titanium	M	10		E6010										
Tungsten	M	10		E6010										
Vanadium	M	50		CT										
Zinc	M	20		CT					TVS	TVS	2,000	5,000		
2,4,5-TP Silvex	P		0.5	d	50									100
2,4-D	P		1	d	70									
Acrolein			10			320	68	21						
Aldicarb	P		10		10									
Aldrin	P	0.05	0.1	CP	0.002 (8)	0.00013	1.5						0.003	
Bromacil	P													
Carbofuran	P			d	36									
Chloranil	P			E619										
Chlordane (Alpha)	P	0.5	1	CP	0.03 (8)		1.2	0.0043						

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Chlordane (Gamma)	P	0.5	1	CP	0.03 (8)	0.00058	1.2	0.0043						
Chlorpyrifos	P		0.1				0.083	0.041						
DDT	P	0.1	0.1	CP	0.1	0.00059	0.55	0.001					0.001	
DDT Metabolite (DDD)	P	0.1	0.1	CP		0.0008	0.6						0.001	
DDT Metabolite (DDE)	P	0.1	0.1	CP	0.1	0.00059	1,050						0.001	
Demeton	P		1					0.1					0.1	
Diazinon	P													
Dieldrin	P	0.1	0.1	CP	0.002	0.00014	1.3	0.0019					0.003	
Endosulfan I	P	0.05	0.1	CP		0.93	0.11	0.056					0.003	
Endosulfan II	P	0.1	0.1	CP										
Endosulfan Sulfate	P	0.1	0.1	CP		0.93								
Endrin	P	0.1	0.1	CP	0.2		0.09	0.0023					0.004	
Endrin Aldehyde	P		0.1		0.2	0.2								
Endrin Ketone	P	0.1		CP										
Guthion	P		1.5					0.01					0.01	
Heptachlor	P	0.05	0.05	CP	0.008	0.00021	0.26	0.0038					0.001	0.2
Heptachlor Epoxide	P	0.05	0.05	CP	0.09	0.0001	0.26	0.0038						
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP	0.006		0.0039							
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP		0.014								
Hexachlorocyclohexane, BHC	P	0.05	0.05				100							
Hexachlorocyclohexane, Delta	P	0.05		CP										
Hexachlorocyclohexane, Tech.	P		0.2	f		0.012								
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	0.2	0.019	1.0	0.08					0.01	4.0
Malathion	P		0.2					0.1					0.1	
Methoxychlor	P	0.5	0.5	CP	40			0.03					0.03	100
Mirex	P		0.1					0.001					0.001	
Parathion	P												0.04	
PCBs	P	0.5	1	CP	0.005	0.000044	2.0	0.014					0.001	
Simazine	P			e										
Toxaphene	P	1	5	CP	0.03	0.00073	0.73	0.0002					0.005	5.0
Vaponite 2	P													
Aroclor 1016	PP	0.5		CP										
Aroclor 1221	PP	0.5		CP										
Aroclor 1232	PP	0.5		CP										

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Aroclor 1242	PP	0.5		CP										
Aroclor 1248	PP	0.5		CP										
Aroclor 1254	PP	1		CP										
Aroclor 1260	PP	1		CP										
Atrazine	PP			e										
Americium (pCi/l)	R													
Americium 241 (pCi/l)	R	0.01												
Cesium 134 (pCi/l)	R	1			80 (10)									
Cesium 137 (pCi/l)	R	1												
Gross Alpha (pCi/l)	R	2												
Gross Beta (pCi/l)	R	4												
Plutonium (pCi/l)	R													
Plutonium 238+239+240 (pCi/l)	R	0.01			15 (10)									
Radium 226+228 (pCi/l)	R	0.5/1 (9)			5 (10)									
Strontium 89+90 (pCi/l)	R	1												
Strontium 90 (pCi/l)	R				8 (10)									
Thorium 230+232 (pCi/l)	R				60 (10)									
Tritium (pCi/l)	R				20,000 (10)									
Uranium 233+234 (pCi/l)	R													
Uranium 235 (pCi/l)	R	0.6												
Uranium 238 (pCi/l)	R	0.6							TVS	TVS				
Uranium (Total) (pCi/l)	R													
1,2,4,5-Tetrachlorobenzene	SV		10	b	2 (8)									
1,2,4-Trichlorobenzene	SV	10		CS										
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS	620	620								
1,2-Diphenylhydrazine	SV			b	0.05	0.04	270							
1,3-Dichlorobenzene (Meta)	SV	10	1	CS	620	400								
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75	75								
2,4,5-Trichlorophenol	SV	50		CS										
2,4,6-Trichlorophenol	SV	10	50	CS	2	2		970						
2,4-Dichlorophenol	SV	10	50	CS	21	21	2,020	365						
2,4-Dimethylphenol	SV	10	50	CS			2,120							

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method' (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
2,4-Dinitrophenol	SV	50	50	CS	14	14								
2,4-Dinitrotoluene	SV	10	10	CS		0.11								
2,6-Dinitrotoluene	SV	10	10	CS			330	230						
2-Chloronaphthalene	SV	10		CS										
2-Chlorophenol	SV	10	50	CS			4,380	2,000						
2-Methylnaphthalene	SV	10		CS										
2-Methylphenol	SV	10		CS										
2-Nitroaniline	SV	50		CS										
2-Nitrophenol	SV	10		CS										
3,3-Dichlorobenzidine	SV	20	10	CS		0.039								
3-Nitroaniline	SV	50		CS										
4,6-Dinitro-2-methylphenol	SV	50	50	CS		13								
4-Bromophenyl Phenylether	SV	10		CS										
4-Chloroaniline	SV	10		CS										
4-Chlorophenyl Phenyl Ether	SV	10		CS										
4-Chloro-3-methylphenol	SV	10	50	CS			30							
4-Methylphenol	SV	10		CS										
4-Nitroaniline	SV	50		CS										
4-Nitrophenol	SV	50		CS										
Acenaphthene	SV	10	10	CS			1,700	520						
Anthracene	SV	10	1	CS		0.0028								
Benzidine	SV		10	d	0.0002	0.00012(8)	2,500						0.1	0.01
Benzoic Acid	SV	50		CS										
Benzo(a)anthracene	SV	10	10	CS		0.0028								
Benzo(a)pyrene	SV	10	10	CS		0.0028								
Benzo(b)fluoranthene	SV	10	10	CS		0.0028								
Benzo(g,h,i)perylene	SV	10	10	CS		0.0028								
Benzo(k)fluoranthene	SV	10	10	CS		0.0028								
Benzyl Alcohol	SV	10		CS										
bis(2-Chloroethoxy)methane	SV	10		CS										
bis(2-Chloroethyl)ether	SV	10	10	CS	0.03 (8)	0.03 (8)								
bis(2-Chloroisopropyl)ether	SV	10	10	CS		1,400								
bis(2-Ethylhexyl)phthalate	SV	10	10	CS		1.8 (8)								
Butadiene	SV													

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Butyl Benzylphthalate	SV	10	10	CS		3,000								
Chlorinated Ethers	SV													
Chlorinated Napthalenes	SV													
Chloroalkylethers	SV	10		CS										
Chlorophenol	SV		50										1.0	1.0
Chrysene	SV	10	10	CS		0.0028								
Dibenzofuran	SV	10		CS										
Dibenz(a,h)anthracene	SV	10	10	CS		0.0028								
Dichlorobenzenes	SV		1											
Dichlorobenzidine	SV	20	10	CS		0.039								
Diethylphthalate	SV	10	10	CS		23,000								
Dimethylphthalate	SV	10	10	CS		313,000								
Di-n-butylphthalate	SV	10	10	CS		2,700								
Di-n-octylphthalate	SV	10		CS										
Ethylene Glycol	SV			d										
Fluoranthene	SV	10	10	CS		42	3,980							
Fluorene	SV	10	10	CS		0.0028								
Formaldehyde	SV													
Haloethers	SV													
Hexachlorobenzene	SV	10	10	CS	6	0.00072								
Hexachlorobutadiene	SV	10	10	CS	1	0.45	90	9.3						
Hexachlorocyclopentadiene	SV	10	10	CS		240	7	5						
Hexachloroethane	SV	10	10	CS		1.9	980	540						
Hydrazine	SV													
Indeno(1,2,3-cd)pyrene	SV	10	10	CS		0.0028								
Isophorone	SV	10	10	CS	1,050	8.4	117,000							
Naphthalene	SV	10	10	CS		0.0028	2,300	620						
Nitrobenzene	SV	10	10	CS	3.5	3.5	27,000							
Nitrophenols	SV													
Nitrosamines	SV													
Nitrosodibutylamine	SV		10	b		0.0064								
Nitrosodiethylamine	SV		10	b		0.0008								
Nitrosodimethylamine	SV		10	b		0.00069								
Nitrosopyrrolidine	SV		10	b		0.016								

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
N-Nitrosodiphenylamine	SV	10	10	CSb		4.9								
N-Nitroso-di-n-dipropylamine	SV	10	10	CSb		0.005								
Pentachlorinated Ethanes	SV			b										
Pentachlorobenzene	SV		10	b	6 (8)									
Pentachlorophenol	SV	50	50	CS	200		9	5.7						
Phenanthrene	SV	10	10	CS		0.0028								
Phenol	SV	10	50	CS		21,000	10,200	2,560					500	1.0
Phthalate Esters	SV			e										
Polynuclear Aromatic Hydrocarbons	SV		10	b		0.0028								
Vinyl Chloride	SV	10	2	CV	2	2								
1,1,1-Trichloroethane	V	5	1	CV	200	200								
1,1,2,2-Tetrachloroethane	V	5	1	CV		0.17		2,400						
1,1,2-Trichloroethane	V	5	1	CV	3	0.6	9,400							
1,1-Dichloroethane	V	5		CV										
1,1-Dichloroethene	V	5	1	CV	7	0.057								
1,2-Dichloroethane	V	5	1	CV	0.4	0.4	118,000	20,000						
1,2-Dichloroethene (cis)	V		1	a	70									
1,2-Dichloroethene (total)	V	5		CV										
1,2-Dichloroethene (trans)	V	5	1	a	100									
1,2-Dichloropropane	V	5	1	CV	0.56 (8)	0.56	23,000	5,700						
1,3-Dichloropropene (cis)	V	5	1	CV		10	6,060	244						
1,3-Dichloropropene (trans)	V	5	1	CV		10	6,060	244						
2-Butanone	V	10		CV										
2-Hexanone	V	10		CV										
4-Methyl-2-pentanone	V	10		CV										
Acetone	V	10		CV										
Acrylonitrile	V		5	c		0.58	7,550	2,600						
Benzene	V	5	1	CV	1	1	5,300							
Bromodichloromethane	V	5	1	CV	0.3	0.3								
Bromoform	V	5	1	CV	4	4								
Bromomethane	V	10	1	CV		48								
Carbon Disulfide	V	5		CV										
Carbon Tetrachloride	V	5	1	CV	0.3	0.25	35,200							

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Chlorinated Benzenes	V	10		CV/CS										
Chlorobenzene	V	5	1	CV/CVS	100	100								
Chloroethane	V	10		CV										
Chloroform	V	5	1	CV	6	6	28,900	1,240						
Chloromethane	V	10	1	CV		5.7								
Dibromochloromethane	V	5	1	CV	14	6								
Dichloroethenes	V		1											
Ethyl Benzene	V	5	1	CV	680	3,100	32,000							
Ethylene Dibromide	V			d										
Ethylene Oxide	V													
Halomethanes	V				100									
Methylene Chloride	V	5	1	CV		4.7								
Pyrene	V	10	10	CS		0.0028								
Styrene	V	5		CV										
Tetrachloroethanes	V	5	1	CV										
Tetrachloroethene	V	5	1	CV	5	0.8	5,280	840						
Toluene	V	5	1	CV	1,000	1,000	17,500							
Trichloroethanes	V	5	1	CV										
Trichloroethene	V	5	1	CV	5	2.7	45,000	21,900						
Vinyl Acetate	V	10		CV										
Xylenes (Total)	V	5		CV										

EXPLANATION OF TABLE

CLP = Contract Laboratory Program
CDH = Colorado Department of Health
dis = dissolved
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SS = species specific
TAL = Target Analyte List

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)							Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life			Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply

THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
TVS = Table Value Standard (hardness dependent), see Table III in (a)
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
CWQCC = Colorado Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.
(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(5) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P= pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(7) See Section 3.8.5 (2)(a) in (b)
(8) Where standard is below (more stringent than) PQL (CDH), PQL is standard.
(9) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0
(10) See section 3.1.11 (f) (2) in (a)

(a) CDH/CWQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 10/17/1991 (ARAR). (Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/CWQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990 - Basin-wide standards are ARAR.

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Bicarbonate	A	10,000		E310.1							
Carbonate	A	10,000		E310.1							
Chloride	A	5,000		E325				250,000	250,000		
Chlorine	A	1,000		E4500				3	3		
Fluoride	A	5,000		E340							
N as Nitrate	A	5,000		E353.1				10,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353.1							
N as Nitrite	A	5,000		E354.1				1,000	1,000		
Sulfate	A	5,000		E375.4				250,000	250,000		
Sulfide	A										
Coliform (Fecal)	B	1		SM9221C							
Ammonia as N	C	5,000		E350				620	60		
Dioxin	D			d	0.00000022	0.000000013			0.000000013		
Sulfur	E	100,000		E600				2.0	2.0		
Dissolved Oxygen	FP	500		SM4500				5,000	5,000		
pH	FP	0.1		E150.1				6.5-9	6.5-9		
Specific Conductance	FP	1		E120.1							
Temperature	FP										
Boron	I	5,000		E6010				750	750		
Total Dissolved Solids	I	10,000		E160.1							
Aluminum	M	200		CT							
Antimony	M	60		CT							
Arsenic	M	10		CT				50			
Arsenic III	M										
Arsenic V	M										
Barium	M	200		CT							
Beryllium	M	5		CT							
Cadmium	M	5		CT				TVS	TVS		
Calcium	M	5,000		CT							
Cesium	M	1,000		NC							
Chromium	M	10		CT							

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Chromium III	M	5		SW8467196				50			
Chromium VI	M	10		E218.5				TVS	TVS		
Cobalt	M	50		CT							
Copper	M	25		CT				TVS	TVS		
Cyanide	M	10		CT				5	5		
Iron	M	100		CT					300 (3)		
Lead	M	5		CT				TVS	TVS		
Lithium	M	100		NC							
Magnesium	M	5000		CT							
Manganese	M	15		CT					50 (3)		
Mercury	M	0.2		CT					0.01		
Molybdenum	M	200		NC							
Nickel	M	40		CT				TVS	TVS		
Potassium	M	5000		CT							
Selenium	M	5		CT				10			
Silver	M	10		CT				TVS	TVS		
Sodium	M	5000		CT							
Strontium	M	200		NC							
Thallium	M	10		CT							
Tin	M	200		NC							
Titanium	M	10		E6010							
Tungsten	M	10		E6010							
Vanadium	M	50		CT							
Zinc	M	20		CT				TVS	TVS		
2,4,5-TP Silvex	P		0.5	d	10						
2,4-D	P		1	d	100						
Acrolein	P		10								
Aldicarb	P		10		10						
Aldrin	P	0.05	0.1	CP	0.002 (6)	0.000074			0.000074		
Bromacil	P										
Carbofuran	P			d	36						
Chloranil	P			E619							
Chlordane (Alpha)	P	0.5	1	CP	0.03 (6)	0.00046			0.00046		

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	(1)			Acute Value	Chronic Value	Woman Creek	Walnut Creek
Chlordane (Gamma)	P	0.5	1	CP	0.03 (6)	0.00046			0.00046		
Chlorpyrifos	P		0.1								
DDT	P	0.1	0.1	CP	0.1 (6)	0.000024			0.000024		
DDT Metabolite (DDD)	P	0.1	0.1	CP							
DDT Metabolite (DDE)	P	0.1	0.1	CP							
Demeton	P		1								
Diazinon	P										
Dieldrin	P	0.1	0.1	CP	0.002 (6)	0.000071			0.000071		
Endosulfan I	P	0.05	0.1	CP							
Endosulfan II	P	0.1	0.1	CP							
Endosulfan Sulfate	P	0.1	0.1	CP							
Endrin	P	0.1	0.1	CP	0.2						
Endrin Aldehyde	P		0.1								
Endrin Ketone	P	0.1		CP							
Guthion	P		1.5								
Heptachlor	P	0.05	0.05	CP	0.008 (6)	0.00028			0.00028		
Heptachlor Epoxide	P	0.05	0.05	CP	0.004 (6)						
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP		0.0092			0.0092		
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP		0.0163			0.0163		
Hexachlorocyclohexane, BHC	P	0.05	0.05								
Hexachlorocyclohexane, Delta	P	0.05		CP							
Hexachlorocyclohexane, Tech.	P		0.2	f		0.0123			0.0123		
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	4	0.0186			0.0186		
Malathion	P		0.2								
Methoxychlor	P	0.5	0.5	CP	100						
Mirex	P		0.1								
Parathion	P										
PCBs	P	0.5	1	CP	0.005 (6)	0.000079			0.000079		
Simazine	P			e		4			4		
Toxaphene	P	1	5	CP	5						
Vaponite 2	P										
Aroclor 1016	PP	0.5		CP							
Aroclor 1221	PP	0.5		CP							
Aroclor 1232	PP	0.5		CP							

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Aroclor 1242	PP	0.5		CP							
Aroclor 1248	PP	0.5		CP							
Aroclor 1254	PP	1		CP							
Aroclor 1260	PP	1		CP							
Atrazine	PP			e		3			3		
Americium (pCi/l)	R									0.05	0.05
Americium 241 (pCi/l)	R	0.01					30				
Cesium 134 (pCi/l)	R	1			80		80			80	80
Cesium 137 (pCi/l)	R	1									
Gross Alpha (pCi/l)	R	2								7	11
Gross Beta (pCi/l)	R	4								5	19
Plutonium (pCi/l)	R									0.05	0.05
Plutonium 238+239+240 (pCi/l)	R	0.01					15				
Radium 226+228 (pCi/l)	R	0.5/1.0 (7)					5				
Strontium 89+90 (pCi/l)	R	1								8	8
Strontium 90 (pCi/l)	R						8				
Thorium 230+232 (pCi/l)	R						60				
Tritium (pCi/l)	R						20,000			500	500
Uranium 233+234 (pCi/l)	R										
Uranium 235 (pCi/l)	R	0.6									
Uranium 238 (pCi/l)	R	0.6									
Uranium (Total) (pCi/l)	R						40			5	10
1,2,4,5-Tetrachlorobenzene	SV		10	b	2 (6)						
1,2,4-Trichlorobenzene	SV	10		CS							
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS	620						
1,2-Diphenylhydrazine	SV			b	0.05 (6)						
1,3-Dichlorobenzene (Meta)	SV	10	1	CS	620						
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75						
2,4,5-Trichlorophenol	SV	50		CS	700						
2,4,6-Trichlorophenol	SV	10	50	CS	2.0 (6)	1.2			1.2		
2,4-Dichlorophenol	SV	10	50	CS	21 (6)						
2,4-Dimethylphenol	SV	10	50	CS							

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
2,4-Dinitrophenol	SV	50	50	CS							
2,4-Dinitrotoluene	SV	10	10	CS							
2,6-Dinitrotoluene	SV	10	10	CS							
2-Chloronaphthalene	SV	10		CS							
2-Chlorophenol	SV	10	50	CS							
2-Methylnaphthalene	SV	10		CS							
2-Methylphenol	SV	10		CS							
2-Nitroaniline	SV	50		CS							
2-Nitrophenol	SV	10		CS							
3,3-Dichlorobenzidine	SV	20	10	CS		0.01			0.01		
3-Nitroaniline	SV	50		CS							
4,6-Dinitro-2-methylphenol	SV	50	50	CS							
4-Bromophenyl Phenylether	SV	10		CS							
4-Chloroaniline	SV	10		CS							
4-Chlorophenyl Phenyl Ether	SV	10		CS							
4-Chloro-3-methylphenol	SV	10	50	CS							
4-Methylphenol	SV	10		CS							
4-Nitroaniline	SV	50		CS							
4-Nitrophenol	SV	50		CS							
Acenaphthene	SV	10	10	CS							
Anthracene	SV	10	1	CS							
Benzidine	SV		10	d	0.0002 (6)	0.00012			0.00012		
Benzoic Acid	SV	50		CS							
Benzo(a)anthracene	SV	10	10	CS							
Benzo(a)pyrene	SV	10	10	CS							
Benzo(b)fluoranthene	SV	10	10	CS							
Benzo(g,h,i)perylene	SV	10	10	CS							
Benzo(k)fluoranthene	SV	10	10	CS							
Benzyl Alcohol	SV	10		CS							
bis(2-Chloroethoxy)methane	SV	10		CS							
bis(2-Chloroethyl)ether	SV	10	10	CS	0.03 (6)	0.0000037			0.0000037		
bis(2-Chloroisopropyl)ether	SV	10	10	CS							
bis(2-Ethylhexyl)phthalate	SV	10	10	CS							
Butadiene	SV										

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Butyl Benzylphthalate	SV	10		CS							
Chlorinated Ethers	SV										
Chlorinated Napthalenes	SV										
Chloroalkylethers	SV	10		CS							
Chlorophenol	SV		50								
Chrysene	SV	10	10	CS							
Dibenzofuran	SV	10		CS							
Dibenz(a,h)anthracene	SV	10	10	CS							
Dichlorobenzenes	SV		1								
Dichlorobenzidine	SV	20	10	CS		0.01			0.01		
Diethylphthalate	SV	10	10	CS							
Dimethylphthalate	SV	10	10	CS							
Di-n-butylphthalate	SV	10	10	CS							
Di-n-octylphthalate	SV	10		CS							
Ethylene Glycol	SV			d							
Fluoranthene	SV	10	10	CS							
Fluorene	SV	10	10	CS							
Formaldehyde	SV										
Haloethers	SV										
Hexachlorobenzene	SV	10	10	CS	0.02 (6)	0.00072			0.00072		
Hexachlorobutadiene	SV	10	10	CS	14	0.45			0.45		
Hexachlorocyclopentadiene	SV	10	10	CS	49						
Hexachloroethane	SV	10	10	CS		1.9			1.9		
Hydrazine	SV										
Indeno(1,2,3-cd)pyrene	SV	10	10	CS							
Isophorone	SV	10	10	CS	1,050						
Naphthalene	SV	10	10	CS							
Nitrobenzene	SV	10	10	CS	3.5 (6)						
Nitrophenols	SV										
Nitrosamines	SV										
Nitrosodibutylamine	SV		10	b		0.0064			0.0064		
Nitrosodiethylamine	SV		10	b		0.0008			0.0008		
Nitrosodimethylamine	SV		10	b		0.0014			0.0014		
Nitrosopyrrolidine	SV		10	b		0.016			0.016		

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
N-Nitrosodiphenylamine	SV	10	10	CSb		4.9			4.9		
N-Nitroso-di-n-dipropylamine	SV	10	10	CSb							
Pentachlorinated Ethanes	SV			b							
Pentachlorobenzene	SV		10	b	6 (6)						
Pentachlorophenol	SV	50	50	CS	200						
Phenanthrene	SV	10	10	CS							
Phenol	SV	10	50	CS							
Phthalate Esters	SV			e							
Polynuclear Aromatic Hydrocarbons	SV		10	b		0.0028			0.0028		
Vinyl Chloride	SV	10	2	CV	2						
1,1,1-Trichloroethane	V	5	1	CV	200						
1,1,2,2-Tetrachloroethane	V	5	1	CV		0.17			0.17		
1,1,2-Trichloroethane	V	5	1	CV	28	0.60			0.60		
1,1-Dichloroethane	V	5		CV							
1,1-Dichloroethene	V	5	1	CV	7						
1,2-Dichloroethane	V	5	1	CV	5						
1,2-Dichloroethene (cis)	V		1	a	70						
1,2-Dichloroethene (total)	V	5		CV							
1,2-Dichloroethene (trans)	V	5	1	a	70						
1,2-Dichloropropane	V	5	1	CV	0.56 (6)						
1,3-Dichloropropene (cis)	V	5	1	CV							
1,3-Dichloropropene (trans)	V	5	1	CV							
2-Butanone	V	10		CV							
2-Hexanone	V	10		CV							
4-Methyl-2-pentanone	V	10		CV							
Acetone	V	10		CV							
Acrylonitrile	V		5	c		0.058			0.058		
Benzene	V	5	1	CV	5						
Bromodichloromethane	V	5	1	CV							
Bromoform	V	5	1	CV							
Bromomethane	V	10	1	CV							
Carbon Disulfide	V	5		CV							
Carbon Tetrachloride	V	1		CV	5						

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Chlorinated Benzenes	V	10		CV/CS							
Chlorobenzene	V	5	1	CV/CVS	300						
Chloroethane	V	10		CV							
Chloroform	V	5	1	CV	Tot THM <100*	0.19			0.19		
Chloromethane	V	10	1	CV							
Dibromochloromethane	V	5	1	CV							
Dichloroethenes	V		1								
Ethyl Benzene	V	5	1	CV	680						
Ethylene Dibromide	V			d							
Ethylene Oxide	V										
Halomethanes	V				100	0.19			0.19		
Methylene Chloride	V	5	1	CV							
Pyrene	V	10	10	CS							
Styrene	V	5		CV							
Tetrachloroethanes	V	5	1	CV		0.8			0.8		
Tetrachloroethene	V	5	1	CV	10						
Toluene	V	5	1	CV	2,420						
Trichloroethanes	V	5	1	CV							
Trichloroethene	V	5	1	CV	5						
Vinyl Acetate	V	10		CV							
Xylenes (Total)	V	5		CV							

EXPLANATION OF TABLE

*	= Total trihalomethanes:chloroform, bromoform, bromodichloromethane, dibromochloromethane
CLP	= Contract Laboratory Program
CDH	= Colorado Department of Health
dis	= dissolved
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL				Table C		Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A,B (1)	Fish & Water Ingestion	Table D Radio-nuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek

RFP = Rocky Flats Plant
SS = species specific
TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
TVS = Table Value Standard (hardness dependent), see Table III in (a)
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
CWQCC = Colorado Water Quality Control Commission

(1) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/CWQCC or EPA
(2) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(3) Lowest value given: dissolved or total recoverable
(4) Segment 5 standards are goals
(5) Includes Table 1: Additional Organic Chemical Standards (chronic only)
(6) Standard is below (more stringent than) PQL, therefore PQL is standard.
(7) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0

(a) CDH/CWQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 9/30/1989. (Environmental Reporter 726:1001-1020:6/1990)
(b) CDH/CWQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990.

Approved by:

Manager, Remediation Programs 2/18/94

RI Project Manager 2/18/94

4.0 DATA REQUIREMENTS AND DATA QUALITY OBJECTIVES

As required by the IAG to meet CERCLA and RCRA requirements, data are necessary to characterize the nature and extent of contamination, support the risk assessment, support the evaluation of corrective/remedial actions, and assist in the development and evaluation of remedial alternatives. Data requirements for this work plan are presented below and derived from guidance documents previously cited.

The objectives of the RFI/RI are to characterize the nature, distribution, and migration pathways of contaminants for each OU12 IHSS in support of the baseline risk assessment, as well as to support the evaluation of remedial alternatives.

Data quality objectives (DQOs) have been specified for each data collection activity, and the work will be conducted and documented in a manner that ensures that the data collected are sufficient and of adequate quality for their intended uses (EPA, 1987). DQOs are qualitative and quantitative descriptions of the data required to support decisions made during remedial response activities. The DQOs are developed prior to data collection activities and are incorporated into the planning process, resulting in a well thought out FSP which details the chosen sampling and analysis options and provides confidence in the decisions made during the remedial process. DQOs were established for the OU12 RFI/RI in accordance with Appendix A of the Rocky Flats Plant Site-Wide Quality Assurance Project Plan (EG&G, 1991e). DQOs are developed using a three-stage process: Stage 1

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identifies decision types, Stage 2 identifies data uses/needs, and Stage 3 is the design of a data collection program.

Through application of the DQO process, site-specific goals were established for the RFI/RI, and data needs were identified for achieving those goals. This section explains the DQO process specific to the RFI/RI for OU12.

4.1 STAGE 1 - IDENTIFY DECISION TYPES

The major elements of Stage 1 include identifying and involving data users, evaluating available data, developing a site conceptual model, and specifying objectives and decision types that will be made during the RFI/RI process. Available data must be obtained and evaluated during this stage to aid in the development of DQOs and to develop a site conceptual model (EPA, 1987). The site conceptual model presented in Section 2.5 identifies the sources, release mechanisms, transport pathways, exposure routes, and receptors. The following sections address each of these elements.

4.1.1 Identify and Involve Data Users

Data users are divided into three general groups: decision makers, program management staff, and technical personnel. The principal decision makers for OU12 are federal officials responsible for RFP operations and the federal and state regulatory officials responsible for environmental protection. These include the DOE Office of Environmental Restoration and Waste Management, DOE Rocky Flats Office, EPA Region VIII, CDH, and natural resource trustees. The program management staff are the prime EG&G contractor personnel responsible for ER Program activities, and include the EG&G Rocky Flats Plant Environmental Management Department. Natural resource trustees include the Department of Interior (U.S. Fish and Wildlife Service), the Colorado Department of Natural Resources,

the Colorado Department of Health, the Attorney General of the State of Colorado, and DOE. Technical personnel include EG&G RFP technical specialists and subcontractors responsible for supervising, coordinating, and performing ER Program activities. The primary technical personnel data users will be risk assessment scientists, statisticians, and feasibility studies engineers.

The data users are brought into the RFI/RI process during planning stages to help define data quality requirements. The work plan is reviewed by the data users and their comments are incorporated in the work plan structure.

4.1.2 Evaluate Available Data

Section 2.0 describes the historical and current conditions of the IHSSs and associated areas within OU12. The following is a brief discussion of the completeness and usability of existing information, based on the data presented in Section 2.0.

4.1.2.1 Current Understanding of Nature and Extent of Contamination

OU12 is comprised of 10 IHSSs located in the 400, 600, and 800 building areas of RFP as shown in Figure 2-1. Brief site descriptions, suspected contaminants present, and suspected location of the contaminants (surface or subsurface) are presented in Table 2.2. In general, most of the IHSSs in OU12 are surface spill sites, with the exceptions being IHSSs 136.1 and 136.2, which were two cooling water ponds. Suspected contaminants include radionuclides, metals, and volatile organics.

Very limited analytical data are available for soil, ground water, and sediment samples collected from areas on or adjacent to OU12. A complete discussion of the existing data is presented in Section 2.4. An assessment of the nature of contamination at each OU12

IHSS has been derived primarily from historical accounts in the HRR (EG&G, 1992c) and the IAG. These historical descriptions have been supplemented by available analytical, geologic, and hydrologic data for the overall OU12 site area and adjacent OUs.

4.1.2.2 Existing Data

Limited soil and ground water analytical data are available from samples collected in areas on or adjacent to OU12. However, the data are not specific to any of the IHSSs within OU12. Section 2.4 and Appendix A present these data. The soils data were collected in 1989, and the ground water data were collected from 1988 to 1991. Most of the data from these years have been properly validated. Therefore, these data are available for evaluation. The existing data are of sufficient quality to be used in a qualitative manner to design the field investigation program and for use in the RFI/RI report and the baseline risk assessment.

The existing data have been statistically analyzed to determine the mean, standard deviation, and range of select metal and radionuclide constituents in shallow soil samples (Tables 4.1 and 4.2). Existing analytical data for volatile organics are insufficient to determine these statistical parameters. The metal and radionuclide data were compared to background data developed for the Background Geochemical Characterization Report (EG&G, 1990a) for total metals in South Rocky Flats alluvial borehole samples and for radiochemistry data in North and South Rocky Flats alluvial borehole samples recognizing that formal acceptance of these background levels has not occurred at this time.

The Background Geochemical Characterization Report points out several characteristics of the background geochemical data set that make formal statistical comparisons of data in OU12 with background data difficult. Beryllium, lithium, and plutonium-239 were shown

to be neither normally nor lognormally distributed in the background data. In addition, statistically significant geochemical differences were noted among different lithologic units for chromium, lithium, gross alpha, plutonium-239, uranium-233/234, and uranium-238. In spite of these limitations, however, certain general observations may be made concerning the analytes of interest in OU12.

The mean concentration of chromium in OU12 is less than the background concentration, and the standard deviation is somewhat higher in OU12. However, the mean concentration of chromium was calculated without data from the areas near former cooling water ponds that are thought to be contaminated with chromium. Therefore, chromium concentrations within OU12 are unknown and will be determined during the RFI/RI.

The mean concentration and standard deviation of lithium are higher in OU12 than in background samples, while the range of OU12 concentrations is less than the background range. Lithium concentrations in upper and lower horizons in OU12 are similar.

The mean, standard deviation, and range of gross alpha concentrations are less in OU12 samples than in background samples. Concentrations in the upper several feet in OU12 are somewhat higher than in the next lower horizon.

Mean gross beta concentration are higher in OU12 than in background areas, but the range of concentrations in OU12 is similar to that found in background samples. Upper and lower horizon samples in OU12 have similar concentrations.

The mean, standard deviation, and range of plutonium-239/240 concentrations are orders of magnitude higher in OU12 than in background plutonium-239 samples, even though an

accurate comparison of these concentrations cannot be made because the isotopes are not reported individually. Concentrations in the upper OU12 horizon are also higher than those observed in the lower horizon.

The mean and standard deviation of uranium-233/234 concentrations in OU12 are higher than in background samples, but maximum concentrations were lower in OU12. Surface horizon concentrations in OU12 are somewhat higher than those found in the next lower horizon.

Mean concentrations of uranium-238 are similar in OU12 and in background samples, but the range of OU12 concentrations is less than in background samples. Mean concentrations in the upper and lower horizons at OU12 are essentially the same.

The mean, standard deviation, and maximum concentrations of tritium are higher in OU12 samples than in background samples. Concentrations in the upper horizon of OU12 are higher than in deeper samples.

The existing data were primarily only useful for identifying potential contaminants that may be found at the site and were used in conjunction with HRR conclusions and IAG requirements to determine the field sampling analyte lists discussed in Section 6.5. As stated previously, the existing data are from sampling locations that span the entire OU12, and cannot be considered representative of all of the IHSSs.

4.1.3 Develop Site Conceptual Model

An integral part of the DQO process is the development of a site conceptual model to identify contaminant pathways to support data collection needs. A site conceptual model

for OU12 was developed based on available data as shown in Figure 2-39. The model includes descriptions of primary and secondary sources, release mechanisms, contaminant migration pathways, exposure routes, and receptors. This preliminary model is very generic at this time because IHSS-specific contaminant and physical data are lacking.

The primary release mechanisms of contaminants from surface spills and ponds are wind erosion, volatile emissions, storm water runoff, irrigation, infiltration/percolation, leaching, and tracking. Secondary release mechanisms include volatilization, deposition, seepage, irrigation, pumpage, and recharge. Exposure (human and biota) to contaminants can occur through multiple pathways including ingestion, inhalation, and dermal contact; however, the actual pathways of significance and potential receptor populations for each exposure pathway will be determined during the risk assessment.

4.1.4 Specify RFI/RI Objectives and Decisions

As stated in the IAG, the primary objectives of the RFI/RI are to characterize the nature and extent of contamination for each OU12 IHSS, to provide information necessary to determine the risk associated with the source of contamination at each OU12 IHSS, and to provide information to evaluate potential remedial action alternatives. From the information generated by the RFI/RI, decisions can be made as to whether remediation is necessary, which remedial alternatives would be appropriate, and develop the Corrective Action Decisions and Record of Decision (CAD/ROD). A summary of the specific DQOs and data needs is presented in Table 4.3. In accordance with the IAG, the specific objectives of the RFI/RI for OU12 are:

Characterize the Nature and Extent of Contamination

The intent of the field sampling program to be performed during the RFI/RI is to determine the physical characteristics of all media and determine the nature and the horizontal and vertical extent of existing contamination at all OU12 IHSSs. Achieving these objectives will require the following:

- Further delineate the areal extent and location of the IHSSs;
- Define the nature and horizontal extent of surficial soil contamination;
- Define the nature and extent of contamination in the soil column beneath each IHSS;
- Determine if ground water beneath each IHSS has been affected by contamination in the overlying soils;
- Assess the potential for contaminated soil to impact the ground water;
- Determine the presence or absence of ground water contamination;
- Assess the ground water migration potential beyond the IHSS and OU12 boundaries; and
- Determine if sediment and surface water have been affected by IHSS activities.

Sampling activities described in Section 6.3 of this work plan will address the objectives listed above, with the exception of surface water. Surface water analysis data will be obtained from EG&Gs sitewide surface water monitoring programs. These data will be evaluated to characterize the nature and extent of contamination associated with IHSS activities.

An analytical level for all of the objectives is required that yields data of sufficient quality for the baseline risk assessment, subsequent analysis, and determination of remedial alternatives. Objectives will be met by adherence to the General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G, 1991d) for sample analysis and RFP Environmental Management Department operating procedures (EMD SOP) (EG&G, 1991f) for sample collection.

Other data needs required to characterize OU12 include:

- Determination of the location of subsurface utilities;
- Further definition of subsurface structures including footing drains, sumps, and vaults;
- Characterization of hydrogeologic conditions;
- Characterization of soils from the surface to the water table;
- Characterization of surface water and sediments; and
- Characterization of the ground water.

The objectives, type of data required, sampling/analysis activities, analytical levels, and data uses are presented in Table 4.3.

Determine Risks Associated with Contamination

To meet the objectives of the baseline risk assessment, specific data need to be obtained to accomplish the four tasks of the risk assessment (data collection/evaluation, exposure assessment, toxicity assessment, and risk characterization).

These tasks will rely on data collected under a sampling plan that is sufficient to determine the contaminants present and the concentrations at which they occur. Analytical data for different environmental media must be sufficient to characterize the lateral and vertical extent of contamination and be representative of sampled areas. Background or control data must also be collected at uncontaminated areas and its use agreed to by the agencies to establish baseline conditions and determine the degree to which contamination may affect receptors.

This specifically requires an inventory of contaminants detected, associated concentrations, and the lateral and vertical distribution of contaminants. In addition, data pertaining to physical characteristics of topography, soil, subsurface water bearing zones, and weather patterns need to be collected both to determine potential migration pathways and to conduct computer modeling studies. Characteristics and locations of possible human populations and biological populations must also be determined.

Recent toxicity information on all identified contaminants must also be collected to evaluate and determine potential risks to the identified receptors.

Support Selection of Remedial Action Alternatives

Data requirements for the evaluation of remedial action alternatives include an identification of the nature and extent of contamination at sites of concern. In addition, the volumes and areas of contaminated media must be determined. This work plan addresses the sampling required to characterize contaminated media at OU12, to support the selection of remedial alternatives in the CMS/FS, and to develop the CAD/ROD. These remedial alternatives may include removal and treatment, *in situ* treatment, containment, and no action.

4.2 STAGE 2 - IDENTIFY DATA USES/NEEDS

The major objectives of Stage 2 are the following:

- Identify data uses;
- Identify data types;
- Identify data quality needs;
- Identify data quantity needs;
- Evaluate sampling and analysis options; and
- Review precision, accuracy, representativeness, comparability, and completeness; (PARCC) parameters.

Stage 2 also includes the selection of the sampling approach and the analytical options for the task including the economic and technical feasibility of the chosen technique. The following sections discuss each of these elements.

4.2.1 Identify Data Uses

In order to ensure that the sampling effort will address the objectives outlined in Section 4.1.4, the anticipated uses for the data must be specifically stated. Data collected during the RFI/RI will be used to characterize the nature and extent of contamination, support the baseline risk assessment, and evaluate remedial alternatives. Characterization of each IHSS includes the surface of the site, the vadose zone, and ground water, as summarized in Table 4.3. Samples will be collected to determine the extent and type of contamination present. Data will also be collected to determine the physical characteristics of the media for use in contaminant transport and pathways analyses.

Data collected for the OU12 RFI/RI will be used in the development of contaminant transport conceptual and computer models for the risk assessment. Conceptual models may be developed for air, the vadose zone, surface water, sediments, and ground water fate and transport.

Additional data needs not specified by the IAG requirements for the RFI/RI, but that will be necessary to evaluate remedial alternatives, include monitoring of response actions and monitoring to comply with regulations during remediation. Therefore, the development of DQOs for the RFI/RI at OU12 included remediation concerns to the extent possible. DQOs for OU12 will be re-evaluated at the completion of the sampling and analysis program.

4.2.2 Identify Data Types

Following identification of the intended users and use of the data, the specific data types must be developed. Data types are summarized on Table 4-3, and will consist of field survey and laboratory analytical results of samples for each RFI/RI objective. Sampling will be primarily of physical media during the RFI/RI. The physical media include soils, sediments, soil gas, surface water, and ground water. The analytical requirements are dictated by the intended use of the data (EPA, 1987).

A list of specific analytes and analytical methods for OU12 has been developed and is presented in Section 6.5. The criteria used to develop the list include historical documentation (HRR), IAG requirements, and existing analytical data for sampling locations in or adjacent to OU12. As discussed in Section 6.3, there are several potential site contaminants associated with the IHSSs in OU12. The available historical information

and evaluation of existing data suggested that, to be conservative, several contaminant classes should be analyzed for during the fielding sampling program.

Exposure assessment modeling requires additional data types. Data necessary for air dispersion modeling generally includes relative wind direction and frequency, atmospheric stability and wind speeds, ambient concentrations of airborne particulates, soil adsorption coefficients, solubility, particle size, soil moisture content, and precipitation. Many of these parameters will be determined from RFP-wide atmospheric studies or from literature values.

Vadose zone alternatives analyses will generally need data to determine vadose zone physical characteristics as well as chemical characteristics. Data necessary for these analyses generally include infiltration rates, soil porosity, unsaturated hydraulic conductivity, bulk density, soil moisture content, soil pH, total organic carbon (TOC) content, matric potential, and leaching potential.

4.2.3 Identify Data Quality Needs

Analytical methods and support levels must be evaluated during the DQO process. The parameters for which an analytical method is valid, its limitations, and any special considerations which will affect data quality must be understood in order to select appropriate methods. Table 4.3 lists the analytical levels appropriate for the intended data uses. The five levels of data quality as presented in EPA's Data Quality Objectives for Remedial Response Activities Development Process (EPA, 1987) are as follows:

- Level I - Screening. Provides the lowest data quality but the most rapid results, and is used for purposes of site health and safety monitoring, preliminary comparison to chemical specific benchmarks, and initial site characterization to

define areas for further study. The data generated provides presence/absence of certain constituents and are generally qualitative rather than quantitative.

- Level II - Field Analysis. Provides less rapid results but better data quality. Analysis includes some mobile laboratory-generated data and data generated by use of field analytical instruments. The data may be qualitative or quantitative.

- Level III - Engineering. Provides an intermediate level of data quality and may be used for site characterization or risk assessment. Engineering analysis includes mobile laboratory-generated data and standard commercial laboratory analyses without full CLP documentation. These data are both qualitative and quantitative. If analysis are conducted in support of treatability models, it will be performed to Level III.

- Level IV - Confirmational. Provides the highest level of data quality and is used for purposes of risk assessment, engineering design, and cost recovery documentation. Confirmation analyses require full CLP analytical and data validation procedures.

- Level V - Nonstandard. Refers to analysis by nonstandard procedures, for example, exacting detection limits or analyses of an unusual chemical compound. These analyses often require method development or adoption. The data validation procedures of Level IV can be applied to Level V, if required.

Analytical data derived from the proposed sampling and analysis program at OU12 will be used, in part, to evaluate human health and ecological risks posed by contamination, if any. Toxicological interpretation of data requires validation of analytical data. Therefore, select soil and ground water samples will be subjected to Level IV analytical procedures and reporting requirements based on the results of Level III analytical procedures. The sampling plan for OU12 has been designed to allow for a tiered approach beginning with soil, soil gas, and ground water screening using Level II and III with validation of these screening results for select duplicate samples subjected to Level IV analyses. Subsequent

sample collection and analysis efforts will be directed by the results of the screening activities.

4.2.4 Identify Data Quantity Needs

Data quantity needs are based on an evaluation of available data for characterizing the nature and extent of potential contamination at OU12 and for providing input to the risk assessment and assessment of remedial alternatives. This is consistent with guidance provided in Data Quality Objectives for Remedial Response Activities (EPA, 1987) and Guidance for Data Useability in Risk Assessment (EPA, 1990). Data presently available are insufficient to meet the objectives defined by the IAG; therefore, the collection of additional data is warranted.

To ensure that a sufficient amount of valid data are generated, the FSP was designed to include a rationale for all activities and a phased approach using screening-level techniques to identify critical sampling sites. The field sampling program described in Section 6.2 and applied to each IHSS provides for screening to be initially completed on a standard grid, with additional screening activities added to further define anomalous readings.

Given the limited availability of existing data, the approach used to determine the number and spacing of samples is taken from Gilbert (1987) and is also presented in EPA documentation (EPA, 1989b). This method allows for the determination of a sampling grid spacing by assuming a target contaminated area size and specified confidence. Additional assumptions used in this work plan are: a very small proportion of the area being studied will actually be measured in sample analysis and the definition of the contaminated area is clear and unambiguous.

The acceptable probability (ß) of not finding the target hot spot is specified as 0.1, or 10 percent, in accordance with EPA guidance (EPA, 1990). A triangular grid was chosen because studies have shown that triangular grids are capable of finding smaller hot spots than a square grid (Gilbert, 1987). Based on Gilbert, a triangular grid with samples spaced a maximum of 25 ft apart provides an acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 25 ft in size. Likewise, a triangular grid with samples spaced a maximum of 50 ft apart provide an acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 100 ft in size. The sizes of the small OU12 IHSSs are greater than a 50 ft by 25 ft ellipse, but spill areas within the IHSSs may be smaller. The larger IHSSs are all greater than 50 ft by 100 ft in size, but potential anomalous areas within these IHSSs may be smaller.

The soil gas and surficial sampling program will use standard triangular grids at most OU12 IHSSs, with additional points added in suspect locations and midway between points with anomalous results. The starting grid point at each site will be chosen using random methods described in EPA guidance (EPA, 1989b). Screening of soil and ground water will be conducted to define anomalous areas from soil gas readings. For surficial sampling, additional samples will be collected from areas observed in the field of stained ground, topographic depressions or other suspect locations within the site to increase the probability of detecting sources of contamination. Sediment samples will be collected in drainage ditches near the sites, if present.

4.2.5 Evaluate Sampling/Analysis Options

The RFI/RI for OU12 will use field screening and surficial soil sampling techniques to direct subsurface data collection activities. This approach maximizes collection of useful data because surficial soil sampling and field screening techniques are used to properly

locate and minimize borehole drilling. Additionally, this approach minimizes the volume of generated hazardous waste material that requires special management, the potential exposure of field personnel to hazardous waste material, and the overall time to perform the field activities.

Five types of activities will be performed during the field program: (1) radiation surveys and chemical screening; (2) nonradionuclide surficial soil sampling; (3) borehole drilling and subsurface soil sampling; (4) installation of tensiometers or equivalent; and (5) installation and sampling of monitoring wells. Section 6.0 describes in detail the field activities.

Section 6.5 of this work plan discusses the analytical program requirements for OU12. Appendix B of the QAPjP (EG&G, 1991e) provides a listing of the CLP analytes and detection/quantification limits for Target Compound List (TCL) volatile, Target Analyte List (TAL) metals, radionuclides, and other surficial soil sampling parameters. These analytical methods are appropriate for meeting the data quality requirements for analytical Levels I through V during the RFI/RI.

4.2.6 Review of PARCC Parameter Information

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are indicators of data quality. The end use of the measurement data should define the necessary objectives for the PARCC parameters. The PARCC goals are specified in the Quality Assurance Addendum (QAA) (Section 10.0) of this work plan. The PARCC parameters are discussed below. Analyte-specific precision and accuracy objectives are also listed in the QAPjP, Appendix B.

Precision measures the reproducibility or degree of agreement among replicate measurements under a given set of conditions. The closer the numerical values of the measurements are to each other, the more precise the measurements. During the OU12 RFI/RI, collection of data using field instrumentation such as water level meters, pH meters, and conductivity meters will be checked by reporting at least three measurements taken at one location and comparing the results. Field analysis instruments such as a mobile gas chromatograph (GC) will be checked by the analysis of replicate samples. Sampling precision will be evaluated by the analysis of field replicates. Analytical precision will be determined by replicate analysis of single samples. The DQO objective for precision will be to achieve the precision criteria associated with each published analytical method used in the analysis of OU12 samples.

Accuracy expresses the bias and precision in a measurement system. Sources of error include the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and sample analysis techniques. Sampling contamination of the OU12 RFI/RI will be assessed by evaluating the results of field rinse and trip blanks. The accuracy of the laboratory analysis will be determined from the results of matrix spike recovery. The DQO objective for accuracy will be to obtain recoveries within the range of acceptability associated with each published analytical method used in the analysis of OU12 samples.

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. Given the lack of previous usable data from the OU12 IHSSs, designing a representative sampling program is difficult.

However, representativeness can be enhanced for the OU12 RFI/RI by the use of proper sampling techniques. Section 6.3 describes the sampling rationale and techniques. Representativeness will also be assessed by the collection and analysis of field duplicate samples.

Completeness is defined as the percentage of measurements made that are judged to be valid. The target completeness objective for the OU12 field and analytical data is 100 percent; 90 percent will be the minimum acceptable level. To ensure that a sufficient amount of valid data are generated, the FSP was designed to include a rationale for all field activities and a phased approach using screening level techniques to identify and locate critical sampling sites. Section 6.0 further discusses these components of the FSP.

Comparability is a qualitative measure defined by the confidence with which one data set can be compared to another. Differences in field and laboratory procedures greatly affect comparability. To optimize comparability, all OU12 RFI/RI sampling techniques and analytical methods will use approved EMD SOP methods.

4.3 STAGE 3 - DESIGN DATA COLLECTION PROGRAM

The intent of Stage 3 is to compile the information and DQOs developed for specific tasks in Stage 2 into a comprehensive data collection program. The data collection program has been prepared for the OU12 RFI/RI and is presented in the FSP (Section 6.0). The FSP includes a detailed list of all samples to be collected including media, sample type, and number of samples. The FSP also includes sample location maps for each IHSS and lists the number and type of QC samples to be collected.

The QAA (Section 10.0) and QAPjP describe the policy, organization, functional activities, and QA/QC protocols necessary to achieve the DQOs dictated by the intended use of the data.

TABLE 4.1
CONCENTRATIONS OF SELECT METALS IN SOILS (mg/kg)

LOCATION	DEPTH	BERYLLIUM	CHROMIUM	LITHIUM
12489	0-3	<1.1	11.6	<21.2
13489	0-3	<0.41	12.3	13.5B
	3-7	<0.42	27.4	5.1B
13589	0-3	<1.0	13.6	<20.4
	4-8	<0.98	5.5	<19.7
13689	0-3	<1.1	9.8	<22.4
	3-7	<1.1	17.1	<22.9
14089	0-3	<1.2	10.8	<23.2
	3-7	<1.6	11.6	<23.6
14289	0-3	<0.42	15.3	9.9B
	3-7	<1.6	33.7	<22.6B
14689	0-3	<0.86	8.4	<17.3
	3-6	<1.1	5.7	<22.2
14789	0-3	<0.85	12.6	<16.9
	3-7	1.2	13.0	<18.7
14889	0-3	1.2	11.7	<22.6
	3-6	<1.0	7.5	<20.9
15489	0-3	2.0	17.5	<19.4
	3-6	1.8	9.5	<21.0
15589	0-3	<1.1	10.6	<21.1
	3-6	<0.96	10.0	<19.1
15989	0-3	<1.0	10.3	<20.2
	3-7	1.1	14.5	<18.2
16889	0-2	<1.0	8.7	<20.3
	3-5	<1.1	11.2	<23.0
17989	0-3	<0.44	9.1	14.2
	3-6	<0.39	10.6	15.5B
0187	0-1	<0.8	14.0	---

TABLE 4.1
CONCENTRATIONS OF SELECT METALS IN SOILS (mg/kg)

LOCATION	DEPTH	BERYLLIUM	CHROMIUM	LITHIUM
		SUMMARY STATISTICS		
Mean	Upper	0.59	12	9.6
	Lower	0.69	14	10
	Combined	0.64	13	10
Standard Deviation	Upper	0.46	2.6	1.7
	Lower	0.44	8.3	2.3
	Combined	0.44	5.9	2.0
Range	Upper	<0.41-2.0	8.4-17.5	9.9-14.2
	Lower	<0.39-1.8	5.5-33.7	5.1-15.5
	Combined	<0.39-2.0	5.5-33.7	5.1-15.5
		STATISTICS FOR TOTAL METAL CONCENTRATIONS IN BACKGROUND SOUTH ROCKY FLATS ALLUVIAL BOREHOLE SAMPLES (EG&G, 1990a)		
Mean		-	18	7.0
Standard Deviation		-	1.1	0.5
Range		-	5.6-31.7	4.0U-44.8U

B Compound detected in blank.
\- Statistics not calculated in EG&G, 1990a.
U Concentrations below detection limit.

Note: For concentrations less than the detection limit, the mean and standard deviation were computed using one-half the detection limit.

TABLE 4.2
CONCENTRATIONS OF SELECT RADIONUCLIDES IN SOILS (pCi/g)

LOCATION	DEPTH (ft)	ALPHA	BETA	PLUTONIUM 239/240	URANIUM 233/234	URANIUM 238	TRITIUM (pCi/l)
13489	0-3	20.7	29.1	15.860	0.27	0.23	-220
	3-7	9.6	23.0	0.024	0.19	0.42	-160
13689	0-3	24.2	39.4	1.756	1.17	0.82	3260
	3-7	12.3	31.4	0.066	1.01	1.82	1000
14289	0-3	6.7	19.0	0.096	1.66	1.20	70
	3-7	1.09	32.4	0.023	0.71	1.32	190
14689	0-3	17.6	28.9	0.031	0.69	0.84	620
	3-6	17.0	30.9	0.018	0.64	0.39	-140
14789	0-3	18.3	26.4	0.090	0.80	0.73	-70
	3-7	7.1	29.1	0.022	0.38	0.43	-130
14889	0-3	17.0	35.3	0.022	1.16	0.80	-50
	3-6	11.4	34.4	0.025	0.71	0.52	230
15489	0-3	20.1	31.5	0.030	1.27	1.00	380
	3-6	24.1	28.9	0.014	0.72	0.99	200
15589	0-3	13.6	33.4	0.031	1.10	0.90	130
	3-6	8.2	26.6	0.030	0.85	0.80	210
15989	0-3	19.8	35.6	0.012	0.85	0.85	50
	3-7	17.2	37.5	0.013	0.91	0.88	-110
16889	0-2	18.1	42.2	0.13	0.95	1.01	-80
	3-5	14.8	36.0	0.005	0.62	0.31	-80
0187	0-1	24.0	24.0	0.060	0.42	0.35	---

TABLE 4.2
CONCENTRATIONS OF SELECT RADIONUCLIDES IN SOILS (pCi/g)

LOCATION	DEPTH (ft)	ALPHA	BETA	PLUTONIUM 239/240	URANIUM 233/234	URANIUM 238	TRITIUM (pCi/l)
				SUMMARY STATISTICS			
Mean	Upper	18	31.3	1.6	0.94	0.79	410
	Lower	12	31.0	0.024	0.67	0.79	120
	Combined	15	31.2	0.87	0.81	0.79	260
Standard Deviation	Upper	4.9	6.80	4.7	0.40	0.28	1000
	Lower	6.4	4.38	0.016	0.24	0.49	350
	Combined	6.3	5.64	3.5	0.35	0.38	760
Maximum	Upper	24.2	42.2	15.860	1.66	1.20	3260
	Lower	24.1	37.5	0.066	1.01	1.82	1000
	Combined	24.2	42.2	15.860	1.66	1.82	3260
Minimum	Upper	6.7	19.0	0.012	0.27	0.23	-220
	Lower	1.1	23.0	0.005	0.19	0.31	-160
	Combined	1.1	19.0	0.005	0.19	0.23	-220
				STATISTICS FOR TOTAL RADIOCHEMICAL CONCENTRATIONS IN BACKGROUND ALLUVIAL BOREHOLE SAMPLES			
Mean		22	23	0.002	0.59	0.62	177
Standard Deviation		8.4	6.64	0.007	0.04	0.03	118
Maximum		42.0	44.0	0.02	3.4	3.2	440
Minimum		3.0	6.0	-0.01	0.2	0.2	-150

Note: Reported tritium values do not include error. Values may be positive or negative.

TABLE 4.3
PHASE I RFI/RI DATA QUALITY OBJECTIVES FOR OU12

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
CHARACTERIZENATURE AND EXTENT OF CONTAMINATION				
Define the nature and horizontal extent of surficial soil contamination				
Characterize surficial soils	Radiation survey data	• Perform field radiation survey at IHSSs	I, II, or III	• Characterize Nature and Extent
	Surficial soil contamination data	• Collect surficial soil samples at IHSSs; analyze for parameters appropriate for each IHSS	IV (V for radiological analyses)	• Baseline Risk Assessment • Evaluation of Remedial Alternatives
Define the nature and vertical extent of contamination in the soil column beneath each IHSS				
Characterize presence or absence of soil contamination at each IHSS	Soil chemical data	• Conduct soil gas surveys at appropriate IHSSs; analyze vapor samples for volatile organic compounds	II or III	• Characterize Nature and Extent
		• Collect subsurface soil and ground water samples at IHSSs for real time analysis	II	• Baseline Risk Assessment • Evaluation of Remedial Alternatives
		• Drill borings and collect subsurface soil core samples, analyze for nonradionuclides and radionuclides at appropriate IHSSs	IV (V for radiological analysis)	

TABLE 4.3
PHASE I RFI/RI DATA QUALITY OBJECTIVES FOR OU12

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Characterize subsurface stratigraphy and depth to ground water	Geologic parameters	• Drill borings and log subsurface geology	I	• Characterize Nature and Extent • Baseline Risk Assessment • Evaluation of Remedial Alternatives
Determine the extent of sediment contamination	Sediment chemical data	• Collect sediment samples at select IHSSs	IV (V for radiological analysis)	• Characterize Nature and Extent • Baseline Risk Assessment • Evaluation of Remedial Alternatives
Determine if ground water beneath IHSSs has been affected by contamination in the overlying soils				
Characterize movement of water in the unsaturated zone	Soil moisture data Leachability values	• Install tensiometers at selected IHSS • Collect ground water screening samples at select IHSSs for real time analysis	I II	• Characterize Nature and Extent • Baseline Risk Assessment • Evaluation of Remedial Alternatives

TABLE 4.3
PHASE I RFI/RI DATA QUALITY OBJECTIVES FOR OU12

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Determine the extent of ground water contamination				
Characterize potential of ground water contamination at appropriate IHSS	Ground water chemical data	• Collect ground water samples from monitoring wells at selected IHSS	IV (V for radiological analysis)	• Characterize Nature and Extent • Baseline Risk Assessment • Evaluation of Remedial Alternatives
Assess the ground water migration potential beyond the IHSS and OU12 boundaries				
Characterize local ground water flow regime at appropriate IHSSs	Water level data	• Obtain water level measurements from well points installed at IHSSs • Install monitoring wells at IHSSs where wells are required • Conduct slug tests on wells installed at IHSSs	I I	• Characterize Nature and Extent • Baseline Risk Assessment • Evaluation of Remedial Alternative

TABLE 4.3
PHASE I RFI/RI DATA QUALITY OBJECTIVES FOR OU12

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
DETERMINE RISKS ASSOCIATED WITH CONTAMINATION				
Contamination identification	Analytical data	• See description for Nature and Extent of Contamination	I, III, IV (V for radiological analysis)	• Baseline Risk Assessment
Exposure assessment	All data that characterize nature and extent	• See description for Nature and Extent of Contamination	I, III, IV (V for radiological analysis)	• Determine potential pathways and receptors
Toxicity assessment	Analytical data Toxicity values	• See description for Nature and Extent of Contamination	I, III, IV (V for radiological analysis)	• Determine risk to receptors
Risk characterization	Toxicity values Exposure assessment	• Not applicable	Not applicable	• Baseline Risk Assessment • Evaluation of Remedial Alternatives
Uncertainty analysis	Statistical parameters	• Not applicable	Not applicable	• Determine adequateness of data to perform Baseline Risk Assessment

TABLE 4.3
PHASE I RFI/RI DATA QUALITY OBJECTIVES FOR OU12

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
SUPPORT SELECTION OF REMEDIAL ACTION ALTERNATIVES				
Nature and extent of contamination	Analytical data Volume of contaminated material	• See descriptions above for Characterizing Nature and Extent of Contamination		• Evaluation of Remedial Alternatives
Treatability studies	Bench-scale testing	• Collect samples pre- and post-treatment to determine effectiveness of alternative	IV (V for radiological analytes)	
Characterize site-specific geologic parameters	Soil physical parameters	• Collect soil samples for parameters identified as appropriate for each IHSS	I, II	• Evaluation of Remedial Alternatives

Approved by:

2/18/94
Manager, Remediation Programs

2/18/94
RI Project Manager

5.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION TASKS

5.1 TASK 1 - PROJECT PLANNING

Project planning for the implementation of the RFI/RI for OU12 will include numerous activities in addition to tasks completed as part of this work plan. Review of previous site investigations, review of the HRR, preliminary site characterization data, preliminary identification of potential ARARs, the development of DQOs, and a FSP have all been completed as part of this work plan and are contained in Sections 2.0, 3.0, 4.0, and 6.0, respectively.

New information and data will be reviewed after approval of this work plan and prior to commencing field operations to assist in planning and coordination of preparatory activities for OU12. Such activities include coordinating with other field investigation programs occurring in the same vicinity as OU12, including OU10 and OU14; accommodating the special security requirements within high security areas; and health and safety concerns for field operations. Additionally, OU12 will include delineation of underground utilities and other related physical features for each IHSS prior to commencing field activities.

Prior to RFI/RI field activities, newly generated data and historical data which has become available since preparation of this work plan will be compiled and evaluated. There are ongoing site investigations at other OUs and plant-wide studies which may provide data relevant to the OU12 investigation. Interviews with plant personnel will be conducted to

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augment past release information and to identify areas where construction activities may have disturbed and/or removed portions of OU12. Personnel in facility operations will be contacted to inquire about any additional information that may be available about OU12 structures and site conditions. Although OU12 IHSSs have been visually inspected during preparation of this work plan, detailed inspection and clearance activities will be performed at each site prior to mobilizing field equipment to provide additional location and accessibility information.

Field activities proposed for OU12 will be integrated with ongoing or proposed field activities for other nearby investigation sites to minimize redundancy and maximize efficiency. The possible investigation sites near OU12 are discussed in further detail in Section 2.2.

It is important to emphasize that project planning and coordination will be required throughout the project duration to accommodate any unforeseen developments. Two project planning documents, one included in this work plan, have been prepared for the OU12 RFI/RI as required by the IAG. A FSP included in this document presents the locations, media, and frequency of sampling efforts. The second document required by the IAG is a Sampling and Analysis Plan (SAP) which includes a QAPjP and SOPs for all field activities. A site-wide SAP has been prepared for the RFP, and is currently being revised in accordance with the IAG. QA procedures and SOPs that are used specifically for OU12 are referenced in this work plan. Any deviations from the QAPjP or SOPs are documented as QA Addenda in Section 10.0 of this work plan, or as Document Change Notices (DCNs) to the SOPs.

5.2 TASK 2 - COMMUNITY RELATIONS

In accordance with the IAG, the RFP has developed a Community Relations Plan (CRP) to inform and actively involve the public in decision-making as it relates to environmental restoration activities. This CRP meets the requirements of all OUs. The vehicle for public involvement in the RFI/RI process is through the Technical Review Group process. The CRP addresses the needs and concerns of the surrounding communities as identified through interviews with federal, state, and local elected officials; businesses; medical professionals; educational representatives; interest groups; media; and residents adjacent to the RFP.

Current community relations activities concerning environmental restoration include participation by RFP representatives in informational workshops; presentations at meetings of the Rocky Flats Environmental Monitoring Council; briefings for citizens, businesses, and surrounding communities on environmental restoration and monitoring activities; and public comment opportunities on various Environmental Management (EM) Program plans and actions. RFP personnel involve several special interest groups in decisions that pertain to environmental restoration activities, including the Rocky Flats Cleanup Commission, the recipient of the EPA Technical Assistant Grant.

In addition, a Speakers' Bureau program provides RFP speakers to civic groups and educational organizations, and a public tours program allows the public to visit the RFP. The RFP also produces fact sheets and periodic updates on environmental restoration activities for public information and responds to numerous public inquiries regarding the RFP.

5.3 TASK 3 - FIELD INVESTIGATION

The OU12 RFI/RI field investigation is designed to meet the objectives outlined in Section 4.0. The following activities will be performed as part of the field investigation, as described in detail in Section 6.0.

The specific objectives of the RFI/RI field investigation for OU12 are:

- Characterize the nature and extent of contamination at each IHSS;
- Support baseline risk assessment including human health and the environment; and
- Support corrective measures studies, feasibility studies, and treatability studies.

The field investigation is designed to characterize current sources and potentially affected media at each IHSS. Many of these sites are still active and may be active after the field sampling program is concluded. Additional contamination that may occur after field sampling activities are completed cannot be determined by this program.

The field investigation developed for each IHSS will consist of two major subtasks:

- Subtask 1 - Radiation Surveys, Surficial Soil Sampling, and Chemical Screening; and
- Subtask 2 - Sediment Sampling, Vadose Zone Monitoring, Soil Boring, and Monitor Well Installation.

Additional field investigation components are included in the plan to characterize potential migration throughout the OU12 area. A summary of each subtask is presented in the following sections. These subtasks are discussed in greater detail in Section 6.0.

5.3.1 Subtask 1 - Screening and Surficial Soil Sampling

The initial task will consist of surface and subsurface media screening and surficial soil sampling to first determine if contamination exists, and then to provide preliminary definition of the extent of contamination. In addition, the locations of footing drains and building sumps will be determined. Screening techniques that provide real-time results will be used to indicate general areas of radiological or chemical contamination. Radiation survey techniques will include high purity germanium (HPGe) radiation surveys supplemented with Sodium Iodide Scintillation Detector (NaI probe) surveys, vertical depth profile sampling, asphalt sampling, and surficial soil sampling. Surficial soil samples will also be collected and analyzed for nonradionuclides, and for verification of HPGe results. Screening methods employed to indicate potential areas of chemical concern will include collection of soil gas, soil and/or ground water screening samples for real time analysis of volatile organic compounds or other parameters using a mobile laboratory and field instruments. Other screening methods will be employed at specific IHSSs to determine the presence of nitrate, hexavalent chromium, and sulfate in ground water. In addition, temporary well points will also be installed to characterize the local ground water system. The proposed screening techniques will provide real time results, identify general areas of primary concern, and allow subsequent field sampling tasks to be efficiently focused.

5.3.2 Subtask 2 - Sediment Sampling, Vadose Zone Monitoring, Soil Boring, and Monitor Well Installation

This task will consist of sediment sampling, vadose zone monitoring, and a focused soil boring and ground water monitoring well installation program at appropriate IHSSs to investigate and quantify the extent of contamination at potentially anomalous areas identified from screening results. The locations of the sediment samples will be determined from the results of Subtask 1. The locations of the borings will be based on the real time results of the

volatile organic compound screening for soil gas, soil and ground water, inorganic parameter screening, the HPGe survey for radionuclides in soil and asphalt, and the surficial soil sample analysis results for metals. The borings will be drilled to bedrock and soil samples collected and analyzed for suspect compounds including volatile organic compounds and metals. Soil sample analysis results will provide quantitative data in anomalous areas tentatively identified in the screening program and be used to define the extent of soil contamination.

Ground water monitoring wells will also be installed based on results of the soil borings and the field screening subtask. If screening and soil boring results indicate that ground water is potentially affected by IHSS releases, alluvial monitor wells will be installed near the centers of the affected areas to evaluate the presence of potentially contaminated ground water. Ground water samples will be collected and analyzed to provide quantitative data in anomalous areas tentatively identified in the screening program and to define the extent of potential contamination associated with OU12 IHSSs.

Vadose zone monitoring will be conducted at appropriate IHSS depending on screening tasks. Tensiometer nests will be installed to monitor vadose zone water.

General procedures and analytical parameters for sediment sampling, and soil boring and monitor well installation are described in Section 6.0 of this work plan. Refinement of these procedures may be required once screening data have been collected. Any minor revisions or proposed changes to the work plan will be presented in the RFI/RI report. Any major revisions will be the subject of technical memoranda as stipulated in the IAG.

5.4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

Analytical procedures will be completed in accordance with the ER Program QAPjP (EG&G, 1991e). Analytical detection limits, sample container and volume requirements, preservation requirements, and sample holding times are discussed in Section 6.5.

Results of data review and validation activities will be documented in data validation reports. EPA data validation functional guidelines will be used for validating organic and inorganic (metals) data (EPA, 1988c). Data validation methods for radiochemistry and major ions data have not been published by EPA, but data and documentation requirements have been developed by EM Program QA staff. Data validation methods for these data are derived from these requirements. Details of the data validation process are described in the QAPjP (EG&G, 1991e).

Data will be reviewed and validated according to data validation guidelines in the QAPjP and the Data Validation Functional Guidelines (EG&G, 1990b). These documents state that the results of data review and validation activities will be documented in data validation reports.

5.5 TASK 5 - DATA EVALUATION

Data collected during the RFI/RI will be incorporated into the existing RFEDS database and will be used to better characterize the nature and extent of contamination. RFEDs personnel will provide assistance in the early stages of sample collection and analysis in order to facilitate the addition of data collected during the RFI/RI to the existing RFEDs database. Screening data will be stored in independent computerized data bases and will be incorporated into RFEDS when appropriate. These results also will be used in determining the impact of OU12 on surface water, ground water, sediments, air, the environment, and

biota, as well as the potential contaminant migration pathways at OU12. Additionally, data will be used to support the evaluation of proposed remedial alternatives and the BRA.

5.5.1 Site Characterization

The additional physical data collected during the RFI/RI will be incorporated into the existing site characterization. Water-level data and slug tests will be used to characterize the alluvial ground water flow regime. Provisions for monitoring vadose zone conditions will also be included.

5.5.2 Source, Soils, Ground Water, Surface Water, and Sediments Characterization

Analytical data from OU12 IHSSs will be used to:

- Characterize the nature of source contaminants;
- Characterize the lateral and vertical extent of contaminant sources in vadose zone soils;
- Characterize the nature and extent of contaminants in ground water;
- Evaluate impact of potential OU12 contamination in surface water and sediments; and
- Evaluate on-site contaminant concentrations.

Analytical data obtained from OU12 samples will be used to characterize the nature and extent of contamination. Data will be summarized graphically and/or in tabular form to assist interpretation. Contaminant distribution maps will be prepared to summarize the spatial distribution of soil and ground water contaminants.

The criteria for the identification of contamination will be analyte-specific for each geologic unit (e.g., Rocky Flats Alluvium or artificial fill). For all analytes (including radionuclides), those concentrations that exceed the site-specific background concentrations will be considered likely evidence of contamination. These data will be compared to sitewide background values provided in the Final Background Geochemical Characterization Report (EG&G, 1991d), recognizing that values presented in that report are not yet accepted by the agencies as background.

5.6 TASK 6 - BASELINE RISK ASSESSMENT

As required by the IAG, a BRA that will address the risk associated with OU12 sources and affected media will be performed as part of the OU12 RFI/RI. This task includes a Human Health Risk Assessment and Environmental Evaluation for OU12. The purpose of the BRA is to characterize the toxicity and levels of hazardous substances present, to characterize contaminant fate and transport, and to assess the potential for human health and environmental impacts or risks associated with the site. The BRA is used to provide a basis for determining whether remedial actions are necessary and to justify performing remedial actions. The Human Health Risk Assessment will address potential public health risks, and the Environmental Evaluation will address potential ecological risks.

Existing data and data collected during the RFI/RI will be used to the extent possible to support the quantitative Human Health Risk Assessment and Environmental Evaluation. Data collected during RFI/RI will support quantitative evaluation of risk due to soil ingestion, inhalation, and dermal contact. Exposure pathways involving surface water, ground water, air, and/or biota as transport media will be also quantitatively evaluated, if necessary. The RFI/RI sampling program will be designed to generate data that meet the requirements set forth in Guidance For Data Useability In Risk Assessment (EPA, 1990).

These assessments will aid in the preliminary screening of site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment. The risk assessment process will be accomplished in four general steps:

1. Data collection/evaluation (identification of contaminants of concern);
2. Exposure assessment;
3. Toxicity assessment; and
4. Risk characterization.

As stated in the IAG and the NCP, a risk characterization of current, future, or potential site condition scenarios will be developed.

The objectives and the description of work for the Human Health Risk Assessment are described in detail in Section 8.0. The Environmental Evaluation Work Plan is presented in Section 9.0.

5.7 TASK 7 - DEVELOPMENT, SCREENING, AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

5.7.1 Remedial Alternatives Development and Screening

This section identifies the process to identify potential technologies applicable to remediation of contaminated soils, sediments, surface water, and ground water at OU12, if detected. Identification and screening of technologies, assembling an initial screening of alternatives, and identification of interim response actions will be conducted while the RFI/RI is being conducted. However, investigation of OU12 is in its initial stage; thus, remedial alternatives

are not reviewed in this section. A preliminary evaluation of the remedial alternatives for OU12 will be performed as data are collected.

The process employed to develop and evaluate alternatives for OU12 will follow guidelines provided in the NCP. Although the CERCLA process will direct remedial investigations at OU12, RCRA regulations will also be considered. CERCLA specifies in greatest detail the steps that should be followed for selection of remedial alternatives. The IAG requires general compliance with both RCRA and CERCLA guidance.

The steps followed to develop remedial alternatives for OU12 are as follows:

1. Develop a list of general types of actions appropriate for OU12 (such as containment, treatment, and/or removal) that may be implemented to ensure compliance with both RCRA and CERCLA guidance.

2. Identify and screen technology groups for each general response action.

3. Identify and evaluate process options for each technology group to select a process option representing each technology group under consideration.

4. Assemble the selected representative technologies into site closure and corrective action alternatives for OU12 that represent a range of treatment and containment combinations, as appropriate.

5. Screen the assembled alternatives in terms of the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost.

6. Develop preliminary cancer risk-based remedial action goals for affected media. Preliminary remedial action goals will be applied as performance objectives for evaluating the effectiveness of specific technology processes identified as candidate components of viable remedial action alternatives. As the CMS/FS evolves, preliminary remediation goals may be revised.

7. Remediation goals associated with toxic, non-cancer risk will be determined using the appropriate reference dose for each chemical present on the site.

For the RFI/RI work plan, the appropriate level of alternatives analysis is the listing of general response actions most applicable to the type of site under investigation. General response actions are defined as those broad classes of actions that may satisfy the objectives for remediation defined for OU12. Table 5.1 provides a list and description of general response actions and typical technologies associated with remediating soils, sediments, ground water, and surface water. Table 5.1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways. Not all of the alternative response actions and typical technologies listed may be appropriate for OU12. Some may be discarded during the screening of alternatives.

The response actions outlined in Table 5.1 must be applied to the potential exposure pathways that will be identified for OU12. In general terms, potential human exposure can be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where the contact could occur with the released contaminant.

The existing data do not adequately characterize the source, release mechanisms, and migration pathways for contamination at OU12. Therefore, the existing data are not sufficient for implementing the screening of alternatives. The OU12 RFI/RI will characterize the nature and extent of contamination and obtain necessary data to:

- Describe the physical characteristics of the site;
- Define current sources of contamination;
- Determine the nature and extent of contamination in soil, ground water, surface water, and sediment;
- Describe contaminant fate and transport; and
- Describe receptors.

These data will provide information for the preliminary screening of alternatives and a comparative evaluation of the technologies with respect to implementability, effectiveness, and cost.

5.7.2 Detailed Analysis of Remedial Alternatives

The detailed analysis and selection of alternatives is the process of analyzing and comparing relevant information in order to select a preferred remedial action. Each appropriate alternative will be assessed in terms of nine evaluation criteria, and the assessments will be compared to identify the key attributes among the alternatives. Assessment in terms of eight evaluation criteria is necessary for the CMS and the subsequent Corrective Action Decision (CAD)/Record of Decision (ROD). The nine specific evaluation criteria are as follows:

1. Overall protection of human health and the environment;
2. ARARs;
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume;
5. Short-term effectiveness;
6. Implementability;

7. Cost;
8. State acceptance; and
9. Community acceptance.

5.8 TASK 8 - TREATABILITY STUDIES/PILOT TESTING

The primary purposes of a treatability study are to provide sufficient technology performance information and to reduce cost and performance uncertainties to acceptable levels so that treatment alternatives can be fully developed and evaluated during detailed analysis. The task includes efforts to evaluate whether treatability studies are necessary and, if so, to prepare for and conduct treatability studies. If remedial alternatives are developed, the data collected as part of the field investigation will be reviewed in terms of whether the alternatives can be evaluated. If additional data are required, treatability studies or field investigations will occur.

If it is determined that a treatability study is necessary, a treatability work plan will also be prepared. The plan will identify treatability tests that need to be conducted as well as the test materials and equipment needed.

5.9 TASK 9 - RFI/RI REPORT

The OU12 RFI/RI report will be prepared to consolidate and summarize the data obtained during field work as well as data collected from previous and ongoing investigations. The RFI/RI report will include a Preliminary Site Characterization Summary and a BRA for OU12. This report will:

- Describe the field activities that serve as a basis for the RFI/RI report. This will include the scope of the RFI/RI and any deviations from the work plan that occurred during implementation of the field investigation;

- Discuss site physical conditions based on existing data and data derived during the RFI/RI. This discussion will include surface features, climate, surface water hydrology, surficial geology (vadose-zone soils), geotechnical soil index properties and classification, stratigraphy, ground water hydrology, demography and land use, and ecology;

- Present site characterization results from all RFI/RI activities to characterize the site physical features and contamination including nature and extent at OU12;

- Discuss contaminant fate and transport based on existing information. This discussion will include a preliminary identification of potential contaminant migration routes, release sources and mechanisms, and a discussion of contaminant persistence, chemical attenuation processes, and potential receptors;

- Present a BRA. The BRA will include human health and environmental evaluations;

- Present a summary of findings and conclusions; and

- Identify data needs, if necessary.

TABLE 5.1

GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
No Action	No remedial action taken at site	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control on-site contact.
Access and use restrictions	Permanent prevention of entry into contaminated area of site. Control of land use.	Site security; fencing, deed use restrictions; warning signs.	Could control on-site exposure and reduce potential for off-site exposure. Some site security fencing and signs are in place. Additional short-term or long-term access restrictions would likely be part of most remedial actions.
Containment	In-place actions taken to prevent migration of contaminants.	Capping; ground water containment barriers; soil stabilization; enhanced vegetation.	If applied to source, could be used to control all pathways. If applied to transport media, could be used to mitigate past releases (except air).
Pumping	Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal.	Ground water pumping; liquid removal from surface impoundments.	Applicable removal of contaminated ground water and bulk liquids (for example, from tanks, pipes, or drums).
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of soils, contaminated structures.	If applied to source, could be used to control all pathways. If applied to transport media, will control corresponding pathway. Must be used with treatment or disposal response actions to be effective.

TABLE 5.1

GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
Treatment	Application of technology to change the physical or chemical characteristics of the contaminated material. Applied to material that has been removed.	Solidification; biological, chemical, and physical treatment.	Applied to removed source material; could be used to control all pathways. Applied to removed transport media, could control air, surface water, ground water, and sediment pathways.
In-Situ Treatment	Application of technologies in-situ to change the in-place physical or chemical characteristics of contaminated material.	In-situ vitrification; bio-remediation.	Applied to source, could be used to control all pathways. Applied to transport media, could be used to control corresponding pathways.
Storage	Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal.	Temporary storage structures.	May be useful as a means to implement removal actions, but definitely would not be considered a final action for pathways.
Disposal	Final placement of removed contaminated material or treatment residue in a permanent storage facility.	Permitted landfill; repositories.	With source removal, could be used to control all pathways. With removal of contaminated transport medial, could be used to control corresponding pathway (except air).
Monitoring	Short-and/or long-term monitoring is implemented to assess site conditions and contamination levels.	Sediment, soil, surface water, and ground water sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.

Approved by:

Manager, Remediation Programs 2/18/94

Suzanne Berman 2/18/94
RI Project Manager

6.0 FIELD SAMPLING PLAN

The purpose of this section of the work plan is to provide a field sampling plan (FSP) that will generate sufficient data to satisfy the RFI/RI objectives outlined in Section 4.0. Section 6.1 presents IHSS-specific objectives. Section 6.2 summarizes site background information and rationale for the sampling and analysis and other data collection activities. Section 6.3 discusses the field data collection locations and frequencies for each site. Section 6.4 describes field sampling procedures and equipment, and Section 6.5 describes the analytical program including sample designation, analytical requirements, sample containers and preservation, and sample handling and documentation. Descriptions of data management procedures (Section 6.6), QA/QC procedures (Section 6.7), and air monitoring and sampling procedures (Section 6.8) complete the FSP for OU12.

The sampling locations and types presented in the FSP are designed to cover the entire IHSS as currently defined. Actual sampling will continue at each IHSS until the edge of contamination or another IHSS is encountered to fully define the extent of contamination.

6.1 OU12 RFI/RI OBJECTIVES

The specific objectives of the RFI/RI field investigation for OU12 are as follows:

- Characterize the nature and extent of contamination at each IHSS;
- Support human health risk assessment and environmental evaluation; and
- Support corrective measures studies, feasibility studies and treatability studies.

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Characterizing the nature and extent of contamination at each IHSS requires that the type of contaminant and its distribution in soil be characterized, and that the extent of migration to other media be determined. Results obtained from field sampling will be used to identify pertinent pathways and potential receptors identified in the site conceptual model, Section 2.5.

The OU12 RFI/RI is designed to characterize potential current sources and potentially affected soils, ground water, surface water, sediment, and air at each IHSS. This FSP is designed to identify potential sources, affected soils and sediment, and locally characterize migration to ground water. Given the scope of this FSP to characterize these media, it is acknowledged that additional TM may be required to fully characterize the nature and extent of contamination. Air will be characterized using data collected under other sitewide programs. Surface water, building footing drains, and ground water are currently proposed to be investigated after evaluation of IHSS-specific soil, sediment, and ground water data. Additional proposed investigations will be presented in a TM to this OU12 RFI/RI Work Plan.

Many of the OU12 IHSSs are still active and may be active after the field sampling program is concluded. Additional contamination caused by post-field sampling activities cannot be determined by this program.

6.2 BACKGROUND AND FSP RATIONALE

The design of a FSP for determining nature and extent of contamination requires an understanding of both the physical characteristics of the IHSS and the nature of potential sources of contamination. OU12 consists of 10 separate IHSSs that can be categorized by type and size: two are small loading docks less than 5,500 ft^2 in area; two are backfilled

ponds used historically to impound cooling tower water; two are fiberglassing areas less than 6,000 ft^2 in area; one has a varied history that encompasses nearly 450,000 ft^2 within the 400 building area; two are associated with acid spills; and one was a storage yard approximately 10,000 ft^2 in area for machining equipment. Of the areas described above, six are located immediately adjacent to buildings and are partially or completely covered with concrete or asphalt. Two have entire buildings within their boundaries, and three have been backfilled or otherwise regraded.

The nature of contamination at most of the OU12 sites is not specifically known. No data have been previously collected at OU12 IHSSs. Historical information presented in the HRR (EG&G, 1992c) provides general indications of the types of compounds that may be anticipated at the sites. In all cases, there is no documentation in the HRR which details the fate of any constituents released to the environment. Soils contamination could have resulted from historical spills, releases to air, storage of material, or ponding of liquids at most of these sites. Asphalt paving, concrete, or soil regrading has occurred after many of the historically reported incidents, removing visible evidence of spills or possible releases.

Given the variable nature of the sites and their relatively brief histories, sampling programs have to be designed to be IHSS-specific. In general, the multi-task sampling approach described below will be used for determining the potential source locations and extent of contamination. The tasks are designed to provide data to refine subsequent tasks and include the following in order of occurrence:

- radiation survey of surface and shallow subsurface soils and asphalt;
- surficial soil sampling for radionuclides and nonradionuclides;

- chemical contamination screening of soil gas, subsurface soils, and ground water;
- determination of the ground water hydraulic gradient using temporary well points;
- installation of soil borings and ground water monitor wells based on the radiation survey and chemical screening; and
- vadose zone monitoring, slug tests, and collection of appropriate geotechnical data to determine physical and chemical characteristics of contaminated media.

This approach has been developed to allow for a systematic investigation of potentially contaminated media at each IHSS and at OU12 as a whole. In the event that the radiation survey, surficial soil sampling, and chemical screening indicates that no contamination is present at a sampling location, then soil borings and monitor wells will not be installed. Conversely, if contamination is detected during the performance of any of the tasks listed above, additional tasks will be conducted until the extent of contamination has been characterized.

As agreed to by DOE and the regulatory agencies in OU12 scoping meetings, minor revisions to implementation of this FSP need only be reported in the RFI/RI report. Minor revisions include minor adjustments to screening and sampling locations warranted by site conditions. It was agreed that screening data and rationale for proposed locations of soil borings and monitor wells would be presented to and discussed with the regulatory agencies in lieu of a TM. One or more TM will be required if more than minor modifications are apparent.

Components of this FSP approach are described in the following sections. The application of the FSP approach to each OU12 IHSS is described in Section 6.3. Specific equipment and procedures for these activities are described in Section 6.4. Provisions are included to

address those sites where concrete or asphalt is now present, but may not have been present when contamination could have occurred. Contingency plans are stated in the event proposed equipment is unavailable or ineffective, or if site conditions (such as concrete covered sites instead of exposed soil) vary from what is anticipated.

6.2.1 Radiation Survey

The initial task will consist of a surface and shallow subsurface media survey to first determine if significant radiological contamination exists compared to background, and then to provide preliminary definition of the extent of contamination. The proposed radiation survey techniques will provide real time results, will identify general areas of primary concern, and will allow subsequent field sampling tasks to be efficiently focused. Radiation survey techniques will include high purity germanium (HPGe) radiation surveys supplemented with gamma activity measurements using a sodium iodide (NaI) scintillation detector. The purpose of the NaI probe is to provide spatial resolution of surficial radioactivity detected with the HPGe. Surface samples of soil, concrete or asphalt, and vertical depth profile soil samples will also be collected to support HPGe surveys as described in Section 6.2.2.

Radiation surveys will be conducted to document the character of surficial radionuclide contamination. HPGe radiation surveys conducted at OU12 IHSSs will be set up on a grid that provides total areal coverage, plus overlap. The HPGe gamma ray detector will be used which is capable of high resolution gamma ray spectroscopy enabling the identification and quantification of gamma-emitting radionuclides. The HPGe results will be supplemented with gamma activity measurements using a NaI probe, one of the best scintillators for detecting gamma photons.

The HPGe detector is mounted either on a tripod or vehicle and placed a set distance above the ground surface to measure gamma rays which originate from surface media. The detector height on the vehicle-mounted system can be varied to accommodate site specific conditions and more narrowly focus the field of view. The detector system integrates gamma radionuclide activity over the detector's "field of view," a volume defined by which 90 percent of those gammas originating in the surface media are measured. As with most screening radiation detectors and measuring instruments, it is assumed that radionuclide distribution is relatively homogeneous over the field of view, and that the distribution varies only with depth. It is recognized that the assumption of homogeneity is probably not valid, however, the physics of all probes used to screen a surface for radionuclides requires this assumption. Supplemental gamma activity measurements will, therefore be taken with the NaI probe to better define anomalous areas within the HPGe field of view. In addition, surficial soil samples and depth profile samples will be collected to further define the HPGe results. HPGe results are typically reported as concentration per unit mass, picoCuries per gram (pCi/g). Detailed information on the capabilities of the HPGe detector is in Appendix G. Also included in the appendix is information regarding detector sensitivity, calibration, operation, and limitations.

Gamma rays originating in the soil or surface media (typically asphalt pavement) are attenuated such that the number reaching the detector decreases exponentially with depth. The attenuation of the gamma rays is a function of the elemental composition of the soil or medium measured. The more dense the soils or surface media, the more gamma attenuation that will occur. Where soils are covered by asphalt or concrete, HPGe measurements will reflect the activity of the pavement, rather than the underlying soil. The capabilities of the HPGe detector provide greater areal coverage and higher quality results than G-M shielded and FIDLER instruments and pancake-type detectors outlined in the

IAG. FIDLER instruments provide relative comparisons of radioactivity at discrete survey points whereas HPGe detectors provide individual radionuclide concentrations over the entire area surveyed.

EG&G currently has in-house capability to conduct HPGe field surveys using a tripod-mounted detector. The tripod-mounted detector has an approximate field of view of 14 meters, or approximately 45 feet (ft). Technical information on the HPGe detector is provided in Appendix G. An SOP is currently in development. Vehicle-mounted HPGe instrumentation with a 60 meter, or approximately 195 ft, field of view is anticipated to be available for field use in late fall 1992. As described in Appendix G, the vehicle-mounted HPGe is six to eight times more sensitive than the tripod-mounted unit because it is equipped with more crystals and therefore, is the preferred detector for site use. Identical results of the same quality but at differing sensitivities are obtained from the tripod-mounted and the vehicle-mounted systems. This allows for direct correlation of the results from the two systems. The large grid spacing proposed for some OU12 IHSSs will be reduced if interferences from buildings require a more focused field of view, or replaced with a tripod-mounted detector, in the event that the vehicle-mounted HPGe either is not available or not effective for the field investigation. The SOP for vehicle-mounted HPGe field screening is currently under development. As a contingency, G-M shielded and FIDLER instruments and pancake type alpha detectors will be used at each OU12 IHSS where HPGe is currently proposed if the SOPs are not yet approved prior to OU12 field work, or if site conditions introduce other difficulties.

6.2.2 Surficial Soil, Asphalt, and Vertical Depth Profile Sampling

Surficial soil sampling will be conducted both for radionuclide and nonradionuclide analysis on established grids at each IHSS. Surficial grab samples, as described in GT.08, will be

collected at paved grid locations, and composite samples collected with the jig and scoop described in SOP GT.08 at exposed soil locations. Sampling equipment and procedures for collecting surficial soil samples for radionuclide and nonradionuclide analysis are in Section 6.4.2. Vertical depth profile soil samples will be collected at 0 to 2, 2 to 4, and 4 to 6-inch vertical depth locations using the sampling equipment and procedures described in Section 6.4.3. Concrete or asphalt samples will be collected at survey points with anomalous surface activity. Equipment and procedures for collecting concrete and asphalt samples are described in Section 6.4.4.

Surficial soil samples will be collected using one methodology for both radionuclide and nonradionuclide analysis but different methodologies depending on whether the location is paved or has exposed soil. For paved locations, grab samples will be collected using the grab sampling methodology in SOP GT.08. The samples will be collected from the soil substrate underlying base materials immediately beneath the pavement. At exposed soil locations, samples will be collected with the jig and scoop described in SOP GT.08. One composite sample will be collected, with subsamples located in the center and four corners of a one meter square area.

Vertical depth profile samples will be collected at a subset of the exposed soil HPGe survey locations to determine the vertical extent of radionuclide contamination. Vertical depth profile samples will be collected at 0 to 2, 2 to 4, and 4 to 6-inch vertical depths at locations determined after the survey results are evaluated. This information is only required in exposed soil or gravel sites to determine the vertical distribution of gamma-emitting radionuclides contributing to the HPGe survey readings. Vertical depth profile samples are not proposed under concrete or asphalt because these dense surfacing materials attenuate gamma rays and no correlation can be made between surface HPGe measurements and

vertical distributions in underlying soils. The vertical depth profile samples will be measured onsite for radionuclide concentration using a laboratory HPGe.

Surficial soil and vertical depth profile sampling at the gridded locations using the field HPGe will be supplemented by analysis of additional surficial soil samples, if necessary, and concrete or asphalt samples using a laboratory HPGe. Additional surficial soil samples may be collected at nongrid locations to allow correlation of remote and direct HPGe measurements and to quantify anomalous readings from the NaI probe. Surficial soil samples and concrete or asphalt samples will be stored in containers for 30 days to allow radon gas to equilibrate with parent radionuclides present in the material matrix. After 30 days, an onsite laboratory HPGe will be used to detect concentrations of gamma-emitting radionuclides in the samples. These data will be used to guide further investigation of anomalous radioactive areas. All samples analyzed using the laboratory HPGe will be retained until the results of the analysis have been evaluated. Duplicate soil samples will be collected at a subset of sample locations and analyzed in a radiochemistry laboratory to determine the concentration of non-gamma emitting radionuclides and to confirm the HPGe detector measurements.

The 30-day lag time for HPGe analysis is not real time, per se, but is more advantageous than the six to nine month turn-around time currently experienced for laboratory radionuclide analysis. The availability of a laboratory HPGe however, is key to implementation of this plan. An SOP for laboratory HPGe field screening is currently under development, and the laboratory HPGe is scheduled to be available by Spring 1993. In the event a laboratory HPGe is not available by the time OU12 field work commences, samples will be sent to a radiochemistry laboratory for analysis. Sampling equipment and procedures for conducting the radiological surveys are presented in Section 6.4.1.

6.2.3 Sediment Sampling

To investigate potential migration of surficial contaminants through surface water runoff, drainage paths identified at specific IHSSs may also be sampled to determine if compounds have migrated from the site via surface water to drainage ditches. At IHSSs where historical information indicates runoff could have been impacted, sediment samples will be collected along likely runoff pathways according to EMD SOP SW.6 and analyzed for suspected compounds including TCL volatiles (if water saturated), TAL metals, radionuclides, and PCBs. Sampling equipment and procedures for sediment sampling are described in Section 6.4.5.

6.2.4 Chemical Screening

Field screening methods for nonradioactive contamination will be used to detect the general location and possible extent of historical spills or releases. As with the radiation survey, these field screening methods provide real-time results from which a focused and efficient field sampling program can be conducted. The equipment selected to conduct field screening is portable, efficient, and provides quality results from which to base further investigations. Field screening will emphasize the use of soil gas sample collection and analysis, with the ability to collect and analyze soil and ground water screening samples to identify extent of contamination migration. In addition to the soil gas surveys outlined in the IAG, the field screening activities included in this FSP offer the ability to achieve an early indication of location and downward migration of contaminants.

An all-terrain vehicle (ATV) equipped with an hydraulic probing rig is capable of driving 1-inch diameter probe rods up to 35 ft in favorable subsurface conditions to allow collection of soil gas, soil, and ground water screening samples. Soil and ground water screening samples will be collected at a subset of soil gas sampling points after evaluation of soil gas

results to verify and delineate soil gas anomalies. The vehicle and rig are ideal for OU12 work, much of which is paved, and is close to buildings, structures, and overhead utility lines. The hydraulic rig is capable of effectively cutting through asphalt and concrete. A mobile laboratory equipped with a gas chromatograph (GC) will be brought onsite to analyze soil gas, soil, and ground water screening samples collected using the hydraulic rig. The mobile laboratory will provide real-time results for volatile organic compounds in these media.

Screening methods are also being investigated for detecting inorganic compounds in soil and ground water screening samples including x-ray fluorescence for detecting metals in soils, and colorimetric or turbidimetric field test kits for determining presence of hexavalent chromium, nitrate, and sulfate in ground water. RFP currently has x-ray fluorescence capabilities in onsite laboratories. Mobile units are anticipated to be available in the future although the schedule is indefinite and SOPs do not exist. Anticipated delays in obtaining mobile x-ray fluorescence units useful for field screening result in their exclusion from the Final OU12 RFI/RI Work Plan. If x-ray fluorescence units become available for field use before OU12 field work begins, and the screening results they can provide are determined to satisfy data needs, a TM and any necessary SOPs will be submitted to the agencies.

Initially, soil gas sampling points will be established on a standard grid at each IHSS with potential volatile organic contamination. Grid size selection is discussed in Section 6.3. The rig will be set up on each point, and will cut through overlying concrete or pavement if present. To collect a soil gas sample, the sampling probe will then be driven to a depth of 5 ft, the retracting tip will be pulled back, and a vacuum applied to obtain the soil gas sample. The sample will be analyzed in the mobile laboratory for volatile organic compounds listed in Table 6.4 and results will be obtained within minutes. Adjacent samples from each IHSS will be compared to derive trends in the soil gas results.

In target areas defined from soil gas results, soil screening samples will be collected using a Kansas-type soil sampler driven with the hydraulic rig and analyzed for volatile organics at the mobile lab. It is anticipated that soil screening samples will be collected at approximately 50 percent of soil gas locations. Using results of the soil gas and soil screening, the probe will be advanced to ground water at select survey locations, and a ground water screening sample collected through dedicated tubing inserted through the drill rod and analyzed in the mobile laboratory. It is estimated that ground water screening samples will be collected at approximately 25 percent of soil gas locations. The procedures, SOP status, and equipment used for field screening activities are discussed in Section 6.4.6, and further information on the use of the hydraulic rig is in Appendix H.

6.2.5 Temporary Well Point Installation

Temporary well points will be installed in ground water screening locations in IHSS 157.2 that are selected after evaluation of all field screening data. The temporary well points will be used to obtain equilibrated ground water elevation data local to IHSSs at which screening results indicate potential ground water contamination and to determine the local hydraulic gradient. Temporary well points will be secured from tampering at the surface and grouted in place once data have been collected. Procedures and equipment required for well point installation are discussed in Section 6.4.6.

6.2.6 Soil Boring and Monitor Well Installation

Using results of the screening and sampling activities described above, a soil boring and well completion program will be conducted to investigate and quantify the extent of contamination at potentially anomalous areas. For planning purposes, approximately 20 to 25 percent of the soil gas sampling sites will be further investigated by soil borings. Borings will be drilled using hollow-stem auger techniques in potential source areas within IHSSs,

and will extend to the water table. SOPs for borehole installation and sampling will be followed as described in Section 6.4.7. Soil samples will be collected and analyzed for one or more of the following parameter groups: radionuclides, target compound list (TCL) volatile organic compounds, target analyte list (TAL) metals, selected anionic constituents, and soil pH. Soil samples will be collected and analyzed to confirm screening results, provide quantitative data, and to define the extent of soil contamination. Hydraulic testing of wells will be conducted as described in Section 6.2.7.2.

Alluvial ground water monitoring wells will be completed based on results of the field screening and soil boring programs. Alluvial monitoring wells will be installed at IHSSs where history, screening data, and soil boring data indicate ground water may have been contaminated. All monitoring wells installed during the RI/RFI process will be sampled quarterly for one year. Validated data will be presented in the RFI/RI report. Subsequent sampling rounds will be discussed in TM. RFP SOPs for monitor well installation, completion and sampling will be followed as described in Section 6.4.9.

General procedures, analytical parameters, and tentative locations for soil boring and monitor well installation are described in this work plan. Minor refinement of the locations may be required once screening data have been collected and will be documented in the RFI/RI report. Any significant revisions to procedures, methodologies, or data needs described in this work plan will be the subject of work plan addenda prepared in the form of technical memoranda as specified in the IAG.

6.2.7 Other FSP Activities

Other activities conducted within the soil boring and monitor well tasks described above include vadose zone monitoring, estimation of hydraulic conductivity of alluvial materials

using slug tests, and geotechnical data collection. The OU12 work plan will also include a provision for investigation of surface water, footing drains, and ground water based on evaluation of soil, sediment, and ground water data. Such investigations, if necessary, will be outlined in OU12 technical memoranda.

6.2.7.1 Vadose Zone Sampling and Monitoring

The applicability of vadose zone monitoring and sampling techniques in the OU12 area will be assessed based on results from the screening tasks of this FSP. Vadose zone monitoring is of particular interest for those IHSSs with exposed soil. Approximately 75 percent of the OU12 area is covered by impervious materials, limiting infiltration and percolation mechanisms throughout much of the area. The spatial relationship of potential contaminant sources to areas of exposed soil which can serve as conduits for infiltration and ground water recharge will, however, be identified. The following methods will be evaluated for use.

One method to measure soil moisture profiles at IHSSs with exposed soil is through the use of vertically-nested tensiometers or equivalent instruments. Tensiometers can be inserted by drilling small diameter boreholes either with hand augers or with the ATV-mounted hydraulic probe. Subsurface geologic conditions may limit the success of these installation methods, although other methods exist. Transducers connected to the tensiometers produce *in situ* readings of soil-water pressure which are recorded electronically in digital form. Soil-water pressure measurements are then used to determine response of vadose zone moisture to precipitation events, and to evaluate whether soil wetting fronts reach the water table. In areas where infiltration is found to reach the water table, a potential method to be used in evaluating the mobility of contaminants present in the vadose zone is leachability tests. Leachability data are used to substantiate whether individual IHSSs are current contributors

to observed ground water contamination. Procedures for vadose zone monitoring and leachability testing are relatively site specific, and no EMD SOP currently exists to globally address these activities. It is likely an OU12-specific SOP will be required. Information on typical vadose zone monitoring equipment and procedures is in Section 6.4.8.

6.2.7.2 Slug Tests

Slug tests will be attempted in all wells completed in the OU12 area for use in determining hydraulic conductivity and transmissivity of the alluvial ground water system. Slug tests will be conducted in accordance with SOP GW.4. Injection tests may be required at existing piezometer locations only, where hydraulic conditions preclude the utility of slug tests, and will be conducted in accordance with SOP GW.3.

6.2.7.3 Geotechnical Data

A minimum of two soil samples will be collected for the analysis of physical parameters from each sedimentologic unit encountered while drilling soil borings at each IHSS. Continuous coring methods will allow collection of relatively undisturbed samples for testing of physical parameters. These samples will be tested to determine moisture content, mineralogic composition, and grain size distribution using both sieve analysis and hydrometers. Bulk density, specific density, porosity, and saturated hydraulic conductivity will be estimated from these data and literature values. A minimum of two saturated and unsaturated samples will also be collected from each IHSS for the determination of total organic carbon (TOC) content, cation exchange capacity, and soil pH. This physical information is necessary for conducting the baseline risk assessment and evaluating the feasibility of future remedial actions.

6.3 SAMPLING LOCATION AND FREQUENCY

This section describes the specific field investigations proposed for each IHSS including sample locations and frequencies. Table 6.1 presents a summary of the proposed field investigations program for each IHSS in OU12. Table 6.1 also shows a comparison of the proposed activities to those outlined in the IAG, and the reasons for any discrepancies. Sampling activities and analytical parameters for this OU12 FSP are based on IHSS-specific conditions and historical use, and are designed to define the nature and extent of contamination at OU12 IHSSs and investigate potential migration pathways.

There are no previous data available at any of the OU12 IHSSs to bias the location of proposed sample points. The only available information on the IHSSs are descriptions of historical use, and documentation of historical spills and releases which are included in the HRR. In most instances, the exact location of reported releases was not given, and many of the releases were not verified. Clean up activities, if any, were not documented. Therefore, in designing the field sampling program, consideration was given to defining the location and extent of possible historical releases with an acceptable level of confidence in the data. Because that level of confidence is a direct reflection of data quantity and quality, the objectives of the program were to provide adequate data for statistical evaluation. The quality and quantity of the program will be evaluated using methods described in Section 4.0, Data Requirements and Data Quality Objectives.

The field sampling program described in Section 6.2 and applied to each IHSS in the following sections provides for screening and surficial soil sampling to be initially completed on a standard grid, with additional sample points added to further define anomalous readings. The use of quick and relatively inexpensive screening methods allows for the determination of general site conditions, as well as to qualitatively identify contaminated

areas at each IHSS. It is realized the success of such methods is somewhat dependent on subsurface geology in the OU12 area.

The approach used to determine grid spacing and sample locations for the different screening and sampling activities within this work plan considered not only statistics as described below and site history, but the capabilities of the technologies used. For example, the vehicle-mounted HPGe radiation surveys proposed in this plan provide soil concentration results representing an approximate 195-foot (ft) diameter circular area, not just a single point. Therefore, grid spacing for HPGe radiation surveys is set at 150 ft for large areas, which provides for total coverage of a site. Tripod-mounted HPGe surveys are established on a 30-ft grid to supplement vehicle-mounted surveys and the NaI probe is conducted on even a finer grid, 15 ft or less. The vehicle-mounted HPGe is unable to remotely detect radionuclides present in soils beneath concrete or pavement. Surficial soil samples will therefore be collected in concrete or paved areas on uniform grids for direct radionuclide measurement. In exposed soil areas, where the vehicle-mounted HPGe measurements are representative of radionuclide activities in soil, minimal numbers of confirmatory surficial soil and depth profile samples will be collected.

The statistical approach used to determine the sample location is taken from a method developed by Gilbert (1987) and is also presented in EPA documentation (EPA, 1989b). This method allows for the determination of a sampling grid spacing dependent on a target contaminated area size and specified confidence. This method assumes the following: the target is circular or elliptical; samples are collected on a square, rectangular, or triangular grid; the area between the grid points is much larger than the actual area defined sample collection and analysis sampled; and the definition of the contaminated area is clear and

unambiguous. The last assumption is difficult to meet at OU12 IHSSs because the size of the reported spills or releases is not known.

The acceptable probability (ß) of not finding the target contaminated area is specified as 0.1 or 10 percent, in accordance with EPA guidance (EPA, 1990). A triangular grid was chosen because studies have shown that triangular grids are less likely to fail to identify a given target than square grids (Gilbert, 1987). Based on the Gilbert methodology, triangular grids spaced approximately 25 ft are within acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 25 ft in size. The sizes of the smaller OU12 IHSSs are greater than 50 ft by 25 ft, but spill areas within the IHSSs may be smaller. Likewise, a triangular grid with samples spaced a maximum of 100 ft apart provide an acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 100 ft in size. The larger IHSSs are all greater than 50 ft by 100 ft in size, but potential anomalous areas within them may be smaller.

The soil gas and surficial soil sampling programs will be established on 25-ft triangular grids at most OU12 IHSSs that are less than 10,000 ft^2 in area, with provisions for additional points to be added in suspect locations (i.e. soil staining near doors of loading docks or where drum handling activities are associated with likely spills). The starting grid point at each site is chosen using random methods described in EPA guidance (EPA, 1989b). At IHSS 136.2, impoundment of cooling tower blowdown water reportedly occurred within an approximate 15,000 ft^2 area. Surficial soil sampling, and soil and ground water screening are proposed at an approximate 25-ft grid. At IHSS 157.2, which encompasses an area approximately 450,000 ft^2, soil gas and surficial soil sampling will be conducted on a 50-ft grid. Additional samples will be collected midway between grid nodes if anomalous screening results are obtained. HPGe radiation surveys will be conducted on a 150-ft

triangular grid spacing, or 30-ft grid for the tripod-mounted detector. NaI probe locations are set at 15-ft grid or less. Additional surficial samples may be collected midway between survey points with radioactivity in excess of preliminary remedial action criteria. Such additional points would be determined in the field.

The screening data will be assembled and summary statistics (including coefficient of variation and power) will be calculated for each IHSS and each parameter. Should the computed power fail to meet the requirements of the risk assessment, additional samples will be collected and analyzed. The number of additional samples that will be collected will be determined using calculations provided in EPA guidance (EPA, 1990).

The additional samples will be located using geostatistical techniques. Unlike classical statistics which assume independence of samples, geostatistics assumes that the data are spatially correlated. Using this analytic approach, the mean concentration and variance of the mean can be estimated at any given location in the contaminated area, and decisions about where additional samples should be collected can be objectively made.

As a first step in this process, the spatial interdependence of samples in two dimensions will be expressed through the development of calculated, and then modeled, semivariograms. The semivariograms will provide a measurement of the uncertainty that exists when a sample concentration is used to estimate the concentration of a contaminant in soil in the surrounding area.

Second, mean concentrations will be estimated across the contaminated area with the geostatistical method referred to as kriging. Kriging uses the information from the semivariogram to find an optimal set of weights that allow estimation of concentrations at

unsampled locations. The kriged estimates will be displayed in the form of a contour map showing sampled and estimated concentrations throughout the IHSSs.

Unlike contour maps prepared with conventional contouring algorithms, a kriged contour map has certain optimal statistical properties. Most important, the method provides measures of the error or uncertainty of the contoured surface (Davis, 1986). Therefore, a separate contour map of the standard error of the estimate (error map) will be prepared in addition to the map of contaminant concentrations referred to above. The standard error is a confidence band about the estimate. Additional samples will be located in areas with the highest standard error.

6.3.1 West Loading Dock (IHSS 116.1)

There are no documented releases on the West Loading Dock, but materials potentially stored on or near the dock include nonradioactive solvents and oil, and manufacturing operations in Buildings 444 and 447 may have resulted in radioactive contamination in the area of the loading dock. The dock is used actively, and overhead piping extends north-south in the western portion of the site. Two long, narrow strips of exposed soil extend across the site, but much of the remainder of the area is paved with asphalt. It is unknown when pavement was placed at the site. A shed is located on the eastern portion of the site, and renders this area of the IHSS inaccessible. Two storm water drains are located in or near the IHSS that drain areas inside and outside the IHSS boundary. Two inactive storm drains were observed, filled with dirt and debris.

6.3.1.1 Radiation Survey, Surficial Soils, and Chemical Screening

A radiation survey using tripod-mounted and vehicle-mounted HPGe detectors will be conducted under IHSS 157.2, Radioactive Site South as shown on Figure 6-1. The locations

for the vehicle-mounted HPGe detector are spaced on a 150-ft grid that encompasses this IHSS. In addition, a tripod-mounted detector will be used at IHSS 116.1 to supplement the vehicle-mounted survey. A NaI probe will be used to survey a minimum of eighteen sample locations to supplement the HPGe survey. Vertical profile samples will be collected in exposed soils at two NaI probe locations. Three asphalt samples will be collected at NaI probe locations and analyzed with the laboratory HPGe.

The remainder of the field sampling program for IHSS 116.1, West Loading Dock, is depicted on Figure 6-2. A minimum of eight surficial soil sampling points will be established on a 25-ft grid, and measured with the laboratory HPGe. Eight surficial soils will be collected and analyzed for TAL metals. At two randomly selected surficial soil sampling locations, duplicate samples will be collected and sent to a laboratory for radionuclide analysis.

Sediment samples will be collected in three locations, one from each of the debris filled drains, and one from the storm drain west of the IHSS, if adequate sample volume can be collected. Sediment samples will be analyzed for volatiles (if saturated), radionuclides, metals, and polychlorinated biphenyls (PCBs).

Soil gas techniques will be used at this IHSS because history indicates potentially spilled wastes included solvents or volatile hydrocarbons. Soil gas data collection points will be located on an approximate 25-ft grid as shown on Figure 6-2. A minimum of eight soil gas points are proposed. Soil gas samples will be analyzed in the mobile laboratory for volatile organic compounds as indicated in Table 6.4.

Based on results of the soil gas survey, soil and ground water screening samples will be collected and analyzed for volatile organic compounds in the mobile laboratory. A minimum of four soil and two ground water screening samples will be collected and analyzed at IHSS 116.1. Additional screening points may be added to further define contamination.

6.3.1.2 Soil Borings and Monitor Wells

A minimum of two ground water screening locations will be drilled using hollow stem auger techniques. The borings will be advanced to the water table or 6 ft beneath the alluvial bedrock contact whichever is encountered first. The anticipated depth of boreholes at this site is 20 ft. Using the sampling methodology described in Section 6.4 of this report, a minimum of four discrete soil samples from each boring will be collected and analyzed for RFP target compound list (TCL) volatile organic compounds and a minimum of four composite soil samples will be analyzed for target analyte list (TAL) metals, PCBs, and radionuclides.

One of the planned borings will be advanced to a depth of 3 ft below bedrock and completed as a monitoring well. A tentative location for the monitoring well is shown on Figure 6-2. The final location of the monitoring well will be determined after evaluation of field screening data. The remaining boring will be abandoned as described in Section 6.4.6. Depth to ground water is expected to be approximately 15 ft below grade, and total depth of the boring will be approximately 28 ft. The top of the screen will be placed approximately 8 ft above the water level and will extend through saturated alluvium. The total depth of the well is anticipated to be approximately 28 ft. The well will be developed and sampled and analyzed for TCL volatiles, TAL metals, PCBs, anions, and radionuclides.

Installation of additional ground water monitoring wells will be dependent on results of radiation surveys, field screening, surficial soil, sediment, soil boring, and monitoring well results.

6.3.2 South Loading Dock (IHSS 116.2)

There are documented releases that occurred at the South Loading Dock, including releases of uranium to the dock from stored drums, and from a small fire. Until 1970, the practice was to dispose of chlorinated solvents used to rinse beryllium parts on the ground near the dock. Air sampling conducted in 1977 in response to solvent dumping, found the area well below EPA standards, therefore, no soil cleanup activities were conducted. The dock is in active use, and is fully covered with concrete.

The field sampling program for the South Loading Dock is depicted on Figures 6-1 and 6-3. The sampling program designed for this dock is similar to that designed for the west loading dock, with minor variations.

6.3.2.1 Radiation Survey, Surficial Soils, and Chemical Screening

A radiation survey using a vehicle-mounted HPGe detector will be performed on a 150-ft grid, under IHSS 157.2, Radioactive Site South. In addition, a tripod-mounted detector will be used at IHSS 116.2 to supplement the vehicle-mounted survey. A NaI probe will be used to survey a minimum of seven sample locations to supplement the HPGe survey. A minimum of three asphalt samples will be collected, one at the HPGe survey location, and two at NaI probe locations.

A minimum of four surficial soil samples will be collected on a 25-ft grid spacing for laboratory HPGe measurement and laboratory analysis for TAL metals. These surficial soil

samples will be held for 30 days, and surveyed with a laboratory HPGe detector to estimate individual radionuclide concentration. Two randomly selected duplicate surficial samples will be sent to an offsite laboratory for radionuclide analysis to confirm HPGe results.

Sediment samples will be collected at a minimum of three locations in the ditch south of the loading dock. Samples will be analyzed for volatiles (if saturated), radionuclides, metals, and PCBs.

A minimum of four soil gas samples will be collected. Soil gas samples will be analyzed for volatile organics in the mobile laboratory. A minimum of four soil screening and two ground water screening samples will be collected at the soil gas survey locations and analyzed for volatile organics in the mobile laboratory.

6.3.2.2 Soil Borings and Monitor Wells

A minimum of two soil borings will be auger-drilled to the water table or 6 ft into the alluvial bedrock contact (whichever is encountered first) at anomalous areas to further define the extent of potential contamination. Using the sampling methodology described in Section 6.4 of this report, a minimum of four discrete samples from each boring will be analyzed for TCL volatiles, and a minimum of four composite samples will be analyzed for TAL metals and radionuclides.

Well 19689, located approximately 100 ft downgradient of the South Loading Dock, may provide contaminant and water level information for this IHSS. However, a minimum of one well will be installed at IHSS 116.2 at one of the borehole locations. A tentative location for the monitoring well is shown in Figure 6-3. The final location will be determined in the field and based on the results of the field screening. The borehole will

be advanced to 3 ft below the bedrock contact, or a total boring depth of approximately 25 ft. Depth to ground water is estimated to be approximately 12 ft at IHSS 116.2. Screen placement will be approximately 8 ft above the water table and extend through the full alluvial thickness. Total depth of the well is anticipated to be 22 ft. This well will be developed following completion, and the ground water will be sampled and analyzed for TCL volatiles, TAL metals, anions, and radionuclides. Installation of additional ground water monitoring wells will be dependent on results of radiation surveys, field screening, surficial soil, sediment, soil boring, and monitor well results.

6.3.3 Cooling Tower Pond West of Building 444 (IHSS 136.1)

The West Cooling Tower Pond (IHSS 136.3 in the IAG) was renumbered as IHSS 136.1 in the HRR (EG&G, 1992c). The West Pond was historically used to impound cooling tower blowdown which may have contained hexavalent chromium in the form of chromate. The HRR also indicated that lithium and small amounts of depleted uranium may have been buried at the ponds. This pond is clearly observed in aerial photographs from 1969 in Figure 2-8.

The field sampling program for IHSS 136.1, West Cooling Tower Pond, is depicted on Figure 6-4. The boundaries of the IHSS, as shown on Figure 6-4, extend beneath Building 460 into areas that will be inaccessible for this investigation. The cooling tower pond was backfilled and is currently paved over. The sampling plan for the pond is not as detailed on the surface as it is for subsurface investigations.

6.3.3.1 Radiation Survey, Surficial Soils, and Chemical Screening

Radiation surveys using a vehicle-mounted HPGe detector will be performed on a 150-ft grid throughout the pond area, under IHSS 157.2, Radioactive Site South. Asphalt samples

and NaI probe surveys will be conducted within the IHSS 157.2 radiation survey as indicated on Figure 6-1.

A minimum of four surficial soil grab samples will be collected from beneath the pavement on a 25-ft grid spacing. As described for other paved IHSSs, surficial soil samples will be held for 30 days, surveyed with a laboratory HPGe detector, and submitted for laboratory analysis of TAL metals. Two duplicate surficial samples will be sent to an offsite laboratory for radionuclide analysis to verify the HPGe results.

One sediment sample will be collected from a storm drain in the southwest portion of the IHSS, if enough sample volume is present in the drain. The sediment sample will be analyzed for volatiles (if saturated), radionuclides, metals, and PCBs.

A minimum of four soil and two ground water screening samples will be collected. Soil cores will be collected at 2-ft intervals to identify possible staining, fill, or native soil horizons possibly associated with the ponds. Ground water samples will be screened using colorimetric screening methods capable of detecting hexavalent chromium concentrations as low as 0.1 milligrams per liter.

6.3.3.2 Soil Borings

A minimum of two soil borings will be drilled to the water table or 6 ft into the bedrock contact (whichever is encountered first) at the IHSS 136.1 location to characterize lithology and to collect samples for laboratory analysis. The estimated total depth of these soil borings is 20 ft. The boring program will be established using the results of field screening methods for hexavalent chromium. The borings will be drilled and sampled using the sampling methodology described in Section 6.4 of this report. A minimum of four composite

samples from each boring will be analyzed for TAL metals and radionuclides. Soil samples from this site will be analyzed both for hexavalent and total chromium.

Installation of ground water monitoring wells will be dependent on the results of radiation survey, field screening, surficial soil, sediment, and boring programs.

6.3.4 Cooling Tower Pond East of Building 444 (IHSS 136.2)

The East Cooling Tower Pond is located in the vicinity of the ditch immediately east of the 400 area security fence as shown in Figure 2-10. An outside contractor, Dowell, used it for only a few days in May 1956. In October, 1956, the empty pond was backfilled although standing water was frequently observed in the general location at this IHSS in post-1956 historical photos.

The use of the East Cooling Tower Pond is similar to the use described for the West Cooling Tower Pond. The liquids in the pond were likely to contain hexavalent chromium in the form of chromate. Either the east or west pond may have contained cleaning solutions from one of the cooling towers, although cleaning solutions in cooling towers typically consist of acids and inorganic compounds. The HRR indicates an oily sheen was historically observed on the pond surface by an interviewed employee.

The field sampling program for IHSS 136.2, East Cooling Tower Pond, is depicted on Figures 6-1 and 6-5. The area has exposed soil and a north-south trending ditch extends through the IHSS. The location of the historical pond is not visible in the field other than the path of the ditch. This drainage ditch could also have been what was identified as a pond in aerial photographs.

6.3.4.1 Radiation Survey, Surficial Soils, and Chemical Screening

Radiation surveys using a vehicle-mounted HPGe detector will be performed on a 150-ft grid throughout the pond area, under IHSS 157.2, Radioactive Site South. In addition, a tripod-mounted detector will be used at a minimum of six locations at IHSS 136.2 to supplement the vehicle-mounted survey. The detector will be set up at locations spaced 30 ft apart in the approximate center of the IHSS. A NaI probe will be used to survey a minimum of 24 sample locations to supplement the HPGe survey. Vertical depth profile samples will be collected at exposed soils at a minimum of three locations in IHSS 136.2.

A minimum of eleven surficial soil samples will be collected on a 25-ft grid spacing to characterize surficial soils. The samples will be surveyed with a laboratory HPGe detector to estimate isotopic radionuclide concentration. Three duplicate samples will be collected and sent to a laboratory for confirmation of HPGe results. Surficial soils will also be submitted for laboratory analysis of TAL metals.

Sediment samples will be collected at a minimum of four locations in the ditch that extends through the IHSS. Samples will be analyzed for volatiles (if saturated), metals, radionuclides, and PCBs.

A minimum of six soil and three ground water screening samples will be collected using the hydraulic probing rig. Two-foot cores will be collected and logged to identify staining, fill, and/or native soil horizons possibly associated with the ponds. Ground water samples will be screened using colorimetric screening methods capable of detecting hexavalent chromium concentrations as low as 0.1 milligrams per liter.

6.3.4.2 Soil Borings and Tensiometers

A minimum of two soil borings will be drilled to the water table at the East Pond location to characterize lithology and to collect samples for laboratory analysis. In these soil borings, samples will be collected to the water table or 6 ft beneath the alluvial bedrock contact, whichever is encountered first. A total depth of 20 ft has been estimated. A minimum of four discrete soil samples will be analyzed for TCL volatile organics, and a minimum of four composite samples will be analyzed for TAL metals and radionuclides per borehole. Soil samples from this site will be analyzed both for hexavalent and total chromium.

A tensiometer or equivalent vadose zone monitoring device will be installed in the vicinity of IHSS 136.2 to measure vadose zone moisture if indications of contamination are determined through other surveys. The tentative location of the nested tensiometer is shown in Figure 6-5.

Installation of ground water monitoring wells will be dependent on results of the radiation survey, field screening, surficial soil, sediment, vadose zone and boring programs.

6.3.5 Radioactive Site South (IHSS 157.2)

The area encompassed by IHSS 157.2, Radioactive Site South includes most of the area around Buildings 444, 447 and 439. In general, the area is documented to contain low levels of uranium and chemical contamination most likely resulting from historical use of buildings in the area as a uranium foundry, a carbon machining shop and a beryllium fabrication facility. Other compounds used in the area include hydraulic oil and carbon tetrachloride in Buildings 439 and 440. Four of the IHSSs within OU12 are fully encompassed by IHSS 157.2, and are addressed individually. These IHSSs include the West and South Loading Docks (IHSSs 116.1 and 116.2, respectively), the Cooling Tower Pond West of

Building 447 (IHSS 136.1), and the Cooling Tower Pond East of Building 444 (IHSS 136.2). Other areas of potential interest in IHSS 157.2, including the Ingot Open Storage Area, were considered in development of the field sampling program. The IHSS 157.2 FSP described in this section was designed to investigate the general condition of IHSS 157.2, and to specifically investigate areas of suspect historical activity not already identified as an IHSS.

The field sampling program for IHSS 157.2, Radioactive Site South, is depicted on Figures 6-1 and 6-6. As shown in the figures, the boundaries of the IHSS totally encompass Buildings 444, 439 and 447, and include portions of Building 460. Areas beneath these buildings are inaccessible for field investigation. All of IHSS 157.2 is within a security area, and field work within the area may be limited in some instances for security reasons. Most of the area is paved with asphalt or concrete, and there are utility lines and sewer lines in some locations. There are original process waste lines under Building 444 that extend past the IHSS 157.2 boundary to the north.

6.3.5.1 Radiation Survey, Surficial Soils, and Chemical Screening

Radiation surveys using a vehicle-mounted HPGe detector will be performed on a 150-ft grid throughout IHSS 157.2 to document surficial conditions throughout the area as shown on Figure 6-1. The IAG required a G-M survey at 480 locations; however, the HPGe detector provides better results over a larger area. Therefore, only 22 locations are required to provide coverage of the entire IHSS. Three tripod-mounted HPGe survey locations have been added in areas where past activities may have resulted in contamination and where building structures may hinder the ability to obtain accurate results. Some of these locations are in IHSSs totally encompassed by IHSS 157.2. In addition, the six tripod-mounted HPGe survey locations proposed for IHSS 136.2 will provide data for IHSS 157.2. NaI probes will

be used to survey anomalous readings from the HPGe. A minimum of twelve asphalt core samples will be collected at HPGe survey locations with anomalous radioactivity for confirmation of HPGe results. A minimum of twelve soil depth profile samples will be collected at HPGe survey locations.

A minimum of 46 surficial soil samples will be collected from alternate nodes on a 50-ft grid from exposed soil areas and from under the concrete and asphalt pavement, as shown in Figure 6-6. Surficial soil samples will be surveyed with a laboratory HPGe detector to directly measure radionuclide concentration. Surficial soil samples will also be submitted to a laboratory for analysis of TAL metals. Eight duplicate surficial soil samples will be sent to a laboratory for full radionuclide analysis and confirmation of HPGe results.

A minimum of five sediment samples will be collected from drainage ditches in the southern and eastern portions of the IHSS. Samples will be analyzed for volatiles (if saturated), radionuclides, metals, and PCBs.

Soil gas screening within IHSS 157.2 will be conducted on an approximate 50-ft grid. A minimum of 81 soil gas survey points are proposed, as shown in Figure 6-6. Soil gas samples will be analyzed for volatile organics in the mobile laboratory. Based on results of the soil gas survey, a minimum of 40 soil and 20 ground water screening samples will be collected at soil gas survey locations using the hydraulic probing rig and analyzed for volatile organics in the mobile laboratory. Temporary well points will be installed and surveyed at 10 of the ground water screening locations to obtain water level information and determine local hydraulic gradient. Placement of well points will consider not only screening results from IHSS 157.2, but also those of IHSSs 116.1, 116.2, 136.1, and 136.2.

6.3.5.2 Soil Borings

A minimum of eight soil borings will be drilled within the IHSS, based on field screening and radiological survey results. Borings will be drilled to the water table or 6 ft below the alluvial bedrock contact, whichever is encountered first. Samples will be collected according to methodology described in Section 6.4. The estimated total depth of borings in this area is 20 ft below the surface. Using the sampling methodology described in Section 6.4 of this report, a minimum of four discrete samples will be analyzed for TCL volatile organics from this IHSS and a minimum of four composite samples will be analyzed for TAL metals and radionuclides.

Installation of ground water monitoring wells will be dependent on results of the radiation survey, field screening, surficial soil, sediment, and soil boring programs.

6.3.6 Sulfuric Acid Spill (IHSS 187)

IHSS 187, Sulfuric Acid Spill, is located immediately east of Building 443. A 3,000-gallon tank storing sulfuric acid leaked approximately half of its contents in September, 1970, and followed an eastward path where it was captured in two earthen pits and neutralized. The spill location and path of the spill were presented in Section 2.0. During spill neutralization activities, approximately 32,000 pounds of lime were used. Since the spill occurred, the tank has been taken out of service, and much of the spill area has been graded over and buildings, trailers, tanks and sidewalks now cover the spill site.

Limited field sampling at the source area is proposed for this IHSS as depicted in Figure 6-7. Because sulfuric acid is not typically persistent in the environment and it was effectively neutralized, it is not anticipated that the historical spill is currently impacting soil or surface water at IHSS 187. Sulfate could have infiltrated through soils to ground water,

therefore, surficial soil sampling and ground water field screening will be conducted. Surficial soils will be collected at a minimum of five locations and analyzed in the field to determine pH. At three of the locations, the hydraulic rig will be used to obtain a ground water sample for field screening of sulfate and pH. Turbidimetric methods are applicable for obtaining screening information for sulfate content in ground water and will be performed as outlined in SOP GW.5. Field instruments will be used to determine ground water pH. Additional sampling along the spill pathway will be conducted if the samples from the source area are determined to be contaminated.

6.3.7 Fiberglassing Area North of Building 664 (IHSS 120.1)

IHSS 120.1, Fiberglassing Area North, was used historically for fiberglassing waste packing boxes in the 1970's. The area may contain residue from spills of polyester resin, peroxide catalyst materials, and cleaning solvents as mentioned in the HRR. Information in the HRR also indicates that elevated gamma radiation and americium were historically detected in the vicinity of the IHSS, although the source of radioactivity was not identified. A fiberglass-sided shed on a concrete slab is located within this IHSS. The area is fenced, although access is not restricted. Empty 55-gallon drums are stored throughout the yard. It is assumed stored drums will be removed prior to implementation of the field sampling plan at IHSS 120.1.

The field sampling program for IHSS 120.1, Fiberglassing Area North, is depicted on Figure 6-8. The sampling program designed for the fiberglassing site is designed to locate potential spill areas as well as generally characterize the IHSS.

6.3.7.1 Radiation Survey, Surficial Soils, and Chemical Screening

Radiation surveys using a vehicle-mounted HPGe detector will be performed on a 150-ft grid throughout the Building 664 area as shown on Figure 6-1. In addition, a tripod-mounted HPGe detector will be used at locations spaced 30 ft apart to supplement the vehicle-mounted HPGe results due to possible interference from Building 664. A NaI probe will be used to survey anomalous readings from the HPGe. Vertical depth profiles will be collected at a minimum of three of the HPGe survey locations.

A minimum of nine surficial soil sampling points will be established on a 25-ft grid at IHSS 120.1. Samples will be surveyed with the laboratory HPGe and analyzed for TAL metals.

Soil gas will be used to determine the lateral extent of potential contamination from spills of solvents associated with historical fiberglassing activities. Soil gas data collection points will be located on an approximate 25-ft grid as indicated on Figure 6-8. A minimum of nine soil gas points are proposed at IHSS 120.1. Soil gas samples will be analyzed in the mobile laboratory for volatile organics. A minimum of five soil and three ground water screening samples will be collected and analyzed for volatile organics in the mobile laboratory, based on soil gas screening results. Temporary well points will be installed and surveyed at the three ground water screening locations to determine local water table elevation and hydraulic gradient.

6.3.7.2 Soil Borings and Tensiometers

A minimum of two deep borings will be drilled at IHSS 120.2, the locations of which are tentatively shown on Figure 6-8. These locations may be refined based on radiation survey and screening results. The two borings will be drilled to the water table, or 6 ft beneath the

alluvial bedrock contact (whichever is encountered first) estimated to occur less than 20 ft below the surface in this area. Using the sampling methodology described in Section 6.4 of this report, a minimum of four discrete samples from IHSS 120.1 will be analyzed for TCL volatile organics, and a minimum of four composite samples will be analyzed for radionuclides and metals, per borehole.

Tensiometers or equivalent devices may be installed in the vicinity of IHSS 120.1 to measure vadose zone moisture if indications of contamination are determined through other surveys. The tentative location of the nested tensiometers is shown in Figure 6-8.

Installation of ground water monitoring wells will be dependent on results of the radiation survey, field screening, surficial soil, and boring program.

6.3.8 Fiberglassing Area West of Building 664 (IHSS 120.2)

The fiberglassing area west of Building 664, IHSS 120.2, has a history similar to the north fiberglassing area. Building 664 is used for radioactive waste storage, however, and could interfere with radiological surveys conducted in the area. Soils are exposed over a portion of this site, although asphalt paving is located near the loading dock door.

The field sampling program for IHSS 120.2, fiberglassing area west of Building 664, is depicted on Figure 6-9. The sampling program designed for this IHSS is similar to that designed for IHSS 120.1, with minor variations.

6.3.8.1 Radiation Survey, Surficial Soils, and Chemical Screening

Radiation surveys using a vehicle-mounted HPGe detector will be performed on a 150-ft grid throughout the Building 664 area as shown on Figure 6-1. Due to possible interference

from Building 664, a tripod-mounted HPGe survey will be performed at a minimum of five locations on a 30-ft grid throughout IHSS 120.2, as shown on Figure 6-1. A NaI probe will also be used to survey anomalous readings from the HPGe. A minimum of three asphalt core samples will be collected at HPGe survey locations. A minimum of one depth profile sample will be collected at the exposed soil HPGe survey locations.

A minimum of eleven surficial soil samples will be collected on a 25-ft grid at the site and surveyed with the laboratory HPGe for radionuclides and sent to a laboratory for TAL metals analysis. The two surficial samples in exposed soil areas and two of the surficial soil samples collected beneath pavement will be split and sent to a laboratory for full radionuclide analysis to confirm HPGe results.

Soil gas will be used to determine the horizontal extent of potential contamination from spills or historical fiberglassing activities. A minimum of 11 soil gas samples on a 25-ft grid will be collected at IHSS 120.2, and analyzed for volatile organics in the mobile laboratory. A minimum of six soil and three ground water screening samples will be collected and analyzed in the mobile laboratory, based on soil gas results. A minimum of three temporary well points will be installed in the ground water screening locations and surveyed at IHSS 120.2 to measure local water table elevation and hydraulic gradient.

6.3.8.2 Soil Borings

A minimum of two soil borings will be drilled at IHSS 120.2, the tentative locations of which are shown in Figure 6-9. The borings will be drilled to the water table or 6 ft beneath the alluvial bedrock contact (whichever is encountered first), which occurs less than 20 ft below the surface and sampled. Using the sampling methodology described in Section 6.4 of this report, a minimum of four discrete samples will be analyzed for TCL volatiles and a

minimum of four composite samples will be analyzed for radionuclides and metals, per boring.

Installation of ground water monitoring wells will be dependent on results of the radiation survey, field screening, and soil boring program.

6.3.9 Nitric Acid Tanks (IHSS 189)

IHSS 189, Nitric Acid Tanks, consists of two 10,000-gallon nitric acid storage tanks where several small spills of nitric acid have been historically documented. The tanks are within concrete containment structures, and there is no visible evidence of degradation in the area.

A limited sampling program is proposed for this site consisting of surficial soil and ground water screening in the vicinity of the tanks. A minimum of five sampling locations outside of the containment berm are identified in Figure 6-10. A minimum of five surficial soil samples will be analyzed in the field for pH. At a minimum of three of the locations, the hydraulic probe will be used to collect ground water screening samples to determine nitrate concentration. Colorimetric test kits will be used to determine if detectable nitrate is present in local ground water. Ground water pH will also be measured in the field. Historical information indicates nitric acid stored in the tank was transferred into the tanks from vendors and the tanks were unlikely to contain waste acids containing dissolved constituents or metals.

6.3.10 Building 881 Conversion Activity Contamination (IHSS 147.2)

Building 881 was converted in 1964 from enriched uranium manufacturing activities to become a nonradioactive metals fabrication facility. Equipment from this conversion were stored in this area and include lathe and rolling mill parts. Mobile trailers, steel boxes

containing depleted uranium, and a fenced storage area cover portions of the site. The steel boxes containing depleted uranium will be removed prior to conducting any sampling at this IHSS.

A limited field program will be conducted at the Building 881 Conversion Activity Site as depicted on Figure 6-11. A tripod-mounted HPGe survey will be conducted at a minimum of nine locations on a 30-ft grid supplemented with NaI probe measurements at anomalous areas. Soil depth profile samples will be collected at a minimum of three HPGe locations and surveyed with laboratory HPGe. A minimum of nine surficial soil samples will be collected, surveyed with the laboratory HPGe, and submitted for offsite laboratory analysis of TAL metals. The need for additional sampling activities will be evaluated after the data have been reviewed.

6.4 SAMPLING EQUIPMENT AND PROCEDURES

Appropriate field sampling and decontamination procedures for the OU12 RFI/RI field investigation will be in accordance with the most recent version of the RFP Environmental Management Division Operating Procedures (EMD SOPs) (EG&G, 1991f) dated March 1, 1992. Appropriate EMD SOPs are referenced in the following sections. The EMD SOPs are supplemented by EPA procedures (EPA, 1989c) and American Society of Testing Materials (ASTM) standards (ASTM, 1991). EMD SOPs are currently in development for some of the procedures within this plan.

6.4.1 Radiation Survey Procedure

Radiation surveys will be conducted with a high purity germanium (HPGe) gamma ray detector developed for high resolution spectroscopy. The HPGe has a broad energy range, exhibits high resolution, excellent gain stability, moderate area averaging, and the ability to

identify and quantify all gamma emitting radionuclides. Radiation survey locations are IHSS specific and are discussed in Section 6.3. Vehicle-mounted HPGe detector surveys will be conducted on a 150-ft grid at OU12 IHSS 157.2, which will also provide coverage of IHSSs 116.1, 116.2, 136.1, and 136.2. One additional survey point in the 600 building area will provide coverage for IHSS 120.1 although tripod-mounted HPGe surveys will also be conducted on a 30-ft grid at IHSSs 120.1, 120.2, and 136.2, and three selected locations in IHSS 157.2. A 30-ft grid was selected for the fiberglassing area located near Building 664 to provide increased resolution for the high background sites. The HPGe detector provides radionuclide concentrations in soil in picoCuries per gram (pCi/g) of gamma-emitting radionuclides including, but not limited to, potassium-40, radium-226, thorium-232, cesium-137, americium-241, plutonium-239, -240, and -241, and uranium-233, -234, -235, and -238. While plutonium is primarily an alpha emitter, gamma and x-rays are also emitted. Plutonium emits gamma rays at very low branchings that can be detected with high sensitivity instruments, such as the HPGe detector. Tritium and strontium-90 are not detected using this method. Appendix G contains detailed technical information on the vehicle-mounted and tripod-mounted detectors. The EMD SOP for the HPGe is presently under development and will be available prior to any OU12 field work. Other equipment requirements are listed in Section 5.2 of EMD SOP FO.16

A NaI probe will be used to supplement the HPGe data at IHSSs where buildings or obstructions may limit HPGe effectiveness and to provide spatial resolution of HPGe readings. The NaI scintillation detector has advantages over other detectors that include: higher probability of interaction per centimeter, a high light yield from deposited energy, and a high atomic number. The EMD SOP for the NaI scintillation detector is currently under development and will be available prior to any OU12 field work.

To supplement the HPGe and NaI probe surveys, surficial soils, vertical depth profile samples, and concrete or asphalt samples collected via procedures in Section 6.4.2, 6.4.3, and 6.4.4, respectively will be surveyed with a laboratory HPGe detector to obtain radionuclide concentrations. A SOP for laboratory HPGe field screening is currently in development and will be submitted prior to any OU12 field work.

6.4.2 Surficial Soil Sampling Procedure

Surficial soil samples for radionuclide and nonradionuclide analysis will be collected both from paved and exposed soil areas in OU12 IHSSs. Separate surficial soil sampling procedures are required for:

- radionuclide and nonradionuclide composite sampling at exposed soil sites; and
- radionuclide and nonradionuclide grab sampling at covered sites.

The jig and scoop described in SOP GT.08 will be used to collect surficial soil composite samples for radionuclide and nonradionuclide analysis at exposed soil locations. Surficial soil samples collected from exposed soil sites will be composites of subsamples collected with the jig and scoop from the four corners and center of a one meter square area. SOP GT.8 is currently under revision to include a description of this sampling procedure. It will be submitted prior to conducting OU12 field work.

At asphalt or concrete-covered sites, surficial soil grab samples will be collected both for radionuclide and nonradionuclide analysis. Grab samples underlying pavement will be collected in accordance with "grab method" procedures in SOP GT.08. Pavement or concrete will be cut and samples collected from soil substrate underlying base materials immediately beneath pavement.

Surficial soil samples for radionuclide analysis will be analyzed onsite with the laboratory HPGe detector. A subset of surface samples that represent a range of radionuclide concentrations will initially be surveyed with the laboratory HPGe detector, then sent to an offsite laboratory for radionuclide analysis and HPGe verification. Nonradiological surficial soil samples will be submitted to an analytical laboratory for TAL metal analysis.

6.4.3 Vertical Depth Profile Procedures

Vertical soil depth profile samples will be collected at exposed soil HPGe survey locations to correlate HPGe and NaI probe results with depth distribution. Tentative locations are shown on Figure 6-1, although the vertical profile sample locations will be determined after evaluation of the HPGe/NaI probe surveys. They will typically be collected with a plug type sampler at 0 to 2, 2 to 4, and 4 to 6 inch depth intervals. A SOP for this procedure will be developed and submitted prior to conducting OU12 field work.

6.4.4 Concrete or Asphalt Sampling

Concrete or asphalt samples will be collected at areas of anomalous activity identified by the HPGe and NaI probe surveys for radionuclide analysis with the laboratory HPGe. Tentative locations are shown on Figure 6-1. The location of concrete or asphalt samples will be determined after evaluation of the HPGe/NaI probe surveys. Samples will be collected with the aid of asphalt or concrete cutters or saws. Procedures for obtaining and analyzing such samples for radionuclides will be submitted in an SOP prior to conducting OU12 field work.

6.4.5 Sediment Sampling

Sediment samples will be collected from tentative locations identified in Section 6.3. If sediments are saturated, a core sampler with a core liner will be used to collect the top

two inches of bed materials for analysis of volatile organics. Samples for nonvolatile analysis will be collected with a stainless scoop. Sampling procedures will follow those outlined in EMD SOP SW.6. Sediment materials will be described according to EMD SOP GT.1.

6.4.6 Chemical Screening Procedures

Real time soil gas sampling will be conducted at specific OU12 IHSSs presented in Section 6.3 according to procedures in EMD SOP GT.9. Soil gas samples will be collected through a 1-inch diameter stainless steel probe rod driven with a hydraulic rig mounted on an all terrain vehicle (ATV). If possible, depending on subsurface conditions, the rig will hammer through overlying concrete or asphalt and drive probe rods through subsurface materials. Soil gas samples will be collected at an approximate depth of 5 ft through tubing placed through the center of the rod. Samples collected through the tube will be immediately injected into the mobile laboratory for volatile organic compound analysis. Additional information on collecting soil gas samples with the ATV-mounted rig are in Appendix H. Alternative soil gas techniques, such as passive collection methods, may be utilized if site conditions warrant.

Soil screening samples are also collected using the hydraulic probing rig. A Kansas Soil Sampler is attached to the end of the rod, and an extension rod inserted to release a piston within the sampler. The sampler is driven 1 ft and a soil core removed. The soil sampler will be used to collect discrete screening samples for volatile organic compound analysis in the mobile laboratory. Additional information on collecting soil samples for screening is in Appendix H. A SOP will be developed to support collection of soil screening samples using the hydraulic probing rig.

Ground water screening samples can be collected and analyzed using the hydraulic probing rig if favorable geologic conditions are encountered. The 1-inch diameter probe rod is advanced to within 1 ft of ground water. A well point sampler is attached to the probe and lowered to the bottom of the borehole. It is driven into ground water and a sample is collected through sampler perforations. Teflon tubing is inserted through the rod and ground water is pumped to sample containers and analyzed for volatile organics in the mobile laboratory. Hexavalent chromium and nitrate can also be analyzed using field colorimetric methods, and sulfate by turbidimetric methods, in IHSSs where this analysis is appropriate based on site history. Additional information on ground water screening sample collection is provided in Appendix H. A SOP will be developed to support collection of ground water screening samples using the hydraulic probing rig.

Temporary well points will be advanced to ground water within IHSSs 157.2, 120.1 and 120.2 to obtain water level information and to determine the ground water flow direction. A pneumatic water level indicator lowered through the probe rod will be used to measure water levels and identify ground water flow direction. This procedure will be documented in the proposed ground water screening SOP prior to implementation.

6.4.7 Borehole Drilling and Soil Sampling Procedures

Borings will be drilled to determine the geotechnical characteristics of the soil, to further investigate trends identified in screening tasks, to collect samples for physical and chemical analysis, and to install monitoring wells. Before any boreholes are drilled, utilities will be located and the drill site will be cleared in accordance with EMD SOP GT.10.

Borings drilled for the purpose of documenting soil contamination will be drilled to the water table or 6 ft below the alluvial bedrock contact, whichever is encountered first.

Drilling the 6-ft bedrock internal will allow a complete sample representative of bedrock conditions to be collected and analyzed.

Hollow-stem auger drilling will be conducted in accordance with EMD SOP GT.2, except where material is impenetrable with this method. If augering is ineffective, rotary drilling will be used in accordance with EMD SOP GT.4. Rotary drilling will only be used in situations where material is impenetrable, with hollow-stem augering the method of choice.

All drill cuttings and soil samples will be surveyed for radionuclides and organic vapors in accordance with EMD SOP FO.15, Use of Photoionizing and Flame Ionizing Detectors, and EMD SOP FO.6, Field Radiological Measurements. Investigation-derived wastes, such as drill cuttings and residual samples, will be handled according to guidelines in EMD SOP FO.8 and FO.9.

All equipment must be decontaminated before and after drilling and sampling takes place in accordance with the procedures outlined in the EMD SOP FO.3 and FO.4. Decontamination water will be handled according to guidelines in EMD SOP FO.7.

All of the borings not completed as monitoring wells will be grouted and abandoned immediately after drilling in accordance with procedures outlined in EMD SOP GT.5. Procedures specified in this EMD SOP are designed to prevent vertical migration of contaminants after abandonment.

Equipment requirements are listed in EMD SOP GT.2, Section 5.1; and other applicable EMD SOP are listed in Section 4.2 of this work plan.

Soil and bedrock samples will be collected during drilling for visual logging in accordance with EMD SOP GT.1 and for chemical and physical analysis in accordance with EMD SOPs GT.2 and FO.13. The soil and bedrock samples will be collected using a hollow-stem auger with a continuous-core sampler. Continuous core will be collected for geologic descriptions for the entire borehole depth. From this core, discrete, 2-ft samples will be submitted for laboratory volatile organic analyses (VOA) beginning at a depth of 2 ft from the ground surface, as shown in Figures 6-12 and 6-13, continuing to the water table or to bedrock, whichever is encountered first. In addition, a discrete VOA sample will be submitted to the laboratory if staining, discoloration, odor or other anomaly is observed during drilling. VOA soil samples should be collected in core liners that are capped and sealed upon recovery. In addition to the VOA samples, linear depth composite samples from the core will be submitted to the laboratory for analysis of the remaining chemical parameters from every consecutive 6-ft interval to the water table.

Soil samples for geotechnical analysis require a minimum amount of disturbance and will be collected in thin-walled metal tubes. The thin-walled metal tube will be driven into the undisturbed soils in advance of the hollow-stem auger, removed, and the tube sealed for transport to the laboratory. Any changes to these geotechnical sampling procedures will be the subject of a Document Change Notice (DCN).

6.4.8 Tensiometer Installation and Monitoring Procedures

Standard nested tensiometers equipped with pressure transducers, or equivalent moisture monitoring equipment, may be installed to measure matric potential of water in the unsaturated zone. The tensiometers will likely consist of a porous ceramic cup attached to a rigid plastic tube. The internal volume of the system will be completely filled with water. The pores in the cup form a continuum with the pores in the soil. Water will move either

into or out of the tensiometer system, until equilibrium is attained across the ceramic cup. Multiple tensiometers allow for the determination of the direction, and in some cases the quantity, of water flux from the ground surface to the water table.

Nested tensiometer arrays will be installed at select OU12 IHSSs as described in Section 6.3. Each array will consist of multiple tensiometers buried at 2-ft intervals from 1 ft above the water table to within 2 ft of the ground surface. The tensiometers will be installed using the hydraulic probe to minimize the soil disturbance. The probe holes will be backfilled with uncontaminated naturally occurring soils to a compaction slightly greater than the bulk density of the undisturbed soils to reduce surface water infiltration, which results in abnormally low tensions in the backfill and the undisturbed soil.

Water used in the tensiometers must be de-aerated and onsite purging may be necessary to prevent the formation of bubbles which can prevent accurate data collection. Purging time will be kept short to minimize wetting of soil adjacent to the porous tensiometer cup. When purging is complete, the system is closed and the soil draws water through the porous cup until equilibrium is established and the pressure is recorded by the pressure transducer and data logger.

The tensiometers will be monitored for as long as the project schedule allows. The EMD SOP for the installation and monitoring of tensiometers is presently under development and will be submitted for approval by EPA and CDH.

6.4.9 Installing and Sampling of Ground Water Monitoring Wells

All monitoring wells will be constructed with materials specified in EMD SOP GW.6. A hollow-stem auger with an inner diameter a minimum of 4 inches larger than the well casing

outer diameter will be used to drill the monitoring wells to produce a minimum annular space of 2 inches. Well construction techniques will follow procedures outlined in EMD SOP GT.6. Investigation-derived wastes such as cuttings and residual samples will be handled in accordance with guidelines outlines in EMD SOP FO.8.

Well construction techniques for all monitoring wells will follow procedures contained in EMD SOP GT.6. Monitoring wells in high-traffic paved areas will be completed flush with the pavement. Wells in areas not exposed to vehicular traffic will be protected by the placement of steel posts around the monitoring wells, as described in EMD SOP GT.6. Pressure grouting procedures will follow guidelines outlined in EMD SOP GT.3. Additional equipment and materials that may be needed for monitoring well installation are listed in EMD SOP GT.6, Section 5.1; other related EMD SOP are cross-referenced in Section 4.2 of EMD SOP GT.6

The wells will be developed no sooner than 48 hours and no longer than two weeks after completion and will not be sampled until at least two weeks after development. Water levels will be measured in all wells and recorded as outlined in EMD SOP GW.1 and the appropriately cross-referenced EMD SOP listed in Section 4.2 of the EMD SOP GW.1. After the water levels reach static conditions, the wells will be developed utilizing low-energy methods, such as an inertial pump or bottom discharging bailer. Well development will follow procedures outlined in EMD SOP GW.2.

Purging procedures will follow those contained in EMD SOP GW.6 and include purging of three to five casing volumes of water or other appropriate criteria. Field parameters (pH, specific conductance, temperature) will be measured after every half casing volume is removed as described in EMD SOP GW.6.

Ground water samples will be collected in a manner that will minimize the amount of agitation or limit the exposure of the sample to the atmosphere. Ground water sampling will be by bailing or the use of a bladder or peristaltic pump. Samples will be collected, handled, and screened in accordance with EMD SOP GW.6 and all related EMD SOP.

All development and purge water will be handled in accordance with guidelines outlined in EMD SOP FO.8. Equipment needed for ground water sampling is listed in EMD SOP GW.6.

Hydraulic testing will be conducted on all ground water wells installed in OU12. Hydraulic testing of ground water wells will include slug tests or injection tests in accordance with SOP GW.4 and GW.5, respectively.

Field parameters will be measured when each ground water sample is collected. Specific conductance, pH, temperature, dissolved oxygen, redox potential, total alkalinity, and turbidity will be measured when ground water samples are collected in accordance with EMD SOP GW.6. Water level measurements will be conducted in accordance with EMD SOP GW.1 and the appropriately cross-referenced EMD SOP listed in Section 4.2 of this EMD SOP GW.1

6.4.10 Surveying of Sample Locations

The locations of all radiation survey points, soil gas survey points, borings, monitor wells, and surface sampling points will be measured with a steel tape prior to sampling or drilling. After sampling, drilling, or well installation, locations will be surveyed using standard land surveying techniques described in the EMD SOP GT.17. Horizontal accuracy will be ± 0.5 ft for surficial soil samples, soil gas survey points, and borings and ± 0.1 ft for

temporary well point locations and wells. Vertical accuracy will be ± 0.1 ft for borings and well point locations, and ± 0.01 ft for wells. Three elevations will be determined for each well: ground surface, top of well casing, and top of surface casing.

6.5 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected during the RFI/RI investigation. It also includes discussions of sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation.

6.5.1 Sample Designation

All sample designations generated for the RFI/RI will conform to the input requirements of the Rocky Flats Environmental Data System (RFEDS). Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sample (e.g., "SB" for soil borings, "SS" for surface soils), a unique five-digit number, and a two-letter suffix identifying the contractor. One sample number will be required for each sample generated, including QC samples. A similar sample designation system will be used for samples collected during the field screening task including soil gas results, soil and ground water screening results, and radiological surveys. Boring numbers will be developed independently of the sample number for a given boring and are assigned by EG&G with appropriate cross-references. These sample numbering procedures are consistent with the RFP QAPjP. If input requirements for the RFEDS system have changed from the above listed, the most current system will be used.

6.5.2 Analytical Requirements

The analytical suites for each OU12 IHSS were developed according to the type of waste suspected to be present at each site. Table 6.2 lists the specific analytes in the above groups and their CLP detection/quantitation limits. Generally, samples from the RFI/RI will be analyzed for some or all of the following radionuclide and chemical parameters:

- Uranium-233/234, 235, 236, and 238;
- Cesium-137;
- Strontium-90;
- Tritium;
- Transuranic elements (plutonium and americium);
- Gross alpha and gross beta;
- TCL volatiles; and
- TAL metals.

Additional parameters, such as pH, will be requested for analysis of soil and sediment samples based on site-specific information. Other parameters may include total and hexavalent chromium analysis, and PCB analysis, if appropriate.

Ground water samples collected from wells installed in the OU12 RFI/RI will be analyzed for the parameters listed above as well as major cations, major anions, total dissolved solids, and pH. Other field parameters, including pH, conductivity, temperature, dissolved oxygen, oxidation-reduction potential, sulfate, nitrate, and turbidity will be measured in accordance with EMD SOP GW.5, Field Measurement of Ground Water Field Parameters. Additional parameters such as hexavalent chromium will be requested on a site-specific basis.

The analytes and detection limits detailed in Table 6.2 address the bulk of detection of potential soil, sediment, and ground water contamination. Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present. Metals are suspected at many of the IHSSs in OU12; therefore, all of the TAL analytes have been selected for RFI/RI analysis. Both filtered and unfiltered samples of ground water will be collected and analyzed at each location.

The following uranium isotopes have been selected for analysis: uranium-233/234, uranium-235, uranium-236, and uranium-238. Plutonium is the only transuranic element that is used on the site. However, americium is a daughter product of plutonium and has been detected in soil at OU12. Therefore, both plutonium and americium have been selected as radionuclide parameters. The uranium isotopes, plutonium, and americium can all be detected with the HPGe detector. Tritium, cesium-137, and strontium-90 will also be analyzed in samples submitted to radiochemistry laboratory for analysis. The HPGe detector will not provide results for tritium and strontium-90. Gross alpha and gross beta are included as general radiological parameters because they are useful indicators of radionuclides. Gross alpha and gross beta will be requested on all soil, sediment, and ground water samples sent to an offsite laboratory for analysis.

Volatile organics have been historically stored and spilled at many of the OU12 IHSSs. Therefore, all of the TCL volatile organics will be included. Semivolatile organics have not been reported in historical descriptions of IHSS activities, and will not be analyzed.

A list of analytical parameters and proposed detection limits for the soil gas surveys at OU12 are in Table 6.4. The mobile laboratory GC is capable of detecting other volatile organics as presented in Appendix H.

6.5.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and the analyses to be performed. The matrices to be analyzed include soils and sediments, and the water matrices for analysis include ground water. Table 6.3 lists the analytical parameters of interest in OU12 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times. Additional specific guidance on the appropriate use of containers and preservatives is provided in EMD SOP FO.13 (Containerizing, Preserving, Handling, and Shipping of Soil and Waste Samples).

6.5.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in EMD SOP FO.13.

6.6 DATA MANAGEMENT AND REPORTING

Field data will be input to the RFEDS using a DATACAP remote data entry module supplied by EG&G. Data will be entered on a daily basis, and a 3.5-inch computer diskette will be delivered to EG&G on a weekly basis. EG&G updates RFEDS on a weekly basis. Data from the system will be available to the contractor immediately after the weekly update. A hard copy report will be generated from the module for contractor use. The data will undergo a prescribed QC process based on EMD SOP FO.14.

The contractor will maintain a data base for field data that is collected during screening tasks. The contractor will provide 3.5-inch diskettes and hard copies to EG&G for their use.

A sample tracking spreadsheet will be maintained by the contractor for use in tracking sample collection and shipment. EG&G will supply the spreadsheet format and will stipulate timely reporting of information. These data will also be delivered to EG&G on 3.5-inch computer diskettes. Computer hardware and software requirements for contractors using government-supplied equipment will be supplied by EG&G. Computer and data security measures will also follow acceptable procedures outlined by EG&G. The RFEDS system is evolving. Data management will follow the procedures in effect at the time this field work is implemented.

Forms provided in the various SOP referenced in Sections 6.3, 6.4, and 6.5 will also be utilized as appropriate to document and manage the data obtained during the OU12 RFI/RI. Copies of appropriate RFEDS forms are presented in Appendix I.

6.7 FIELD QC PROCEDURES

Field QC procedures for media screening tasks, soil sampling, and ground water sampling are discussed in this section. Field procedures for soil and ground water sampling are established from previous investigations at RFP. QC procedures for media screening including equipment calibration, media sample collection procedures and equipment, and decontamination procedures are presented in Appendix H.

Sample duplicates, field preservation blanks, and equipment rinseate blanks will be prepared. The analytical results obtained for these samples will be used by the RPD project manager to assess the quality of the field sampling effort. The types of field QC samples

to be collected and their application are discussed below. The frequency with which QC samples will be collected and analyzed is provided in Table 6.5.

Duplicate samples will be collected by the sampling team for use as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures and equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field blanks of analyte-free (ASTM Type II) water will be prepared by the sampling team and will be used to provide an indication of any contamination introduced during field sample preparation.

Equipment (rinseate) blanks will be collected from final decontamination rinseate to evaluate the success of the field sampling team's decontamination efforts on non-dedicated sampling equipment. Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection. The rinseate is collected and placed in the appropriate sample containers.

Procedures for monitoring field QC are provided in the sitewide QAPjP.

6.8 AIR MONITORING AND SAMPLING PROCEDURES

Air monitoring will be performed during field activities to ensure that quality data are obtained during sampling and that all sampling activities comply with the Interim Plan for Prevention of Contaminant Dispersion (IPPCD) (EG&G, 1991g) and in accordance with

EMD SOP FO.1. It is expected that the Final PPCD will be completed by the time the OU12 RFI/RI is implemented. If so, compliance with the Final PPCD will be maintained.

Air quality monitoring requirements for activities such as borehole drilling where there is a significant potential for producing appreciable quantities of suspended particulates include the following:

- Site perimeter and community Radiological Ambient Air Monitoring Program (RAAMP) monitoring;
- Local real-time monitoring of Respirable Suspended Particulates (RSP) at individual activity work sites shall be conducted using a TSI Piezobalance Model 3500 Respirable Aerosol Mass Monitor. Local RSP measurements will be used to guide the project manager's evaluation of the potential hazards associated with activity-related emissions. The threshold RSP concentration for curtailing intrusive activities will be designated in the site-specific Health and Safety Plan; and
- Additional worker health and safety monitoring as required by the Site-Specific Health and Safety Plan.

As mentioned in Sections 6.0 and 8.0, one goal of the RFI/RI is to support quantitative evaluation of human health risk due to inhalation of contaminants derived from OU12 surface soils. Inhalation exposure often is evaluated by direct measurement of suspended particulate concentration assuming a conservative suspended particulate concentration in ambient air. Any surface soil contamination as a result of OU12 releases is expected to occur as individual sites of limited area scattered throughout the RFP 400, 600, 800 areas. As a result, suspended particulate data from air samples collected in the vicinity of OU12 sites probably would be representative of the 400, 600, 800 areas.

Total suspended particulate and respirable particulate data are collected at a monitoring station located near the RFP east gate. Suspended particulate data also have been collected in the vicinity of the 903 Pad east of the 400, 600, and 800 areas, and may be collected for other RFP OU prior to or during the OU12 RFI/RI. If areas of surface soil contamination are identified at OU12 during field activities, suspended particulate data from these sources will be evaluated for applicability to OU12 inhalation exposure evaluation. If appropriate, these data will be used to provide a conservative estimate of total suspended particulates and respirable particulates in the vicinity of OU12. However, if it is determined that these data may not be representative of OU12 conditions, an OU12-specific air sampling program will be designed to provide the necessary data. This air sampling program could be addressed in a TM.

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
116.1	Submit ARMS Survey	NA	Submit ARMS Survey	NA	In Agreement
	G-M Survey • Radiological Survey	11	Radiation Survey • Field HPGe Survey Locations • NaI Probe • Surficial Soil • Depth Profiles[a] • Asphalt[b]	--* 18 8 2 3	Improved Technology Improved Coverage Improved Coverage Improved Coverage Improved Coverage
	2-inch Surface Scrapes[a]	5	Surficial Soil Samples (TAL Metals)	8	Improved Coverage
	Soil Gas Survey	11	Chemical Screening • Soil Gas • Soil Screening[c] • Ground Water Screening[c]	8 4 2	Optimized Placement and Coverage Analytical Real Time Data Analytical Real Time Data
			Sediment	3	Improved Coverage
	Soil Borings	5	Soil Borings	2	Optimized Placement and Coverage
			Soil Samples • Volatiles • Metals, PCBs, radionuclides	8 8	Optimized Placement and Coverage
	Well Completion	2	Well Completion	1	Optimized Placement and Coverage

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
116.2	Submit ARMS Survey	NA	Submit ARMS Survey	NA	In Agreement
	G-M Survey • Radiological Survey	11	Radiation Survey • Field HPGe Survey Locations • NaI Probe • Surficial Soil • Asphalt[b]	 --* 7 4 3	 Improved Technology Improved Coverage Improved Coverage Improved Coverage
	2-inch Surface Scrapes[a]	4	Surficial Soil Samples (TAL Metals)	4	In Agreement
	Soil Gas Survey	11	Chemical Screening • Soil Gas • Soil Screening[c] • Ground Water Screening[c]	 4 4 2	 Optimized Placement and Coverage Analytical Real Time Data Analytical Real Time Data
			Sediment	3	Improved Coverage
	Soil Borings	4	Soil Borings Soil Samples • Volatiles • Metals, radionuclides	2 8 8	Optimized Placement and Coverage Optimized Placement and Coverage
	Well Completion	1	Well Completion	1	Optimized Placement and Coverage

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
136.1	Submit ARMS Survey	NA	Submit ARMS Survey	NA	In Agreement
	G-M Survey • Radiological Survey	58	Radiation Survey • Field HPGe Survey Locations • Surficial Soil • Asphalt[b]	--* 4 --*	Improved Technology Improved Coverage Improved Coverage
	2-inch Surface Scrapes[a]	3	Surficial Soil Samples (TAL Metals)	4	Improved Coverage
			Chemical Screening • Soil Screening[d] • Ground Water Screening[d]	4 2	Improved Coverage Analytical Real Time Data and Colorimetric Results
			Sediment	1	Improved Coverage
	Soil Borings	3	Soil Borings	2	Optimized Placement and Coverage
			Soil Samples • Volatiles • Metals, radionuclides	 8 8	Optimizted Placement and Coverage

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
136.2	Submit ARMS Survey	NA	Submit ARMS Survey	NA	In Agreement
	G-M Survey • Radiological Survey	59	Radiation Survey • Field HPGe Survey Locations • NaI Probe • Surficial Soil[b] • Depth Profiles[a]	 6 24 11 3	 Improved Technology Improved Coverage Improved Coverage Improved Coverage
	2-inch Surface Scrapes[a]	3	Surficial Soil Samples (TAL Metals)	11	Covered with HPGe
			Chemical Screening • Soil Screening[d] • Ground Water Screening[d]	 6 3	 Improved Coverage Analytical Real Time Data and Colorimetric Results
			Sediment	4	Improved Coverage
	Soil Borings	3	Soil Borings Soil Samples • Volatiles • Metals, radionuclides	2 8 8	Optimized Placement Optimized Placement
			Nested Tensiometer	1	Increased Coverage

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
157.2	Submit Radiological Survey Results 1973-1983	NA	Submit Radiological Survey	NA	In Agreement
	G-M Survey • Radiological Survey	480	Radiation Survey • Field HPGe Survey Locations • NaI Probe • Surficial Soil[b] • Depth Profile[b] • Asphalt[b]	 24 --[c] 46 12 12	 Improved Technology Improved Coverage Improved Coverage Improved Coverage Improved Coverage
	2-inch Surface Scrapes[a]	10	Surficial Soil Samples (TAL Metals)	46	Covered with HPGe
			Chemical Screening • Soil Gas Survey • Soil Screening[d] • Ground Water Screening[d]	 81 40 20	 Improved Coverage Analytical Real Time Data Analytical Real Time Data
			Sediment	3	Increased Coverage
	Soil Borings	10	Soil Borings Soil Samples • Volatiles • Metals, radionuclides	8 32 32	Optimized Placement Optimized Placement
			Well Points	10	Increased Coverage

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
187	Submit Documentation Describing Nature of Sulfuric Acid Spill	NA	Submit Documentation	NA	In Agreement
			Surficial Soils (pH)	5	Increased Coverage
			Ground Water Screening (Sulfates, pH)	3	Increased Coverage
120.1	Submit ARMS Survey	NA	Submit ARMS Survey	NA	In Agreement
	G-M Survey • Radiological Survey	32	Radiation Survey • Field HPGe Survey Locations • NaI Probe • Surficial Soil[b] • Depth Profile[b]	 9 --[a] 9 3	 Improved Technology Improved Coverage Improved Coverage Improved Coverage
	2-inch Surface Scrapes[a]	36	Surficial Soil Samples (TAL Metals)	9	Optimized Placement
	Soil Gas Survey	32	Chemical Screening • Soil Gas Survey • Soil Screening[c] • Ground Water Screening[c]	 9 5 3	 Coverage Enhanced with Real Time Analytical Data

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
	Soil Borings		Soil Borings	2	Increased Coverage
			Soil Samples • Volatiles • Metals, radionuclides	 8 8	Increased Coverage
			Well Points	3	Increased Coverage
			Nested Tensiometers	1	Increased Coverage
120.2	Submit ARMS Survey	NA	Submit ARMS Survey	NA	In Agreement
	G-M FIDLER • Radiological Survey	31	Radiation Survey • Field HPGe Survey Locations • NaI Probe • Surficial Soil • Depth Profile[a] • Asphalt[b]	 5 -- 11 1 3	 Improved Technology Improved Coverage Improved Coverage Improved Coverage Improved Coverage
	2-inch Surface Scrapes[a]	35	Surficial Soil Samples (TAL Metals)	11	Optimized Placement
	Soil Gas Survey	31	Chemical Screening • Soil Gas Survey • Soil Screening[c] • Ground Water Screening[c]	 11 6 3	 Coverage Enhanced with Real Time Analytical Data

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
	Soil Borings		Soil Borings	2	Improved Coverage
			Soil Samples • Volatiles • Metals, radionuclides	 8 8	Improved Coverage
			Well Points	3	Improved Coverage
189	Submit Documentation Describing Nature of Nitric Acid Spills	NA	Submit Documentation	NA	In Agreement
			Chemical Screening • Surficial Soils (pH) • Ground Water Screening (nitrate, pH)	 5 3	 Increased Coverage Increased Coverage
147.2	Submit Documentation Describing What Conversion Activity Occurred in Building 881	NA	Submit Documentation	NA	In Agreement

TABLE 6.1
OU12 IAG REQUIREMENTS/PROPOSED FSP COMPARISON

	IAG		FSP		
IHSS Number	Activity	No. of Samples	Activity	No. of Samples	Rationale
			Radiation Survey • Field HPGe Survey Locations • NaI Probe • Surficial Soil • Depth Profile	 9 --[e] 9 3	 Increased Coverage Increased Coverage Increased Coverage Increased Coverage
			Surficial Soils (TAL Metals)	9	Increased Coverage

Table 6.1 Footnotes:

* Included in IHSS 157.2 Radiation Survey.

[a] Collection of vertical profiles will be correlated with HPGe results. Numbers and locations of profiles indicated may be revised.

[b] Collection of asphalt or concrete samples will be correlated with HPGe results. Numbers and locattions of samples indicated may be revised.

[c] Soil and ground water screening samples will be collected based on soil gas results and analyzed for VOCs in mobile laboratory. Minimum number of samples is indicated.

[d] Soil screening samples will be collected for recording evidence of staining or distrubed soil horizons. Ground water screening samples will be evaluated with colorimetric methods for chromium.

[e] NaI Probe locations at anomalous areas identified by HPGe survey.

TABLE 6.2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU12

Analytical Parameter	Water Limits	Soil Limits
Target Analyte List Metals†	(µg/l)	(mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Cesium*	1000	200
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron, Total	100	20
Lead	5	1.0
Lithium*	100	20
Magnesium	5000	2000
Manganese, Total	15	3.0
Mercury	0.2	0.2
Molybdenum*	200	40
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Strontium*	200	40
Thallium	10	2.0
Tin*	200	40
Vanadium	50	10.0
Zinc	20	4.0
Target Compound List Volatiles‡	(µg/l)	(mg/kg)
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10

TABLE 6.2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU12

Analytical Parameter	Water Limits	Soil Limits
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (Total)	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
trans-1,3-Dichloropropene	5	5
Bromoform	5	5
4-Methyl-2-pentanone	5	10
2-Hexanone	10	10
Tetrachloroethene	10	5
Toluene	5	5
1,1,2,2,-Tetrachloroethane	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Total Xylenes		5
Polychlorinated Biphenyls	(µg/l)	(mg/kg)
Aroclor-1016	0.5**	80
Aroclor-1221	0.5**	80
Aroclor-1232	0.5**	80
Aroclor-1242	0.5**	80

TABLE 6.2

ANALYTICAL PARAMETERS AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU12

Analytical Parameter	Water Limits	Soil Limits
Aroclor-1248	0.5**	80
Aroclor-1254	1.0	160
Aroclor-1260	1.0	160
Radionuclides†	(pCi/l)	(dry)(pCi/g)
Gross Alpha	2	4
Gross Beta	4	10
Uranium 233/234, 235, and 238 (each isotype)	0.6	0.3
Americium 241	0.01	0.02
Plutonium 239/240	0.01	0.03
Tritium	400	400 (pCi/ml)
Cesium 137	1	0.5
Strontium 89/90	1	1
Anions†	(mg/l)	
Nitrate/Nitrite	5	TBD
Sulfate	5	TBD
Chloride	5	TBD
Fluoride	0.1	TBD
pH	0.1 pH unit	TBD
Specific Conductance	TBD	TBD
Total Organic Carbon†	1 μg/l	1 mg/kg

† Limits refer to detection limits
‡ Limits refer to quantitation limits
* Non-CLP TAL Metals detection limit
TBD To be determined
** Laboratory Practical Quantitation Limits (PQLs) exceed potential ARARs.

Note: Detection and quantitation limits are highly matrix dependent. The limits listed here are the minimum achievable under ideal conditions. Actual limits may be higher.

Detection/quantitation limits for residue samples are not specified by the GRRASP. The unknown nature of this matrix prevents establishment of specific limits. Detection/quantitation limits will be the minimum obtainable for a given matrix.

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~~MAY 27 1994~~

TABLE 6.3

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL AND WATER SAMPLES

SOIL SAMPLES:

Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 250 mℓ wide-mouth glass jar	Cool, 4°C	180 days[1]
TCL Volatiles	2 x 125 mℓ wide-mouth Teflon-lined jar	Cool, 4°C	7 days
PCBs	1 x 9 oz. wide-mouth Teflon-lined glass vials	Cool, 4°C	7 days until extraction, 40 days after extraction
Radionuclides	1 x 1 ℓ wide-mouth glass jar	None	180 days
TOC, Anions, pH, and specific conductance	1 x 250 mℓ wide-mouth glass jar	Cool, 4°C	28 days

[1]Holding time for mercury is 28 days.

WATER SAMPLES:

Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 1 ℓ polyethylene bottle	Nitric acid pH <2; Cool, 4°C	180 days[1]
TCL Volatiles	2 x 40 mℓ VOA vials with teflon-lined septum lids	Cool, 4°C	7 days
PCBs	1 x 4 ℓ amber glass bottle	Cool, 4°C	7 days until extraction, 40 days after extraction
Radionuclides	12 ℓ polyethylene bottle(s)	Nitric acid pH <2; Cool, 4°C	180 days
TOC	1 x 250 mℓ polytehylene bottle	Sulfuric acid pH <2; Cool, 4°C	28 days
Anions	1 x 1 ℓ polyethylene bottle	Cool, 4°C	28 days
Nitrate/Nitrite	1 x 250 mℓ polyethylene bottle	Sulfuric acid pH <2; Cool, 4°C	28 days
pH, temperature, and specific conductance	In-situ, beaker or bucket	None	Analyze immediately

[1]Holding time for mercury is 28 days.

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TABLE 6.4

SOIL GAS PARAMETERS AND PROPOSED DETECTION LIMITS

Sample Type	Detection Limit (μg/l)
Acetone	1
Benzene	1
Carbon tetrachloride	1
Ethylbenzene	1
Hydrogen sulfide	1
Methylene chloride	1
Methane	1
PCE	1
Styrene	1
TCE	1
Toluene	1
Xylenes (total)	1
1,1,1-TCA	1
1,2-DCE	1
2-Butanone (Methylethyl Ketone)	1

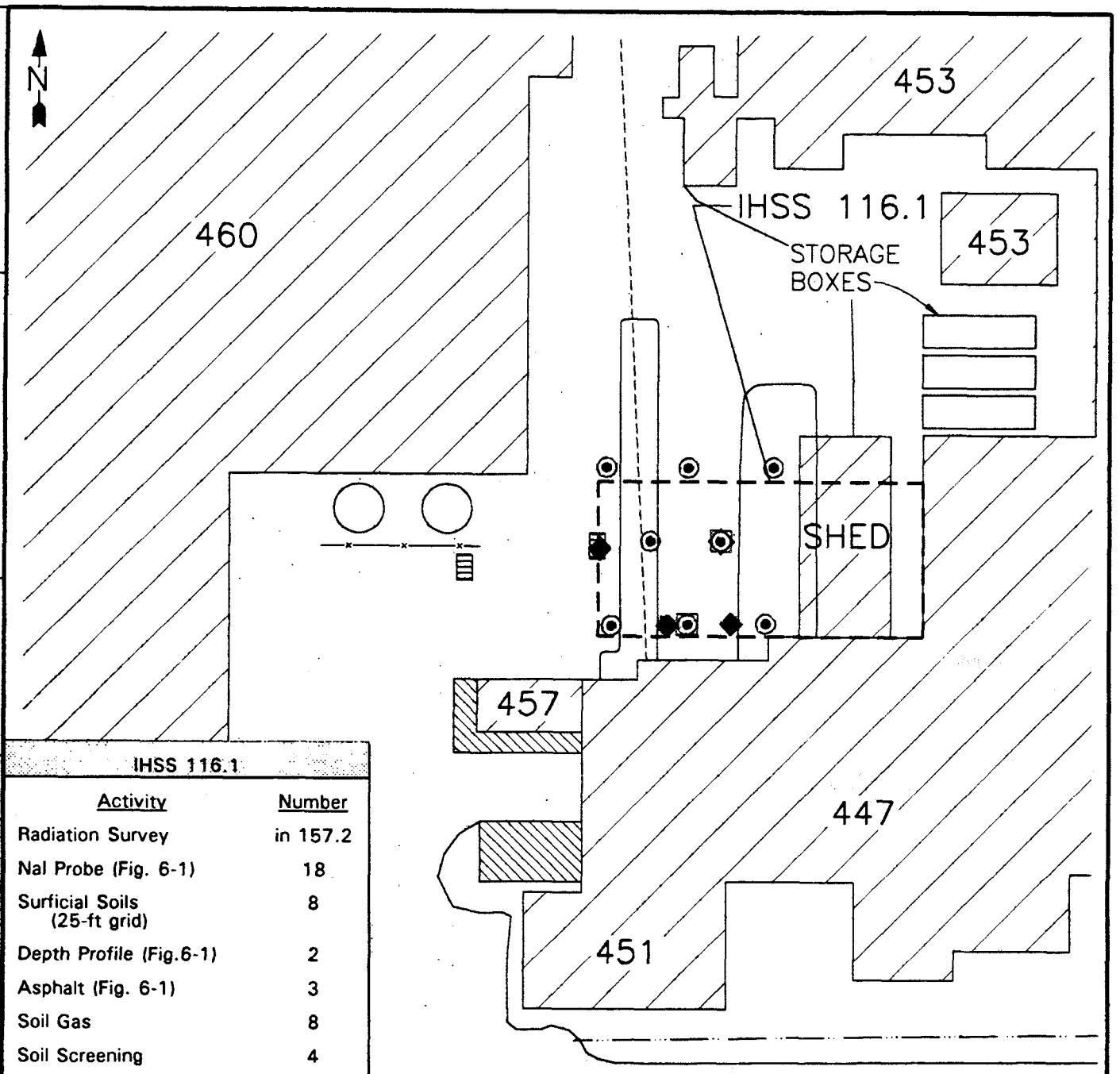
Note: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary.

TABLE 6.5

FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Sample Frequency	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Equipment Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20

1/10 = one QC sample per ten samples collected



IHSS 116.1	
Activity	Number
Radiation Survey	in 157.2
NaI Probe (Fig. 6-1)	18
Surficial Soils (25-ft grid)	8
Depth Profile (Fig.6-1)	2
Asphalt (Fig. 6-1)	3
Soil Gas	8
Soil Screening	4
Ground Water Screening	2
Sediment	3
Soil Borings	2
Monitor Well	1

EXPLANATION

- BUILDING
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- IHSS BOUNDARY
- OVERHEAD PIPING
- FENCE
- DRAIN
- DRAINAGE
- SURFICIAL SOIL SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION
- SOIL GAS SURVEY LOCATION
- SOIL BORING LOCATION (TENTATIVE)
- MONITORING WELL LOCATION (TENTATIVE)

25 0 25 50 FEET

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

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FIGURE 6-2
FIELD SAMPLING PLAN FOR IHSS 116.1 - WEST LOADING DOCK BUILDING 447

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DATE 9/30/92
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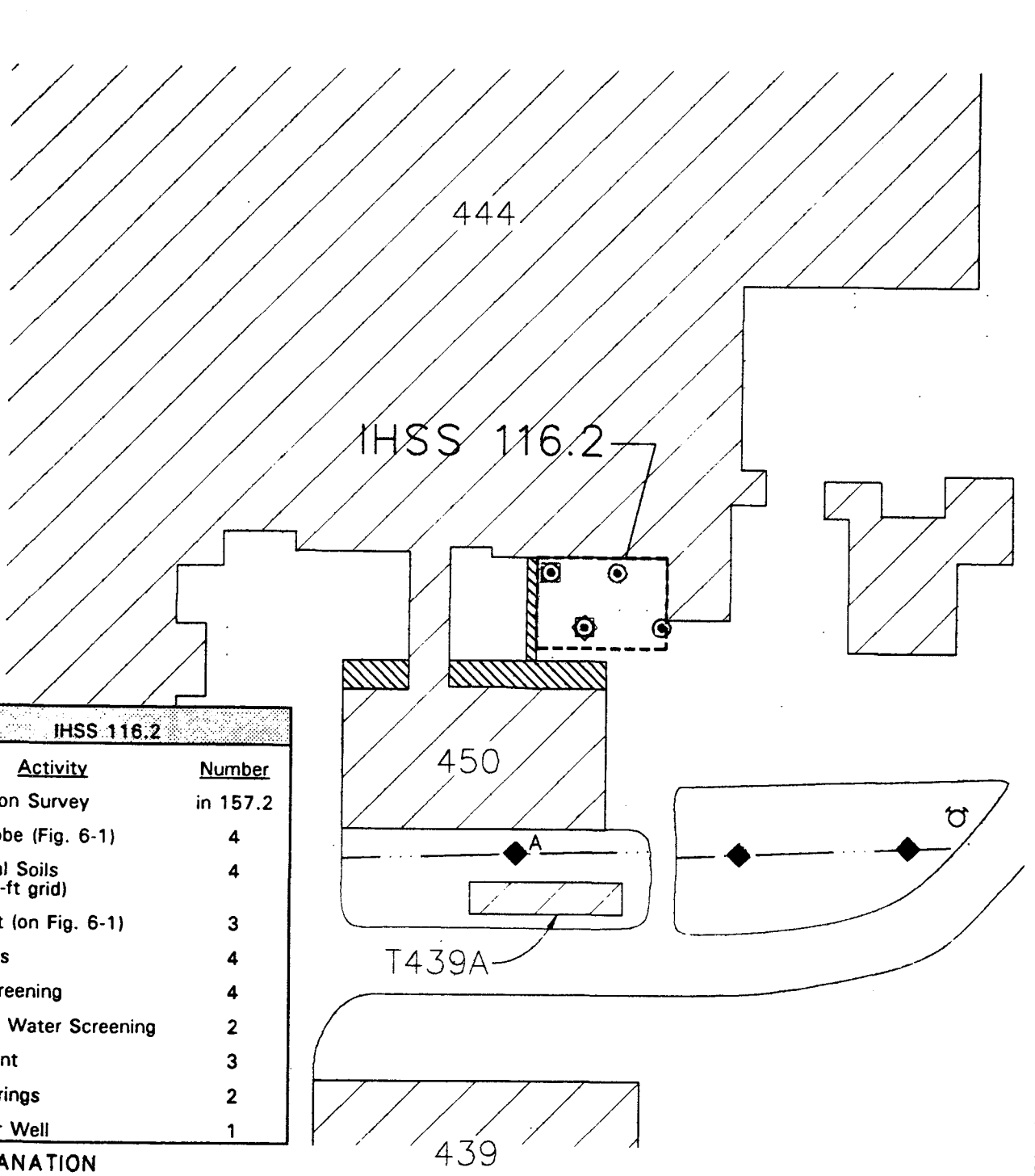

IHSS 116.2	
Activity	Number
Radiation Survey	in 157.2
NaI Probe (Fig. 6-1)	4
Surficial Soils (25-ft grid)	4
Asphalt (on Fig. 6-1)	3
Soil Gas	4
Soil Screening	4
Ground Water Screening	2
Sediment	3
Soil Borings	2
Monitor Well	1

EXPLANATION

- BUILDING
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- WATER HYDRANT
- SURFICIAL SOIL SAMPLING LOCATION
- SOIL GAS SURVEY LOCATION
- SEDIMENT SAMPLING LOCATION
- SOIL BORING LOCATION (TENTATIVE)
- MONITORING WELL LOCATION (TENTATIVE)

25 0 25 50 FEET

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

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FIGURE 6-3
FIELD SAMPLING PLAN FOR IHSS 116.2 - SOUTH LOADING DOCK BUILDING 444

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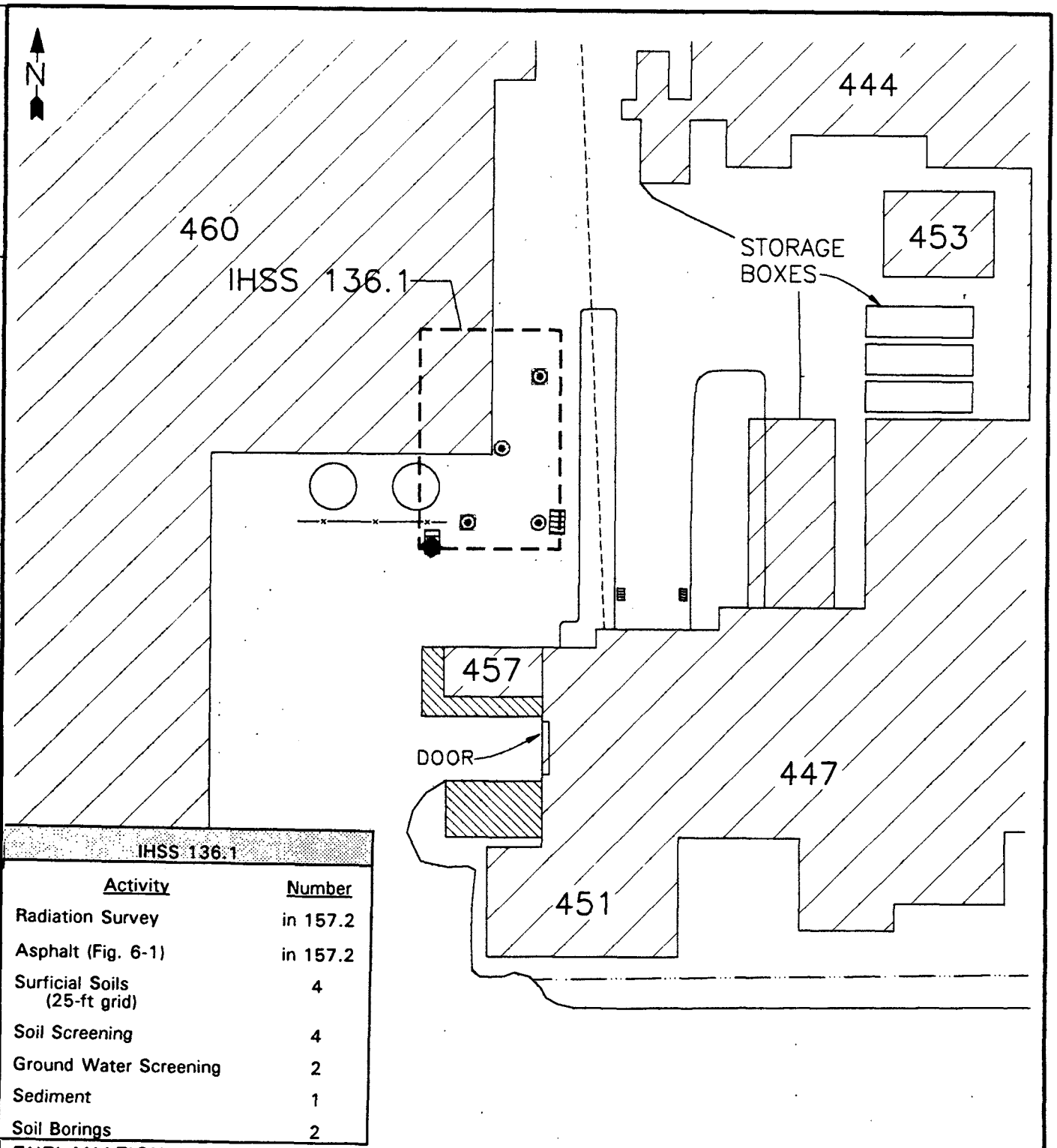

IHSS 136.1	
Activity	Number
Radiation Survey	in 157.2
Asphalt (Fig. 6-1)	in 157.2
Surficial Soils (25-ft grid)	4
Soil Screening	4
Ground Water Screening	2
Sediment	1
Soil Borings	2

EXPLANATION

- BUILDING
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- IHSS BOUNDARY
- OVERHEAD PIPING
- DRAIN
- DRAINAGE
- SURFICIAL SOIL SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION
- HYDRAULIC PROBE LOCATION
- SOIL BORING LOCATION (TENTATIVE)

25 0 25 50 FEET

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

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FIGURE 6-4
FIELD SAMPLING PLAN FOR IHSS 136.1 - COOLING TOWER POND WEST OF BUILDING 444

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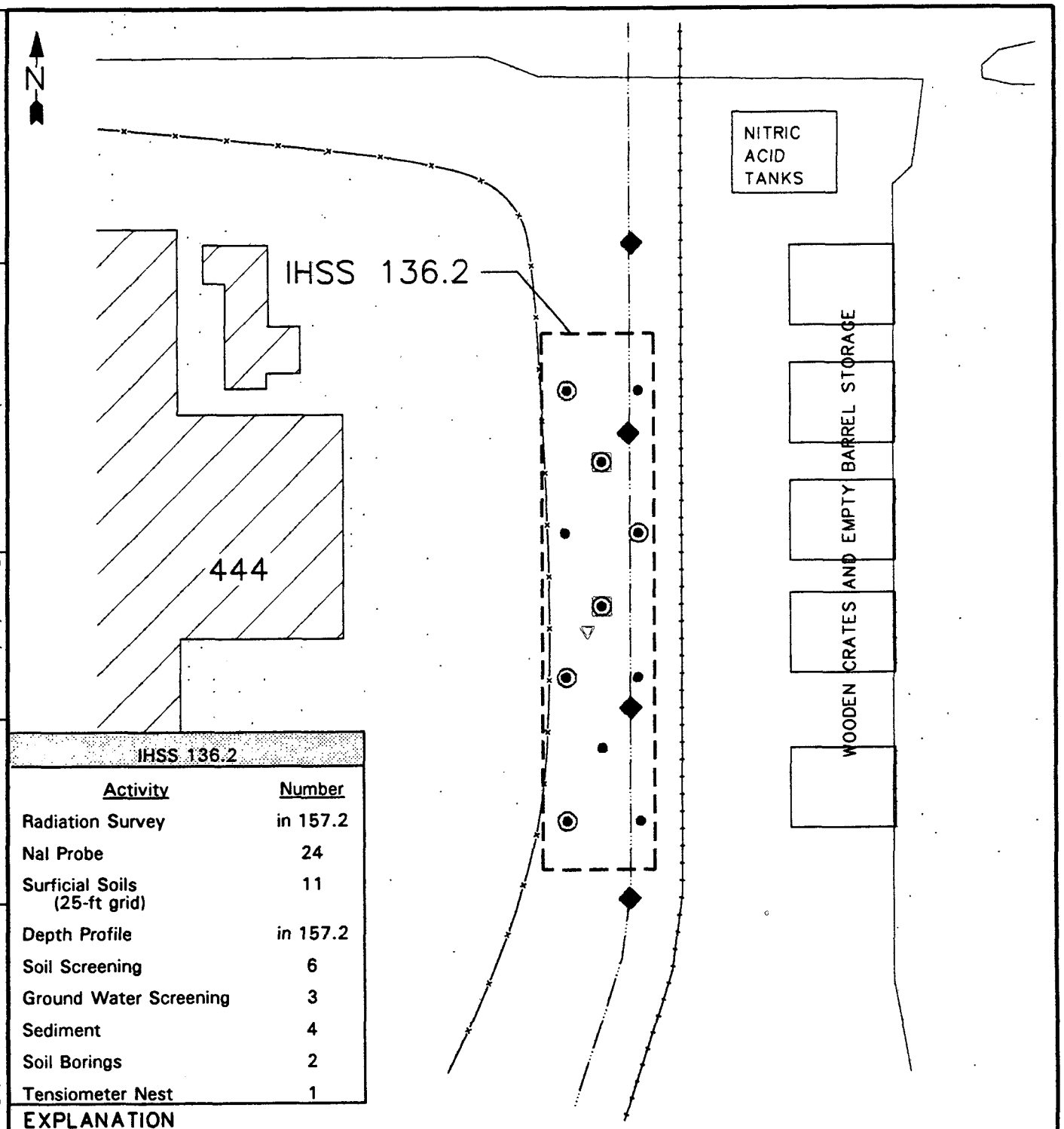

IHSS 136.2	
Activity	Number
Radiation Survey	in 157.2
NaI Probe	24
Surficial Soils (25-ft grid)	11
Depth Profile	in 157.2
Soil Screening	6
Ground Water Screening	3
Sediment	4
Soil Borings	2
Tensiometer Nest	1

EXPLANATION

- BUILDING
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- SOIL OR GRAVEL
- RAILROAD
- FENCE
- SURFICIAL SOIL SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION
- HYDRAULIC PROBE LOCATION
- SOIL BORING LOCATION (TENTATIVE)
- NESTED TENSIOMETER LOCATION(TENTATIVE)

25 0 25 50 FEET

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

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FIGURE 6-5
FIELD SAMPLING PLAN FOR IHSS 136.2-COOLING TOWER POND EAST OF BUILDING 444

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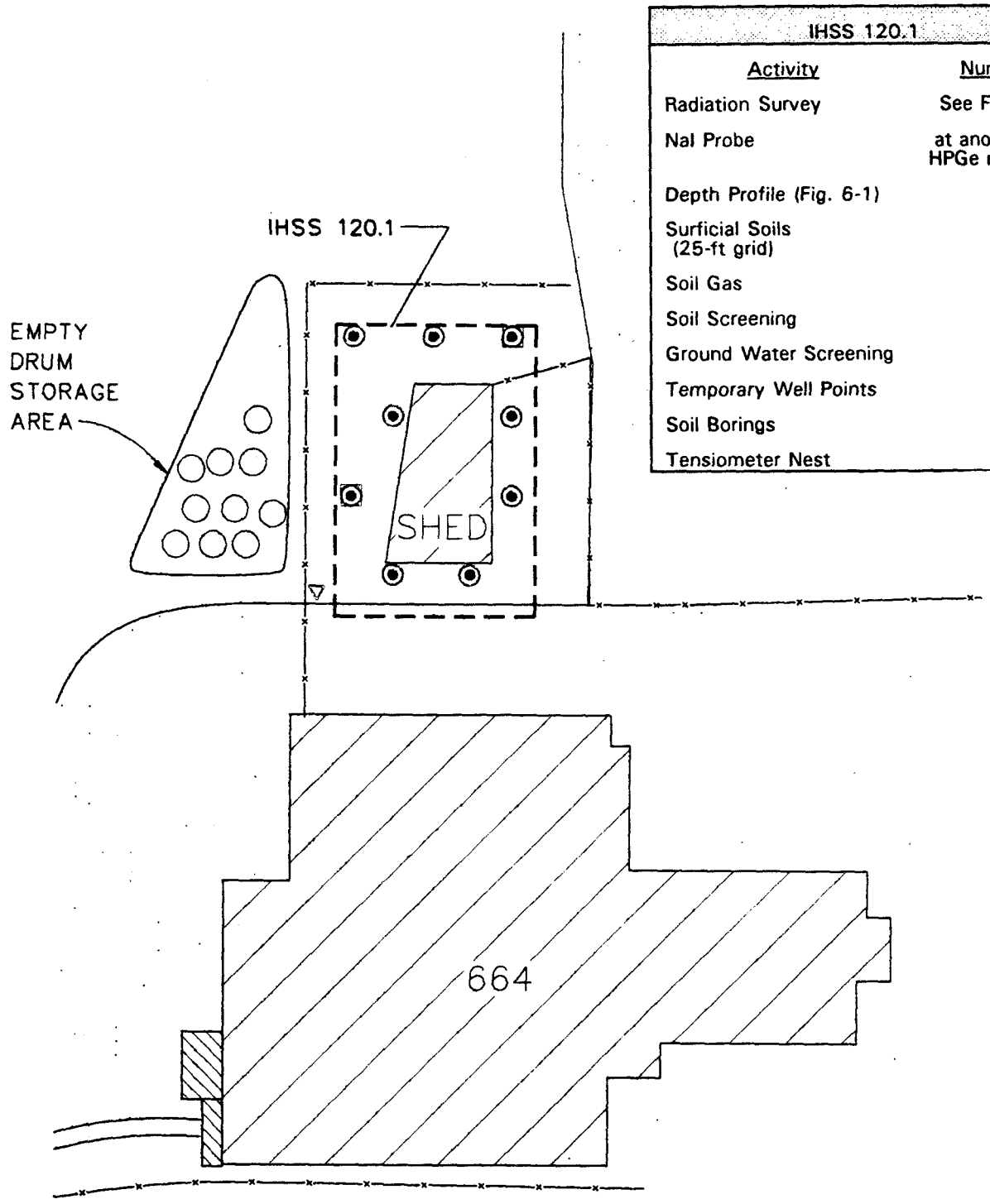

IHSS 120.1	
Activity	Number
Radiation Survey	See Fig. 6-1
NaI Probe	at anomalous HPGe readings
Depth Profile (Fig. 6-1)	3
Surficial Soils (25-ft grid)	9
Soil Gas	9
Soil Screening	5
Ground Water Screening	3
Temporary Well Points	3
Soil Borings	2
Tensiometer Nest	1

EXPLANATION

- BUILDING
- IHSS BOUNDARY
- PAVEMENT
- SOIL OR GRAVEL
- RAILROAD
- FENCE
- CONCRETE
- SURFICIAL SOIL SAMPLING LOCATION
- SOIL GAS SURVEY LOCATION
- SOIL BORING LOCATION (TENTATIVE)
- NESTED TENSIOMETER LOCATION(TENTATIVE)

25 0 25 50 FEET

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

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FIGURE 6-8
FIELD SAMPLING PLAN FOR IHSS 120.1-FIBERGLASSING AREA NORTH OF BUILDING 664

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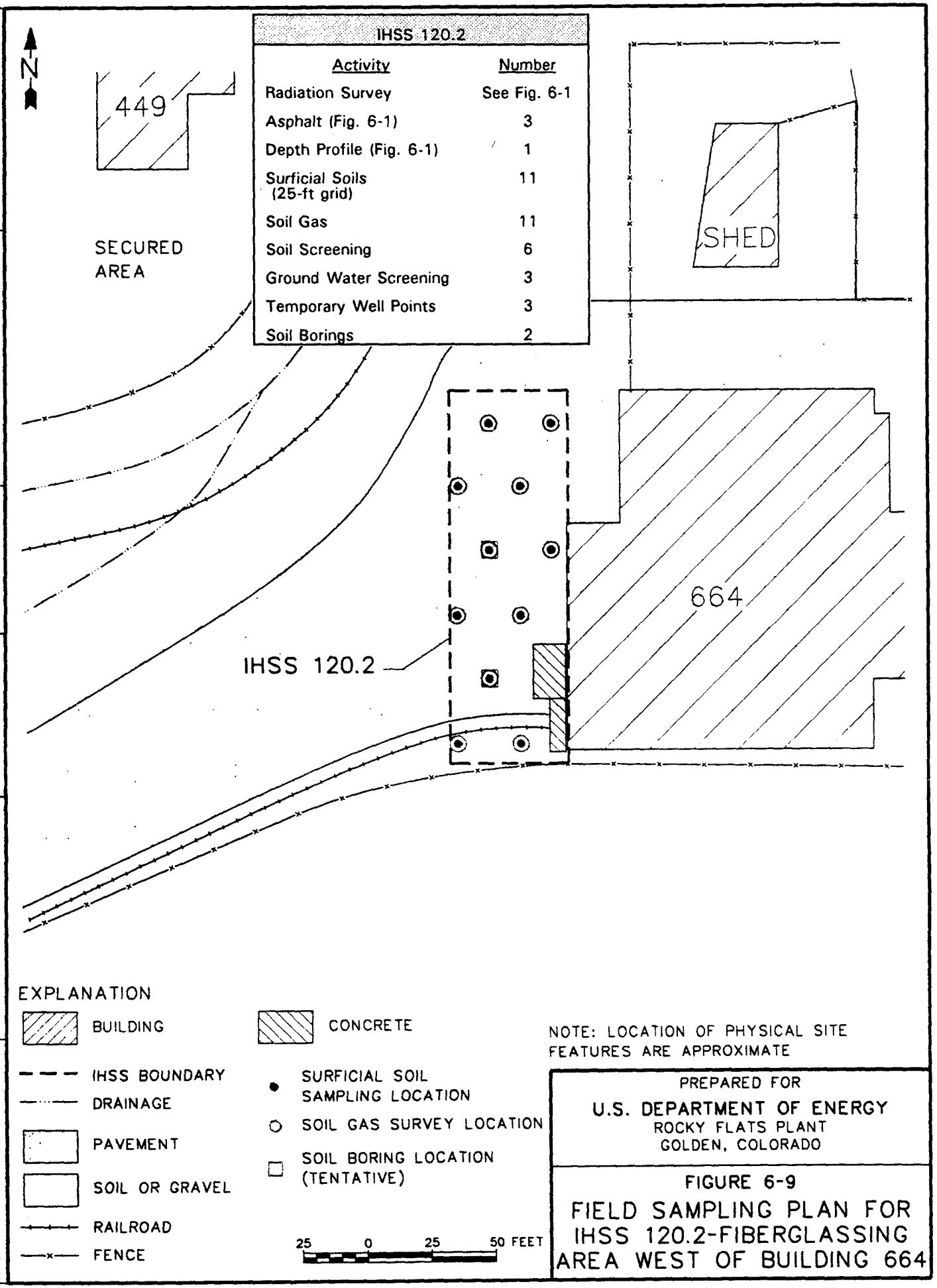
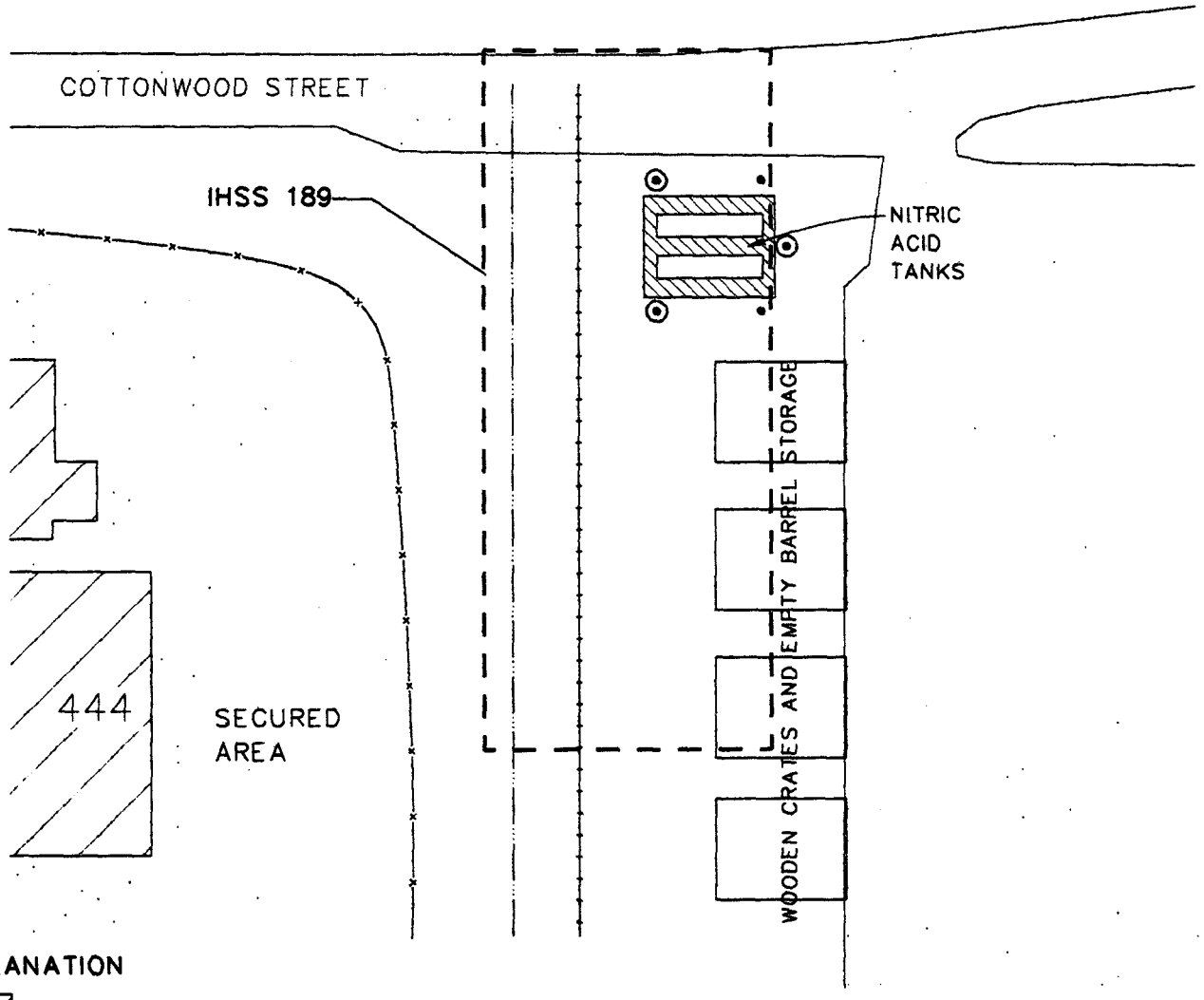


IHSS 120.2	
Activity	Number
Radiation Survey	See Fig. 6-1
Asphalt (Fig. 6-1)	3
Depth Profile (Fig. 6-1)	1
Surficial Soils (25-ft grid)	11
Soil Gas	11
Soil Screening	6
Ground Water Screening	3
Temporary Well Points	3
Soil Borings	2

IHSS 189	
Activity	Number
Surficial Soils (pH only)	5
Ground Water Screen (nitrate and pH only)	3



EXPLANATION

- BUILDING
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- SOIL OR GRAVEL
- RAILROAD
- FENCE
- CONCRETE
- ● SURFICIAL SOIL SAMPLING LOCATION
- ○ HYDRAULIC PROBE LOCATION

25 0 25 50 FEET

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

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FIGURE 6-10
FIELD SAMPLING PLAN FOR IHSS 189-NITRIC ACID TANKS

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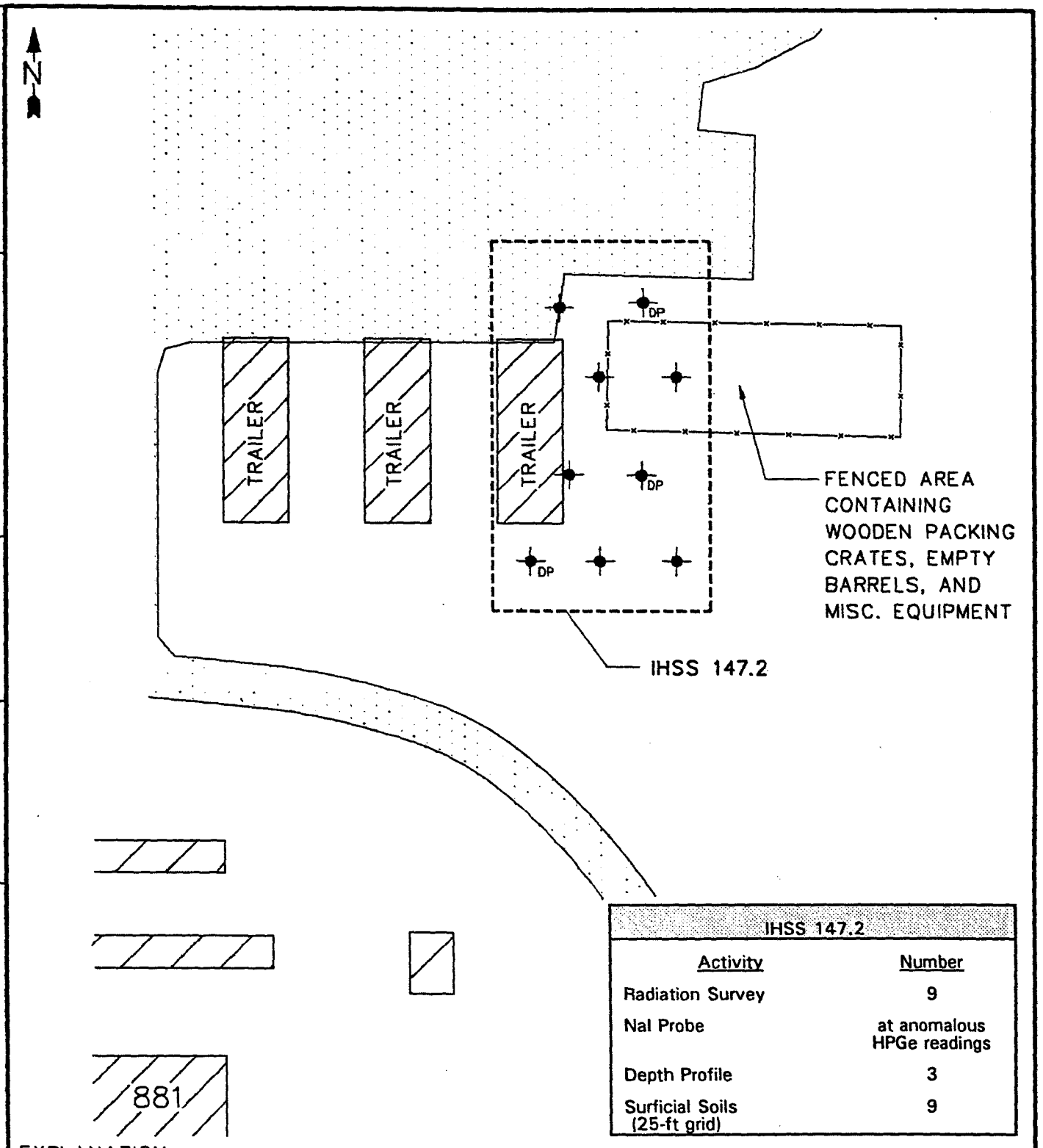

IHSS 147.2	
Activity	Number
Radiation Survey	9
NaI Probe	at anomalous HPGe readings
Depth Profile	3
Surficial Soils (25-ft grid)	9

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

EXPLANATION

- BUILDING
- IHSS BOUNDARY
- PAVEMENT
- SOIL OR GRAVEL
- FENCE
- RADIATION SURVEY
- SURFICIAL SOIL/DEPTH PROFILE SAMPLING LOCATION
- DP DEPTH PROFILE SAMPLE LOCATION

25 0 25 50 FEET

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FIGURE 6-11

FIELD SAMPLING PLAN FOR IHSS 147.2-BUILDING 881 CONVERSION ACTIVITY

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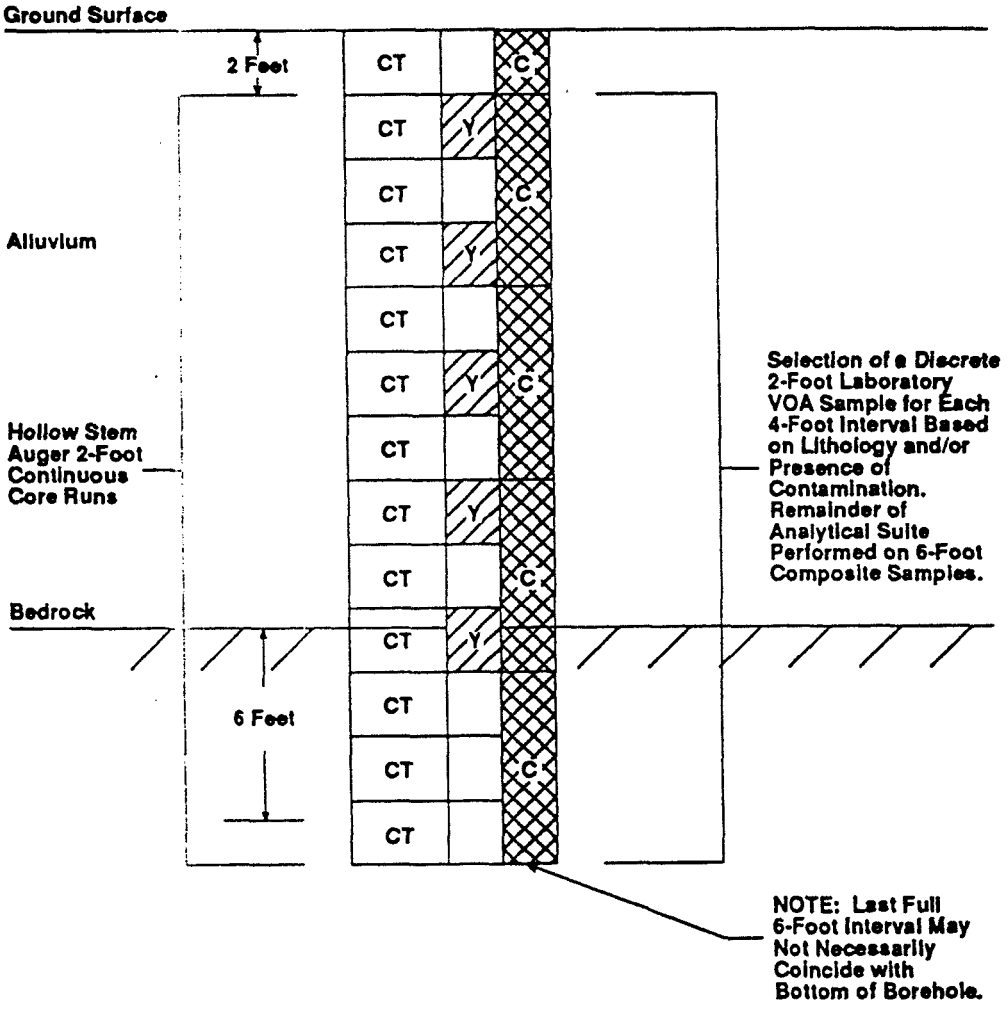
FEB 2 5 1994

Typical Source Characterization Borehole in Alluvium



CT — 2-Foot Continuous Hollow Stem Auger Core Run

Y — Discrete 2-Foot Laboratory Sample for Volatile Organic Analysis

C — Composited 6-Foot Intervals for Laboratory Analysis of Remainder of Analytical Suite (2-Foot at the 0-2 Foot Depth Interval)

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FIGURE 6-12
LITHOLOGIC AND CHEMICAL SAMPLING FOR SOURCE CHARACTERIZATION BOREHOLES IN ALLUVIUM

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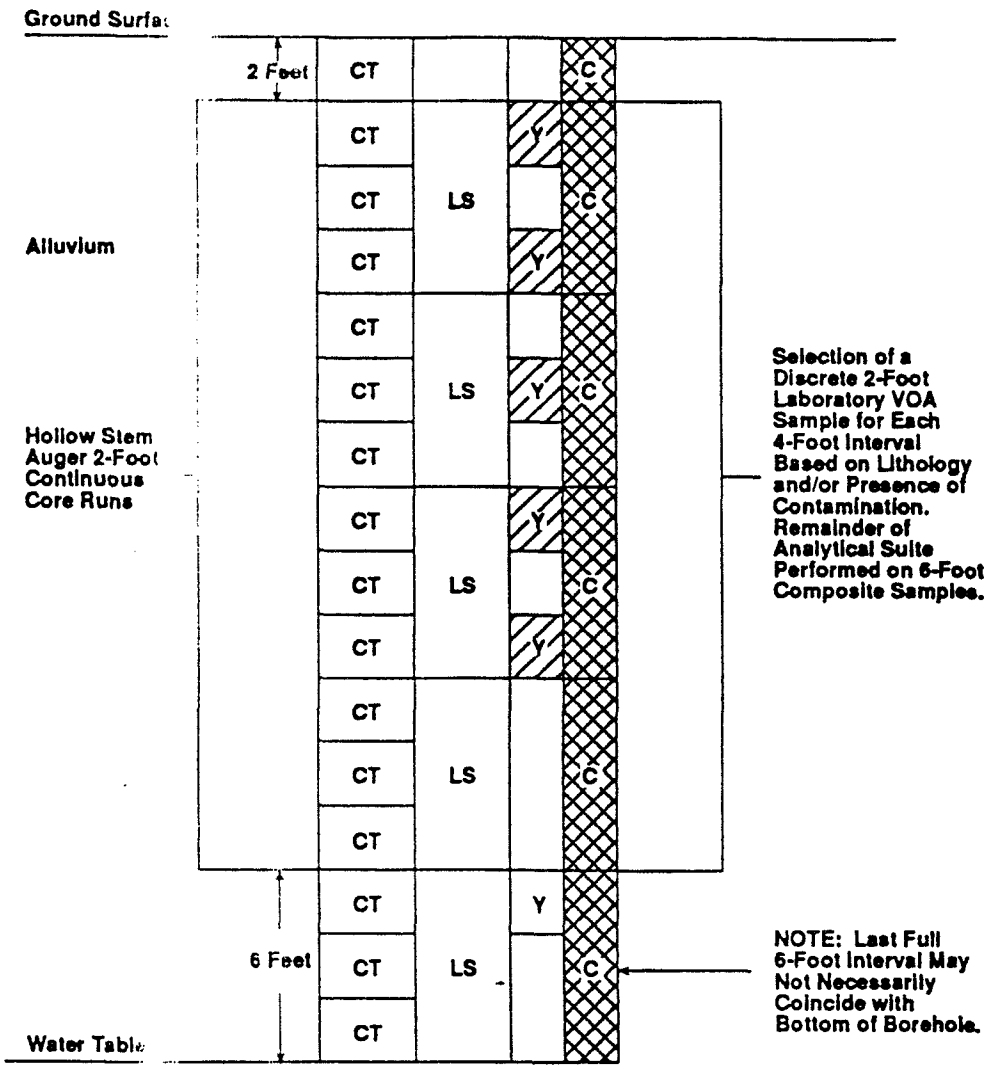
FEB 25 1994

Typical Source Characterization Borehole Above Saturated Alluvium



CT — 2-Foot Continuous Hollow Stem Auger Core Run

LS — Laboratory Sample for Chemical Analysis

Y — Discrete 2-Foot Laboratory Sample for Volatile Organic Analysis

C — Composited 6-Foot Intervals for Laboratory Analysis of Remainder of Analytical Suite (2-Foot at the 0-2 Foot Depth Interval)

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FIGURE 6-13

LITHOLOGIC AND CHEMICAL SAMPLING FOR SOURCE CHARACTERIZATION BOREHOLES ABOVE SATURATED ALLUVIUM

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FEB 25 1994

Approved by:

Manager, Remediation Programs 2/18/94

Suzanne Berman 2/18/94
RI Project Manager

7.0 SCHEDULE

A preliminary schedule for conducting the OU 12 RFI/RI is summarized in Figure 7-1. Dates shown comply with milestone listed in Table 6 of the IAG, dated January 22, 1991. Submittal of this work plan occurred on October 5, 1992. The draft OU12 RFI/RI report is scheduled for submittal on April 20, 1994. The final RFI/RI is scheduled for submittal on September 15, 1994.

Compliance with the schedule shown in Figure 7-1 is highly contingent upon the implementation of the field sampling plan (FSP) described in Section 6.0 and the turn-around time assumed for laboratory analyses of samples. The FSP has been designed to include available screening methods in order to reduce the amount of samples undergoing laboratory analysis. Both subtasks of the investigation involve laboratory analyses that are assumed to have a duration of 120 working days, or six calendar months. Current turn-around time is exceeding nine calendar months in some instances. It is possible however, that planned improvement in these turn-around times and the proposal of supplemental investigative techniques that reduce the number of samples submitted for laboratory analysis will result in durations less than those assumed for the schedule.

The TM submittals shown in conjunction with the BRA refer to technical memoranda as required by the IAG. The exact timing of these submittals is not certain and thus will be subject to revision depending on progress with the BRA. It should be recognized that the

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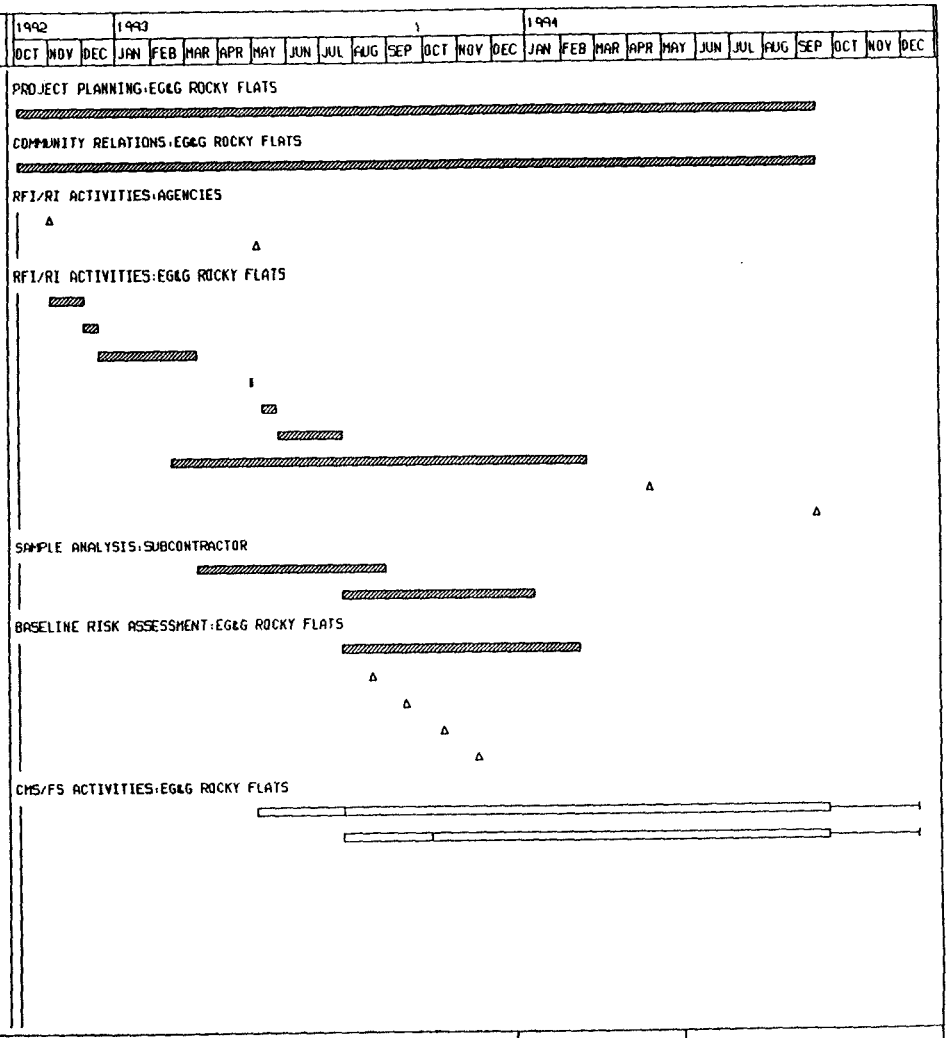
duration shown for the BRA is extremely limited and may in fact, fall short of requirements. However, it is necessary to show the BRA as being complete by mid February in order to produce the draft RFI/RI report on April 20, 1994.

Revisions to this RFI/RI schedule may be necessary and will be requested at least two weeks prior to a due date. The schedule revision request will include appropriate information describing the reason for the revision.

MAY 2 7 1994

CHECKED BY BJN	APPROVED BY BJN	DRAWN BY JAA	~~DATE 3/26/92~~ RC	FILE NAME 40103\F01-701.DWG	REVISION NO. A

DESCRIPTION	ORIG DUR	EARLY START	EARLY FINISH
PROJECT PLANNING	500	05OCT92	15SEP94
COMMUNITY RELATIONS	500	05OCT92	15SEP94
WORK PLAN APPROVED	0	03NOV92E	02NOV92
DRILLING APPROVAL	0	05MAY93E	04MAY93
PLANNING	20	03NOV92	01DEC92
SCREENING SUBTASK MOBILIZATION	10	02DEC92	15DEC92
RFI/RI FIELD SCREENING/SAMPLING	60	16DEC92	11MAR93
AGENCY MEETING	1	30APR93	30APR93
DRILLING SUBTASK MOBILIZATION	10	10MAY93	21MAY93
RFI/RI FIELD DRILLING	40	24MAY93	19JUL93
DATA EVALUATION	260	1?FEB93	22FEB94
SUBMIT DRAFT RFI/RI REPORT	0	20APR94E	19APR94
SUBMIT FINAL RFI/RI REPORT	0	16SEP94E	15SEP94
SAMPLE ANALYSIS (FIRST SUBTASK)	120	12MAR93	27AUG93
SAMPLE ANALYSIS (SECOND SUBTASK)	120	20JUL93	05JAN94
BASELINE RISK ASSESSMENT	150	20JUL93	16FEB94
TM III SUBMITTAL	0	17AUG93E	16AUG93
TM IV SUBMITTAL	0	17SEP93	16SEP93
TM V SUBMITTAL	0	19OCT93	18OCT93
TM VI SUBMITTAL	0	18NOV93	17NOV93
DEV AND SCREENING OF REMEDIAL ALTS	360	03MAY93	26SEP94
TREATABILITY STUDIES	305	20JUL93	26SEP94



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RUN DATE 05MAY92
START DATE 05OCT92
DATA DATE 05OCT92
FINISH DATE 14DEC94

SURETRAK

OU12 RFI/RI WORK PLAN

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 7-1
OU12 RFI/RI WORK PLAN
IMPLEMENTATION
SCHEDULE

Approved by:

Manager, Remediation Programs 2/18/94

Suzanne Berman 2/18/94
RI Project Manager

8.0 HUMAN HEALTH RISK ASSESSMENT PLAN

8.1 OVERVIEW

8.1.1 Regulatory Basis

Section 300.430(d) of the National Contingency Plan (Federal Register March 8, 1990, p. 8709) states that, as part of the remedial investigation, a human health risk assessment is to be conducted as part of a Baseline Risk Assessment (BRA) to determine whether contaminants of concern identified at the site pose a current or potential risk to human health and the environment in the absence of remedial action. This section describes the Human Health Risk Assessment components, which include:

- Data collection/evaluation which includes identification and description of contaminants of concern (COCs);
- Exposure assessment;
- Toxicity assessment; and
- Risk characterization.

These components correspond to the four components within the IAG required in Section VII.D.1. for contaminant identification and documentation, exposure assessment and documentation, toxicity assessment and documentation, and risk characterization. Uncertainty analysis will be an integral part of each of these four components.

DOCUMENT CLASSIFICATION REVIEW WAIVER
PER R.B. HOFFMAN, CLASSIFICATION OFFICE
JUNE 11, 1991

Figure 8-1 illustrates the basic Human Health Risk Assessment process and components. The objective of this assessment is to identify and characterize the following:

- Toxicity and levels of hazardous and radioactive contaminants present in relevant media (e.g., air, ground water, soil, surface water, and sediment);
- Environmental fate and transport mechanisms within specific environmental media and cross-media fate and transport where appropriate;
- Potential human and environmental receptors;
- Potential exposure routes and extent of actual or expected exposure;
- Extent of expected impact or threat and the likelihood of such impact or threat occurring (i.e., risk characterization);
- Levels of uncertainty associated with the above.

To ensure acceptance of the human health risk assessment, four technical memoranda will be prepared for review and approval. These memoranda will outline how the most crucial steps in the risk assessment will be performed and address the following:

- Contaminants of concern;
- Exposure scenarios;
- Fate and transport models; and
- Toxicity values.

The Human Health Risk Assessment considers risks from both radiological and nonradiological contaminants. The EPA and DOE require a two-phase evaluation for the radiological portion of the assessment. The Human Health Risk Assessment will incorporate the two-phase analysis which includes:

- The implementation of procedures established by the International Commission on Radiological Protection (ICRP) and adopted by the EPA used to estimate the radiation dose equivalent to humans from potential exposure to radionuclides through all pertinent exposure pathways; and

- The computation of health risk, based on age-averaged lifetime excess cancer incidence per unit intake (and per unit external exposure) for radionuclides of concern.

Human Health Risk Assessment results will be used to determine if remedial actions are warranted at OU12 and, if so, what associated cleanup levels will be necessary to protect human health. Cleanup levels are computed during the feasibility study.

A number of guidance and information documents will be used to provide direction for developing the Human Health Risk Assessment. These include:

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual Volume 1. (Part A). Interim Final. 1989. EPA/540/1-89/002 (EPA, 1989d), including Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03 Human Health Evaluation, Supplemental Guidance: "Standard Default Exposure Factors";

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual. Volume 1. (Parts B and C). Interim Final. 1991. Publication Nos. 9285.7-01B and 9285.7-01C.

- Guidance for Data Useability in Risk Assessment. Interim Final. 1990. EPA/540/G-90/008 (EPA, 1990);

- Superfund Exposure Assessment Manual. 1988. EPA/540/1-88/001 (EPA, 1988c);

- Procedures established by the ICRP and adopted by EPA in Federal Guidance Report No. 11 (EPA, 1988b);

- Radiation Protection of the Public and the Environment, DOE Order 5400.5;
- Risk Assessment in the Federal Government: Managing the Process. 1983. National Academy Press, Washington, D.C.; and
- Publications of the National Council of Radiation Protection, International Council on Radiological Protection, United National Scientific Committee on the Effects of Atomic Radiation, as appropriate.

In addition to available national EPA guidance, supplemental Region VIII risk assessment guidance will be used, if applicable.

8.1.2 Background of Site Contamination

OU12 is comprised of 10 IHSSs throughout the 400, 600, and 800 building areas as defined in the Historical Release Report (HRR) (DOE, 1992c). The HRR also identifies areas of under-building contamination (UBC), and several other previously unrecognized sites that are potential areas of contamination (PACs). Although investigation of these sites is not part of OU12, the presence of these sites is recognized and information incorporated into this plan. Historical quantitative data is nonexistent for these areas and only qualitative historical data is available from the HRR as discussed in Section 2.1 of this work plan. Radiation surveys of the OU12 area were conducted in 1981 and 1989 which tentatively identified areas of anomalous radioactivity near the west loading dock (IHSS 116.1) and one of the fiberglassing areas near Building 664. These surveys have been included in Appendix D. However, the quality of this radiological survey data is in question and will require data useability analysis prior to its use in the Human Health Risk Assessment.

Contaminants identified in the HRR at OU12 IHSSs and within the OU12 area include enriched and depleted uranium, plutonium, beryllium, chlorinated solvents, chromates,

nitric and sulfuric acids, carbon tetrachloride, and hydraulic oil among others. These compounds may occur in the groundwater, soils, ambient air, surface water, and sediments of OU12.

OU12 is encompassed entirely in the industrial area at the RFP. Thus, the primary target population currently identified at OU12 is industrial site workers. Other target populations will also be considered in the human health risk assessment and exposure scenarios presented in the exposure assessment technical memorandum of the Human Health Risk Assessment. Potential exposure pathways to target populations considered may include:

- Ingestion of ground water, surface water, sediments, and soil;
- Inhalation of airborne soil and sediment particles, vapors, and gases; and
- Dermal contact with soils, ground water, surface water, and airborne particulates.

Data needs and DQOs are presented in Section 4.0 of this work plan. Section 6.0 of this work plan describes how the data needs identified will be collected. The data needs and FSP address the objectives described in Subsection 4.2 and include characterizing the nature and extent of contamination and the data collection necessary to assess the complete potential exposure pathways. Data to be collected in the OU12 RFI/RI or obtained from other programs and used in the Human Health Risk Assessment includes sampling the following media.

- **Soils:** Data characterizing vertical depth contaminant concentrations in OU12 will be used to support discussions of contaminant fate and transport and, ultimately, the exposure assessment.

- **Surficial Soils:** Radiological and nonradiological surface soil data will be used to estimate exposure and risk through ingestion and dermal routes, and, if necessary, estimate windborne particulate concentrations for subsequent inhalation exposures.

- **Surface Water and Sediments:** Data characterizing contaminants in surface water and sediments can be used to support discussions of contaminant fate and transport, in addition to estimating exposure and risk from ingestion or dermal contact with surface water and sediments, and inhalation of sediments.

- **Ground Water:** Data characterizing site-specific hydrogeology and potential contaminants in alluvial groundwater systems can be used to support discussions of contaminant fate and transport in addition to estimating exposure and risk from ingestion, inhalation, or dermal contact with groundwater.

- **Air:** Data characterizing the potential for dispersion of contaminated sediments can be used to support discussions of contaminant fate and transport in addition to estimating exposure and risk from inhalation. Air pathway analyses will be based on dispersion modeling.

A comprehensive quantitative assessment of all contaminants of concern and potential exposure pathways will be performed for surficial soils, surface water and sediments as part of the RFI/RI. This RFI/RI includes a preliminary determination of the presence or absence of ground water contamination at suspect OU12 IHSSs. This information may allow identification of preliminary contaminants of concern (COCs) and exposure pathways for ground water. Further investigation of ground water contamination may result in additional RFI/RI activities that may not be completed within the IAG schedule. The remainder of this section generally describes the individual Human Health Risk Assessment components as they relate to the overall risk assessment.

8.2 DATA COLLECTION/EVALUATION

The objective of this section is to describe the procedures to identify contaminants potentially present at OU12 IHSSs at concentrations that could be of concern to human health. The contaminant description and identification of COCs component of the Human Health Risk Assessment provides a summary of historical and RFI/RI data collected at OU12, provides an evaluation of historical and RFI/RI data relative to performing the Human Health Risk Assessment, and describes how to use this information to perform the hazard identification. The contaminant description section includes the following information:

- Data collection;
- Data evaluation; and
- Hazard identification.

8.2.1 Data Collection

The objective of the data collection task is to summarize all data available for use in the Human Health Risk Assessment in preparation of further data evaluation activities. This step, then, identifies the historical data relevant to performing the Human Health Risk Assessment, assembles the RI data, and establishes data formats to facilitate data evaluation. The following data attributes are important to this step:

- Site description;
- Sample design with sample locations;
- Analytical method and detection limit;
- Results for each sample, including qualifiers;

- Sample quantification limits and/or detection limits for nondetects;
- Field conditions; and
- Sample documentation (for example, chain-of-custody and Standard Operating Procedures (SOPs)).

8.2.2 Data Evaluation

Historical and RFI/RI data will be evaluated using EPA's Guidance for Data Useability in Risk Assessment (EPA, 1990). The EPA identified the following data usability criteria:

- Assessment of data documentation for completeness;
- Assessment of data sources for appropriateness and completeness;
- Assessment of analytical methods and detection limits for appropriateness;
- Assessment of sampling data quality indicators (completeness, comparability, representativeness, precision, and accuracy); and
- Assessment of analytical data quality indicators (such as spike recoveries, duplicates, and blanks) for completeness, comparability, representativeness, precision, and accuracy.

The RFI/RI data that can be used to support a quantitative Human Health Risk Assessment will be identified. Part of this evaluation will include identification of the most appropriate summary process and format. This will involve identifying statistical summary techniques that consider spatial and temporal data distributions, determining if arithmetic or geometric means are appropriate, and determining the appropriate method for dealing with nondetected values and qualified data. The data summary will include:

- The frequency of detection (number of positive detects/number of analyses) for each compound and sample location; and
- The minimum- and maximum-reported concentrations for each contaminant at each sample location.

Tentatively identified compounds (TICs) reported in the RFI/RI data will be evaluated relative to their usefulness in the Human Health Risk Assessment. If only a few TICs are reported relative to other contaminants, or if they are unrelated to RFP, they will be screened in the COC selection process and may be considered for exclusion. If numerous TICs are reported and they appear related to the RFP, they will be carried through the Human Health Risk Assessment only to the extent that they aid characterizing human health risk as needed for site decisions. It is anticipated that risks resulting from exposure to TICs will not be characterized because of the absence of specific contaminant identity and available toxicological information.

8.2.3 Hazard Identification

The objective of the hazard identification is to identify contaminants present at OU12 in concentrations high enough that may be of concern relative to human health considerations. The HRR identified uranium, plutonium, beryllium, chlorinated solvents, chromates, acids, and hydraulic oil within OU12. In addition to these contaminants, others may be identified based on RFI/RI analytical results. Criteria for performing the hazard identification include, but may not be limited to:

- Frequency of detection;
- Environmental media concentrations which exceed background concentrations; and

- Comparison with Health/Environmental Criteria.

8.2.4 Selection of Contaminants of Concern

Analytical results from OU12 field sampling will be screened to retain those contaminants which are most likely to contribute significantly to risks to humans. These COCs represent the most toxic, persistent, or mobile contaminants identified at OU12. If COCs have to be selected, adequate documentation will be prepared to justify including or excluding specific contaminants. As required by the IAG Section VII.D.1.a, a technical memorandum which includes a listing of the hazardous substances present within OU12 will be prepared and submitted to the EPA and State of Colorado for review and approval. The COCs selected from this list will be included in the memorandum with the known corresponding ambient concentrations of these contaminants. The memorandum will be submitted prior to the required submittal of the BRA for OU12.

Figure 8-1 illustrates the screening process to be applied to the OU12 data set to identify the COCs for use in the human health risk assessment. This screening process was developed using the discussion in the EPA Risk Assessment Guidance for Superfund as a guide (EPA, 1989a). Additionally, professional judgement will be utilized in identifying COCs. The reasoning and justification backing this judgement will also be documented in the technical memorandum.

The resultant list of COCs will represent those contaminants that survived the screening process. Generally, each step identified in Figure 8-1 represents a screening criterion which, after evaluation, either retains or eliminates a specific contaminant for consideration in the risk assessments. Flow to the left deletes chemicals from the quantitative risk assessment; flow to the right retains the contaminant in the quantitative

risk assessment. If a potential contaminant of concern is associated with a "hot spot" (a waste-related contaminant concentrated in a particular area), the chemical will be automatically included in the risk assessment.

Brief discussions of each step in the COC identification process are provided in the following sections.

8.2.4.1 Site-Specific Chemical Analyte List

The screening process will be initiated with the analytical results from the site-specific chemical analyte list for each media of concern: soils, surface soils, surface water and sediments, and ground water. The chemical analyte list will be extensive enough to identify the hazardous substances present at OU12 in the media of concern for the identified exposure pathways. The analyte list will include volatile organics, metals, and radionuclides.

8.2.4.2 Essential Nutrients

The next screening step is to determine if any of the contaminants retained in the screening process are essential human nutrients. As stated in RAGS section 5.9.4, "chemicals that are essential human nutrients, present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and toxic only at very high doses (i.e., much higher than those associated with contact at the site) need not be considered further in the quantitative risk assessment. Examples of such chemicals are iron, magnesium, calcium, potassium, and sodium" (EPA, 1989d). Prior to eliminating these compounds, they will be shown not to be present at levels which could result in adverse health effects. Consequently, contaminants that meet the essential nutrient criteria will not be considered further.

8.2.4.3 Detection Frequency

The detection frequency of each potential contaminant will be calculated and supported by statistical information. Those constituents with a detection frequency greater than 5 percent will be retained for further consideration; those with a detection frequency less than 5 percent will be eliminated.

8.2.4.4 Hot Spot Delineation

The hot spot assessment step in the COC screening process is designed to retain contaminants with elevated concentrations that might otherwise be eliminated because of infrequent detection. In theory, if a contaminant eliminated from the detection frequency step in the screening process is concentrated in a particular area at an obviously elevated concentration, and is considered a potential waste-related contaminant, that contaminant will be brought back into the screening process as a potential COC. To aid in the hot spot assessment step, all concentrations will be compared qualitatively against the central tendency (e.g., mean) concentration on a chemical-specific basis.

8.2.4.5 Statistical Comparison to Background

Statistical methods will be employed to determine if contaminants carried over from the detection frequency analysis had concentrations statistically different from site background concentrations. These tests will analyze for equality of variance between the two populations. Because the tests performed may be affected by the underlying distribution (i.e., the tests assume a near-normal distribution), a second series of nonparametric tests will be employed. A third comparison will consist of comparing the observed site maximum concentrations to background concentrations defined in acceptable literature sources.

8.2.4.6 Toxicity Concentration Screen

The purpose of the toxicity concentration screen is to focus the quantitative risk assessment on those contaminants posing the greatest risk given the exposure scenarios considered. To conduct the toxicity concentration screen, noncarcinogens and carcinogens identified in each media will be grouped accordingly and combined with toxicity constants identified in EPA's Integrated Risk Information System (IRIS) or Health Effects Assessment Summary Tables (HEAST). The maximum concentration for each of the potential contaminants will be multiplied by the inverse of the reference dose (1/Rfd) for the noncarcinogenic contaminants. The maximum concentration for carcinogens will be multiplied by the slope factor. The multiplication described yields a risk factor for each of the potential contaminants (noncarcinogens and carcinogens). By summing the risk factors for each group, the contribution to the total risk will be calculated on a percentage basis. Those contaminants contributing to greater than one percent of the total risk will be retained for the quantitative risk assessment.

Contaminants retained through the screening process represent the most prevalent, toxic, persistent, or mobile contaminants. These will be added to the list of contaminants of concern, which will be used in the quantitative risk assessment.

There are inherent uncertainties that must be recognized in the data collection and evaluation component of the Human Health Risk Assessment. Uncertainties include those associated with field sampling laboratory analysis and laboratory quality assurance procedures, and with accuracy of the RFEDS database or other databases compiled for use in the risk assessment. All of these sources of information are used to identify and describe COCs. Uncertainty analysis will be performed to characterize and quantify, if possible, the sources and magnitudes of uncertainty in the data collection and evaluation

component. Quantitative techniques may include sensitivity analysis, or numerical methods such as Monte Carlo analysis. A more detailed description of uncertain analyses considered for use in completing the overall Human Health Risk Assessment for OU12 is in Section 8.5.

8.3 EXPOSURE ASSESSMENT

The objectives of the exposure assessment are to identify actual or potential chemical and radiological exposure pathways, characterize potentially exposed populations, and determine the concentration and duration of exposure. The exposure assessment includes several tasks:

- Characterization of the exposure setting relative to contaminant fate and transport and potentially exposed populations;
- Identification of exposure pathways which are comprised of a source and mechanism of release to the environment, an environmental transport medium, a point of potential contact for humans or biota, an exposure point, and an exposure route at the exposure point;
- Identification of exposure scenarios associated with pathways to current and potential future exposed populations; and
- Identification of uncertainties associated with the exposure assessment that impact the risk characterization.

Exposure is defined as the contact of an organism with a contaminant or physical agent. The magnitude of exposure is determined by measuring or estimating the amount of a contaminant available at the exchange boundaries. When contaminants migrate from the

site to an exposure point, or when a receptor directly contacts contaminated media, exposure can occur.

8.3.1 Conceptual Site Model

The conceptual site model developed for OU12 discussed in Section 2.5 and shown on Figures 2-39 and 2-40 will be used to evaluate primary and secondary contaminant sources and releases, and potential receptors and associated exposures. The models help to characterize the exposure setting relative to contaminant fate and transport mechanisms through exposed receptors. These models may be revised, based on RFI/RI data collected for the OU, to incorporate new information.

To assess the potential adverse health effects associated with access to the site, the potential level of potential receptor exposure to the selected contaminants must be determined. Both current and potential future receptors are considered in this determination. The primary current receptors identified at OU12 include occupational site workers, and offsite residents. Offsite potential future receptors include light industrial and ecological site worker. Future onsite residential receptors will be considered, although it is highly unlikely the RFP will allow unrestricted, residential use in the future.

Intakes of potentially exposed receptors will be calculated separately for all appropriate pathways of exposure to contaminants. Then, the total chronic intake by each route of exposure will be calculated by adding the intakes from each pathway. Total oral, inhalation, and dermal chronic exposures as well as external exposure from radionuclides will be estimated separately. Exposure concentrations will be estimated as described in Section 8.3.4 for a variety of reasonable exposure conditions in order to evaluate the range of plausible exposure concentrations. At a minimum, the exposure assessment will

consider the estimated minimum, expected, and reasonable maximum exposure (RME) concentrations. EPA guidance defines RME as the 95 percent upper confidence limit on the arithmetic mean. RME concentrations will be determined using proper statistics. Other factors will be considered to estimate intake including contact rate, frequency of exposures, exposure duration, body weight of the exposed population, and averaging time.

8.3.2 Contaminant Fate and Transport

The conceptual site model helps identify potential contaminant fate and transport mechanisms. These could include soil contaminants leaching to ground water and subsequent transport, soil entrainment and downwind deposition, or surface runoff that transports surface soil and sediments downslope. Contaminant-specific characteristics affect fate and transport. Factors affecting the probability a contaminant will migrate include, but are not limited to, the following:

- Solubility;
- Partition coefficients;
- Vapor pressure;
- Henry's Law constant;
- Bioconcentration or dilution factors; and
- Half-life or degradation in the environment.

The evaluation of these factors will help determine if contaminants can migrate from their sources to potential receptors; not only those receptors identified under current use scenarios, but those identified under potential future exposure scenarios as well.

Models utilized for fate and transport evaluation will be described and submitted in a technical memorandum to the EPA and State of Colorado for review and approval as required by the IAG Section VII.D.1.b. The memorandum will include a summary of the data that will be utilized in these models. Representative data will be utilized and the limitations, assumptions, and uncertainties associated with the models shall be documented. This memorandum will be submitted prior to the required submittal of the baseline risk assessment.

8.3.3 Exposure Pathways

By using the conceptual site model and information on contaminant fate and transport, exposure pathways can be identified. This information, combined with data on the physical site setting and potentially exposed site worker population, will be used to identify and evaluate complete exposure pathways. The Human Health Risk Assessment will consider only complete exposure pathways, those for which data support the presence of a source, release mechanism, transport mechanism, exposure route and affected receptor. Complete exposure pathways include the receptors and exposure route (ingestion, inhalation, dermal, and external irradiation).

As required by the IAG Section VII.D.1.b, a technical memorandum will be submitted to EPA and the State of Colorado for review and approval concerning the exposure scenarios. The memorandum will describe the present, future, potential, and reasonable use scenarios. A description of the assumptions made and the data used will be included. This memorandum will be submitted prior to the required submittal of the baseline risk assessment.

8.3.4 Exposure Point Concentrations

By using the data set identified as part of Subsection 8.2.2, exposure point concentrations will be estimated. Some data will be collected at the point of exposure. Other data collected at the source may be used in conjunction with a transport model to estimate expected concentration at some exposure point. Because modeling may add uncertainty, the work plan emphasizes collecting data at exposure points where possible even though these data provide only a snapshot of conditions in time and space.

A statistical approach will be taken to characterize a range of exposure point concentrations for representative exposure scenarios and conditions. The initial step will be to evaluate and characterize the underlying statistical distribution (e.g., normal, lognormal, etc.,) through classical methods such as histograms and goodness of fit tests, and similar summary statistics. Based on this initial assessment, suitable measures of central tendency and dispersion such as the mean, variance, and similar summary statistics will be developed. These measures will be used to characterize exposure point concentrations for different cases of interest such as: the expected case; the 95 percent lower confidence limit case, and the 95 percent upper confidence limit the RME case.

8.3.5 Contaminant Intake Estimation

Contaminant intake or exposure is normalized for time and body weight, and is expressed as milligrams of chemical per kilogram of body weight per day (mg/kg/day). Radionuclide intake is expressed in picoCuries (pCi). Six basic factors are used to estimate intake: exposure frequency, exposure duration, contact rate, chemical concentrations, body weight, and averaging time. These factors are based on the types of exposure, for example, ingestion, inhalation, or dermal.

The lower confidence limit, upper confidence limit and average exposure point concentrations are used in conjunction with receptor activity patterns to estimate contaminant intake for each exposure route as appropriate. EPA guidance such as Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors Interim Final, March 25, 1991 (EPA, 1989d) will be consulted in developing bounding case exposure parameters to support an unbiased exposure assessment. Also, the averaging time for carcinogens and noncarcinogens differ.

Other standard contaminant intake rates established by the EPA that will be used, if appropriate, include the following:

- Soil ingestion rates based on age; and
- Inhalation rates based on activity levels.

Contaminant intake rates can also be estimated for dermal exposures. Of the three routes of exposure (ingestion, inhalation, and dermal), the greatest uncertainty is associated with dermal exposures.

8.3.6 Uncertainty in the Exposure Assessment

The ability to construct exposure scenarios for a site depends on the amounts and kinds of environmental data collected for that purpose. Some uncertainty is inherent in environmental data collection. The numbers and kinds of uncertainties included in the exposure assessment directly impact the risk characterization; many professional judgements impact the identification and description of physical site attributes that affect exposure and activity patterns. One of the major areas of uncertainty in the exposure

assessment is the prediction of human activities that lead to contact with environmental media and exposures to site-related contaminants. This section of the Human Health Risk Assessment will identify and evaluate how site attributes related to environmental sampling and analysis, fate and transport modeling, and exposure parameter estimation and assumptions about them affect uncertainty relative to assessing risk.

8.4 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to describe the contaminants considered in the Human Health Risk Assessment relative to their potential to cause harm. The toxicity assessment has two general steps. The first determines what adverse health impacts, if any, could result from exposure to a particular contaminant. These are typically classified as carcinogenic and noncarcinogenic health effects. The second step, the dose-response evaluation, quantitatively examines the relationship between the level of exposure and the incidence of adverse health effects.

Toxicity depends on the dose or concentration of the substance (dose-response relationship). Toxicity values are a quantitative expression of the dose-response relationship for a contaminant and take the form of reference doses (RfD), Inhalation Reference Concentrations (RfC), and cancer slope factors, each of which are specific to exposure via different routes.

Two sources of toxicity values are currently available for chemicals and radionuclides. The primary source is the EPA's Integrated Risk Information System (IRIS) data base, which contains up-to-date health risk and regulatory information. IRIS contains only those RfDs and slope factors that have been verified by EPA work groups, and is considered by EPA to be the preferred source of toxicity information for chemicals.

If values are unavailable in IRIS, the most recently available Health Effects Assessment Summary Tables (HEAST), issued by EPA's Office of Research and Development, will be consulted to identify interim RfDs and slope factors for chemicals and radionuclides. Other sources such as ICRP and National Commission on Radiological Protection (NCRP) will also be consulted, if IRIS or HEAST values are unavailable.

Toxicity values for substances identified in OU12 which lack EPA toxicity values can be developed in consultation with EPAs Environmental Criteria Assessment Office (ECAO). It is not expected that toxicity values will be developed within the OU12 Human Health Risk Assessment. However, ECAO may be consulted if other acceptable values are not available.

A technical memorandum will be submitted to EPA and the State of Colorado for their review and approval listing the toxicological and epidemiological studies utilized to perform the toxicity assessment as required by the IAG Section VII.D.1.c. This memorandum will be submitted prior to the required submittal of the baseline risk assessment.

In addition to identifying appropriate toxicity values, this section of the Human Health Risk Assessment will provide brief toxicity profiles based on recent, published literature for each contaminant evaluated in the Human Health Risk Assessment. These profiles will describe the acute, chronic, and carcinogenic health effects associated with radioactive and nonradioactive contaminants identified in OU12. Acute and chronic exposure to site-related radionuclides will be discussed, but most of the information presented will deal with the carcinogenic hazard posed by the site-specific radionuclides.

The toxicity assessment section will include a discussion of uncertainties. The numbers and kinds of uncertainties identified for the toxicity assessment directly impact the risk assessment. Uncertainties for the toxicity assessment are associated with the toxicity values and their derivation, or the lack of toxicity values for site-related contaminants. Uncertainties include, but may not be limited to, the following:

- Not all constituents at the site have critical toxicity values (such as cancer slope factors or reference doses), therefore, potential risk cannot be quantified for these constituents and this may underestimate risk from the site;
- Using cancer slope factors derived from the upper 95th percent confidence limit is likely to lead to overestimation of risk. Carcinogen slope factors assume no threshold for effects; if thresholds do exist, the true risks could be zero at sufficiently low doses;
- Lacking toxicity data, synergistic or antagonistic effects cannot be accounted for quantitatively; and
- Critical toxicity values derivation include, but may not be limited to, the following:
    - Extrapolating toxicity values from high experimental doses to low doses for environmental exposures;
    - Extrapolating data from tests with experimental animals to humans; extrapolating test data collected over short durations to long-term exposure durations;
    - Extrapolating data collected using homogeneous experimental animal populations to humans who individually can vary substantially in their individual dose-response reactions;

- Extrapolating from continuous experimental doses given to animals to intermittent human exposures; and
- Extrapolating absorption rates.

The methods used to derive slope factors and reference doses are intended to be conservative in recognizing these types of uncertainties. In addition to the numerical approaches used to incorporate uncertainty in deriving toxicity values, the overall quality of the toxicology data base for a compound is evaluated. This can include consideration of a number of studies, their consistency, the availability of information on multiple species and multiple routes of administration, the demonstration of a clear dose-response relationship, plausible biological mechanisms of action, and especially direct evidence of effects in humans. Such reviews are performed by the EPA in developing toxicity parameter values and result in an overall evaluation of the confidence level in the toxicity values. Not all toxicity values represent the same degree of uncertainty; all are subject to change as new evidence becomes available.

8.5 RISK CHARACTERIZATION

This part of the Human Health Risk Assessment presents the evaluation of potential risks to public health associated with exposure to contaminants at the OU12 site. Potential carcinogenic and noncarcinogenic risks associated with complete exposure pathways will be estimated. Risk characterization involves integrating exposure assumptions and toxicity information to quantitatively estimate the risk of adverse health effects. Risk characterization will be performed in accordance with EPA guidance (EPA, 1989d).

Noncancer health effects will be assessed by comparing the estimated daily intake or exposure to a contaminant to its reference dose (RfD). This comparison measures the

potential for noncarcinogenic health effects given the chemical intake factors used to estimate exposure. To assess the potential for noncancer effects posed by multiple contaminants, the EPA's hazard index (HI) approach will be used. The method assumes dose additivity. Hazard quotients (individual chemical intake divided by the chemical RfD) are summed based on identification of exposure pathways and chronic, subchronic, and shorter-term exposures; if the index exceeds one, there is a potential for health effects. The compounds can be segregated by effect and mechanism of action to determine a segregated HI. However, this will only be undertaken if the sum of the HIs exceed unity.

The potential for carcinogenic effects for nonradiological contaminants will be estimated by calculating excess lifetime cancer risks from the lifetime average exposure and cancer slope factor. IRIS slope factors for radionuclides of concern will be used to estimate risks from exposure for up to four pathways: inhalation, ingestion, air immersion, and external irradiation. HEAST tables will also be used to identify interim RfDs and slope factors for any radionuclides of concern not included in the IRIS database, and radiological risks will be estimated according to guidance provided by the EPA (1989d).

For radiological contaminants, dose to the public will first be determined for the pathways in question for each radionuclide of concern. Based upon these doses, the risk of an effect will be determined using age- and sex-specific coefficients for individual organs receiving radiation doses. In accordance with EPA guidance, organ-specific dose conversion factors will be used to derive slope factors that represent the age-averaged lifetime excess cancer incidence per unit intake for the radionuclides of concern. The sum of the risks from all radionuclides and pathways yields the lifetime risk from the overall exposure. Risks will be combined as appropriate, taking into consideration the plausibility of multiple exposures.

The Human Health Risk Assessment will present the chemical and radiological risk estimates separately with discussion on the additivity potential for these risks. Both noncancer and cancer risks will be estimated by using RME combined with exposure assumptions. This allows risk ranges to be considered rather than a single value, and more closely considers the uncertainty associated with the estimates. In addition, risks may be added across exposure routes if conditions for doing so (i.e., biologically plausible and consistent with reasonably expected exposure scenarios) indicate that it is appropriate.

Not all contaminants identified at OU12 will have toxicity values, thereby limiting the ability to develop quantitative estimates of risk. Where adequate toxicity values cannot be identified, potential risks associated with exposure to those constituents will be dealt with qualitatively.

The numbers and kinds of uncertainties identified in the Human Health Risk Assessment directly impact the interpretation of estimated risks developed in this section. Quantitative risk estimates derived in risk assessments are conditional estimates that include numerous assumptions about exposures and toxicity. Uncertainty is introduced from a variety of sources including, but not limited to, the following:

- Sampling and analysis;
- Exposure estimation;
- Exposure population dynamics; and
- Toxicological data.

Risk assessment involves extrapolation of often incomplete data and information obtained under one set of conditions to a likelihood or probability of events to be encountered

under different circumstances. The objective of this task will be to evaluate the reliability of the Human Health Baseline Risk Assessment as a scientifically credible instrument upon which to base risk management decisions. An uncertainty analysis will be performed to characterize and quantify, to the extent practicable, the sources and magnitudes of uncertainty in the human health risk assessment. The existing data bases may be inadequate for accurate analysis, and the complexity of the process requires the incorporation of expert or subjective judgments. Quantitative techniques may include sensitivity analysis of testable or untestable assumptions, first-order analysis to evaluate the propagation of errors, or numerical methods such as Monte Carlo analysis. Other methods of analysis of incomplete data sets may utilize Batesian theorems, expert systems that analyze the consequences of events relative to others, or other types of logic systems such as event or fault trees to handle uncertainty. The results of these analyses can be converted into quantitative terms to express probabilities.

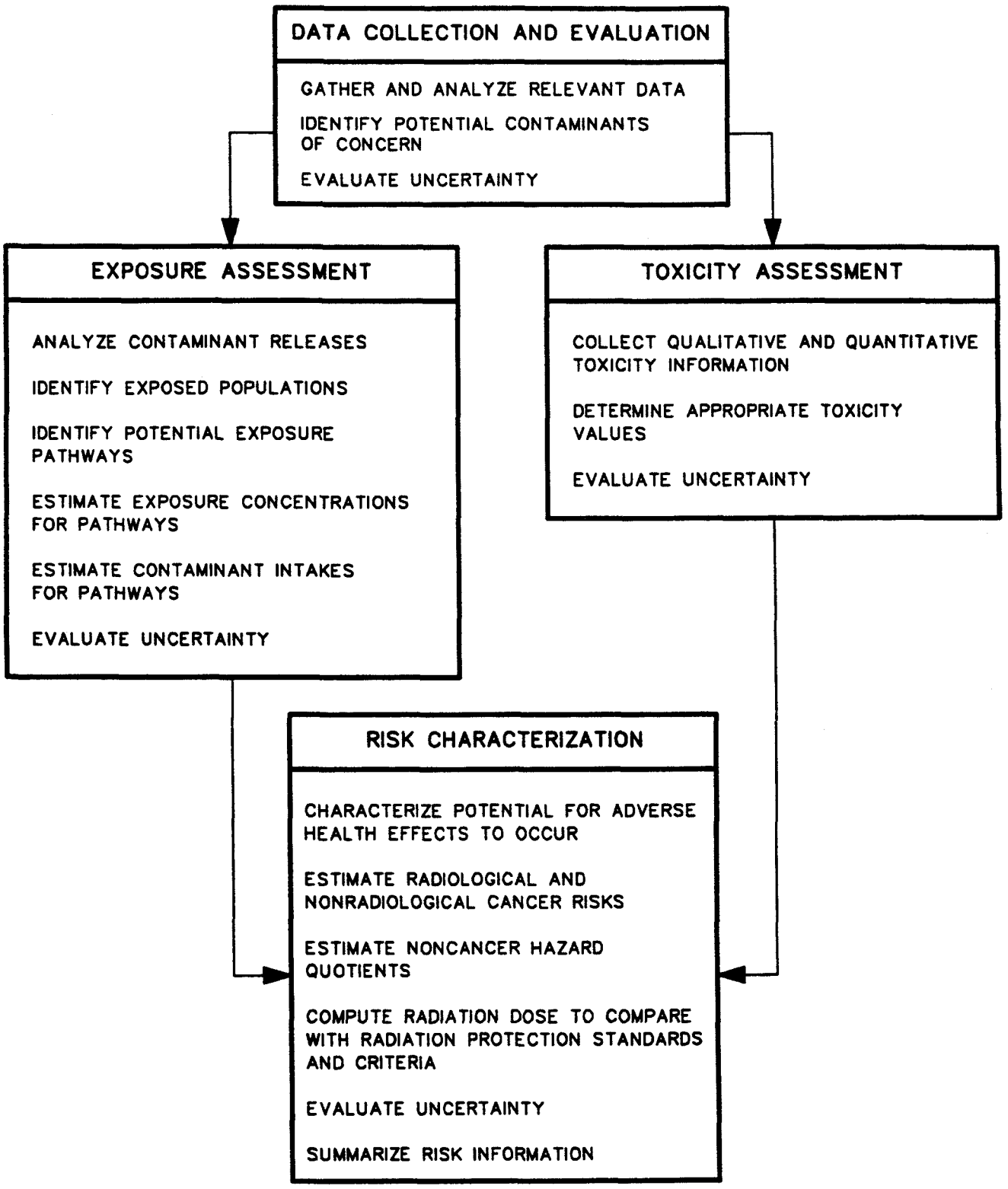

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FIGURE 8-1
HUMAN HEALTH RISK ASSESSMENT

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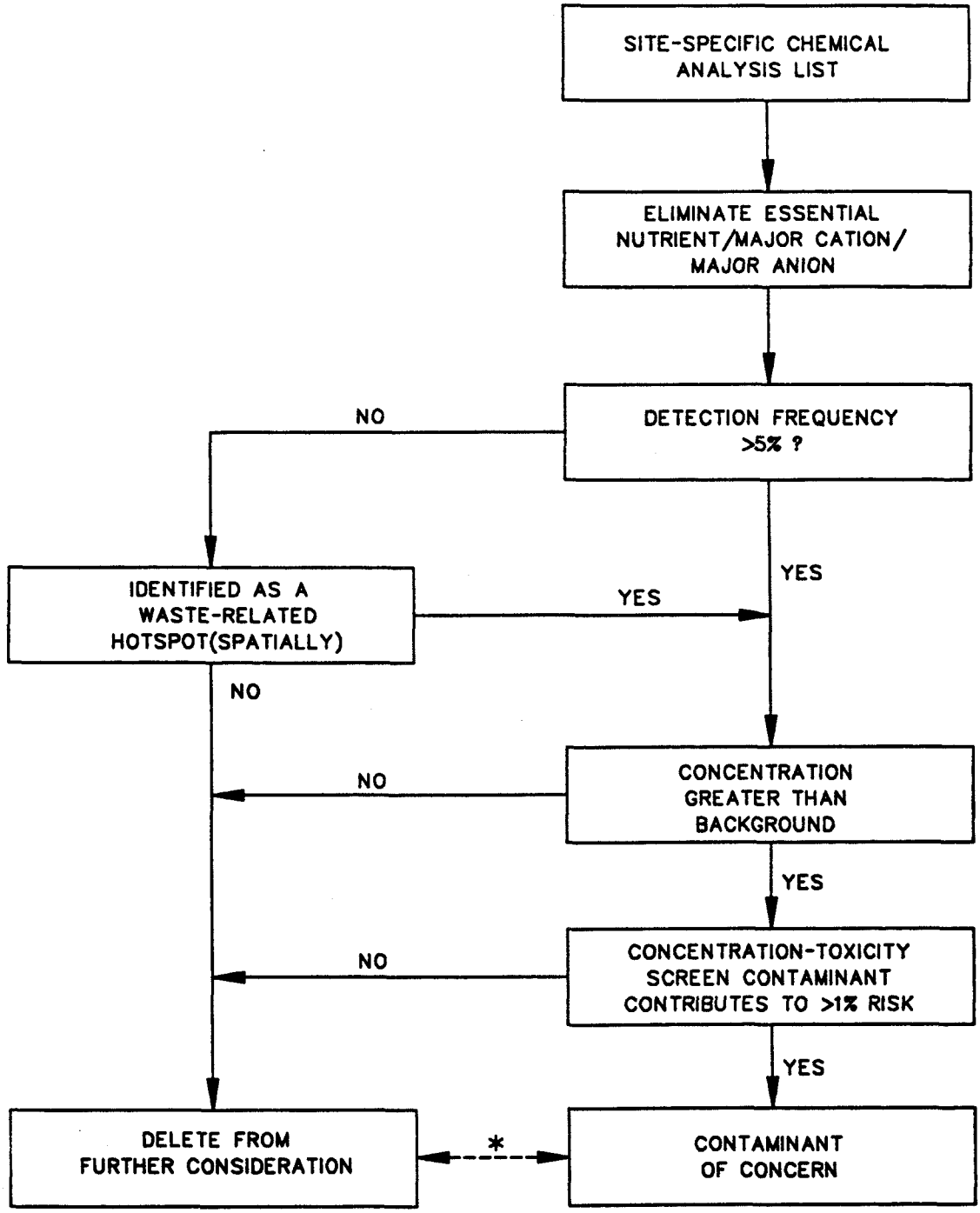
CHECKED BY BJN



* PROFESSIONAL JUDGEMENT MAY BE USED TO RETAIN OR DELETE A CHEMICAL

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FIGURE 8-2
PROTOCOL FOR INDENTIFICATION OF CONTAMINANTS OF CONCERN FLOW CHART

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MAY 27 1994

Approved by:

Manager, Remediation Programs 2/18/94

RI Project Manager 2/18/94

9.0 ENVIRONMENTAL EVALUATION WORK PLAN

9.1 INTRODUCTION

OU12 lies entirely within the production area at the RFP site in the 400, 700, and 800 building areas. This zone has been developed to such an extent that there are no viable ecosystems or natural habitat presently existing. There are insufficient ecosystems, components, or functions existing on OU12 to require a comprehensive ecological risk assessment. In addition, the area containing IHSSs in OU12 overlaps with other plant site OUs, and is contained within the OU9 preliminary study area. OU9 is the Original Process Waste Lines, a network that extends throughout much of the production area. The OU9 Environmental Evaluation (EE) Work Plan defines an ecological risk assessment within the production study area that is reduced in scope and focused on requirements proportional to the depauperate ecosystems considered. The objective of the OU12 EE is to address and characterize effects of contaminants on ecological resources present, and then to determine if there is a risk of contamination of offsite biota by target taxa migrating from the study area.

Coordination of OU12 EE requirements with the OU9 EE is mandated by the overlapping study areas. A two-stage approach will be conducted in the OU9 EE consisting of habitat and biota surveys and ecotoxicological investigations. Habitat and biological surveys proposed for OU9 will cover the entire industrial area, including OU12, and the results will apply to the OU12 study area. Following is a brief description of the study

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components presently proposed for OU9, and how these studies relate to the OU12 EE. These sections are based on the technical memorandum for a revision to the EE proposed for OU9 (EG&G, 1992i).

9.2 BIOLOGICAL AND HABITAT SITE CHARACTERIZATION

Biota and habitat surveys proposed for OU9 will be adequate for the biological and habitat characterization of OU12 and will not be duplicated or repeated. These surveys will provide the following information applicable to OU12:

- Comprehensive survey and mapping of types and extent of habitats, particularly habitats that could support migratory birds;
- Presence and/or use of habitats by raptors and migratory birds, including waterfowl and passerine species; and
- Presence or absence of threatened and endangered species, or species of special concern.

This characterization will include a literature review, expert consultation, and field surveys for habitat presence verification, bird species presence, vegetation, and mammal population characterization. This information will be included in the three following reports:

- Habitat survey report for compliance with acts and regulations protecting migratory birds;
- Biological survey report for compliance with acts and regulations protecting threatened and endangered species; and
- A report of results of small mammal investigations.

A list of state and federal plant and animal species of concern is included in Table 9.1. Although several birds, one plant species, and one mammal species are listed as occurring somewhere at RFP, (designated on the table with a "Y"), there are no habitats within OU12 anticipated to support their potential existence. The OU9 EE will address the potential presence of these species within the production area.

9.3 ECOTOXICOLOGICAL INVESTIGATIONS

Ecotoxicological investigations will be conducted if the following conditions are present on OU12:

- If target taxa are present on the study area and are accumulating or concentrating target analytes; and either
- The contaminated target taxa are capable of migration outside the OU12 study boundaries; or
- The contaminated target taxa are highly mobile and actually move outside the study or industrial area boundaries.

If the above conditions are not met, then it is presumed that there is no risk of contamination of offsite biota from OU12.

If an ecotoxicological investigation is necessary, it would consist of the following procedures:

- Developing a site-specific Conceptual Exposure Model to identify potential pathways for exposure of onsite biota;

- Developing a Conceptual Biota Transport model to identify potential pathways for offsite transport;
- Selection of target taxa and target analytes (biologically active COCs); and
- Direct measurement of target analytes within target taxa; and
- Potentially conducting histopathological investigations of selected organs and tissues to develop baseline pathology data.

A technical memorandum has been submitted for EPA and CDH review and approval and USFWS and CDOW review. The OU9 TM describes procedures for conducting this type of investigation for the industrial area and will be adapted, if needed, for the study area in OU12.

9.4 ENVIRONMENTAL EVALUATION REPORT

The Environmental Evaluation (EE) portion of the BRA in the OU12 RFI/RI report will consist of results from the OU9 investigation. If an ecotoxicological investigation is conducted, the results will be included in the EE portion of the BRA in the RFI/RI report.

TABLE 9.1

SOC SPECIES COMPLIANCE LIST AND HABITAT PREFERENCE

Group	Common Name	Scientific Name	Status	RFP	Habitat	Time
Plants	Forktip Threeawn	*Aristida besiramea*	CS	Y	xeric uplands with sandy soils and open barrens	year-round; blooms?
	Colorado Butterfly Plant	*Gaura neomexicana var. coloradensis*	C2,cs		transition between wetland bottoms and drier uplands above wet meadows	year-round; blooms Jul-Sep
	Toothcup	*Rotala ramosior*	CS		obligate wetland species	year-round; blooms?
	Divuvium Lady's Tresses	*Spiranthes diluvialis*	E,cs		moist swales dominated by grasses, wetlands dominated by sedges, rushes, and cattails	year-round; blooms late Jul-Aug
Amphibians & Reptiles	Northern Leopard Frog	*Rana pipens spp.*	C2,cu	Y?	breeds in marshes and intermitent ponds, forages in riparian and mountain meadows	year-round; breeds Mar-Jun
	Texas Horned Lizard	*Phynosoma comulum*	C2,ng		arid and semiarid open country, xeris uplands	year-round; forage in sm
Fish	Planis Topminnow	*Fundulus sciadicus*	C2		streams, lakes	year-round; spawn sp & esm
	Common Shiner	*Notropis comulus*	CS		streams, lakes	year-round; spawn sp & esm
Birds	Peregrine Falcon	*Falco peregrinus*	E,e	Y	nest in cliffs, forage in upland and wetland areas	year-round; sp & fl
	Bald Eagle	*Haliaeetus leuccaphalus*	E,e	Y	perch trees near body of water, riparian areas, or wetlands	year-round; sp & fl
	White-Faced Ibis	*Plegadic chichi*	C2,ng		near streams, meadows, ponds, and agricultural fields	migrant; sp, esm, fl
	Ferruginous Hawk	*Buteo regalis*	C2,ng,cs	Y	breeds in shortgrass prairie, croplands, mtn meadows, perks	year-round
	Whooping Crane	*Grus americana*	E,e		forages in marshes, cropland (grain fields), and sagebrush	migrant; sp & fl
	Harlequin Duck	*Histrionicus histrionicus*	C2		open water	migrant; sp & fl

TABLE 9.1

SOC SPECIES COMPLIANCE LIST & HABITAT PREFERENCE

Group	Common Name	Scientific Name	Status	RFP	Habitat	Time
Birds (continued)	Western Snowy Plover	*Charadrius alexandrius rivosus*	C2,ng,cs		prefers lakes & reservoirs	migrant; sp & fl
	Mountain Plover	*Charadrius montanus*	C2,ng,cs		xeric upland, shortgrass prairie	breeds esp-fl
	Piping Plover	*Charadrius melodus*	T,t		forages on open water or wet open ground	migrant; sp & fl
	Long-Billed Curlew	*Numenius americanus*	C3,ng,cs		grassland, lakes, reservoirs, or marshes	migrant; sp & fl
	Least Tern	*Sterna antillarum*	E,e		forages on open water or wet open ground	migrant; sp & fl
	Black Tern	*Childonia niger*	C2,ng		breeds in marshes, uses marshes and open water for migration	breeds esp-sm migrates sp & fl
	Swainson's Hawk	*Buteo swansonii*	C3C,ng	Y	nests in trees/shrubs, forages in grassland, agland, riparian areas, and greasewood	year-round; breeds lwn-sp
	Yellow-Billed Cockoo	*Coccyzus americanus*	C3B,cu,ng		riparian lowland, transition areas	breeds spl migrates sp & fl
Mammals	Swift Fox	*Vulpes velox*	C2,cu		shortgrass prairie, and areas with loose soils	year-round; breeds wn
	Black-Footed Ferret	*Mustela nigripes*	E,e		prairie dog colonies	year-round
	Preblas Meadow Jumping Mouse	*Zapus hudsonius preblei*	C2,cs	Y	moist fields, brush, brushy field, marsh, thick veg woods	breeds lsp-esm; forage sp & sm
	Fringed Myotis	*Myotis thysanodes*	C2,ng		old buildings	breeds sp; forage sm

Status:
(E) endangered species (federal)
(T) threatened species (federal)
(P) proposed to list (federal)
(e) endangered species (state)
(C1) Federal Category 1 (propose to list)
(C2) Federal Category 2 (appropriate to list but no data)
(C3) Federal Category 3 (formerly proposed)
(t) threatened species (state)
(ng) Colorado State nongame species
(cs) Colorado State nongame species of concern
(cu) Colorado State undetermined species

Approved by:

Manager, Remediation Programs 2/10/94

RI Project Manager 2/18/94

10.0 QUALITY ASSURANCE ADDENDUM

This section consists of the Quality Assurance Addendum (QAA) for investigations at Operable Unit 12 (OU12), which supplements the "Rocky Flats Plant Sitewide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP) (EG&G, 1991e). This QAA establishes the site specific Quality Assurance (QA) controls applicable to the investigation activities described in the OU12 work plan.

OU12 is one of 16 operable units (OUs) identified for investigations under the Rocky Flats Plant (RFP) Interagency Agreement (IAG). OU12 contains 10 individual hazardous substance sites (IHSSs), which are described in Section 2.0 of this RFI/RI work plan. The OU12 work plan was prepared in accordance with the federal and state of Colorado regulations and guidance documents identified in the Section 1.0, Introduction.

10.1 ORGANIZATION AND RESPONSIBILITIES

The overall organization of EG&G Rocky Flats and the Environmental Management Department (EMD) and divisions involved in Environmental Restoration (ER) Program activities is shown in Figures 1-1, 1-2, and 1-3 of Section 1.0 of the QAPjP. Individual responsibilities are also described in Section 1.0 of the QAPjP.

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Contractors will be tasked by EG&G Rocky Flats to implement the field activities outlined in the OU12 work plan. The specific EMD personnel who will interface with the Contractors and who will provide technical direction are shown in Figure 10-1.

10.2 QUALITY ASSURANCE PROGRAM

The QAPjP was written to address QA controls and requirements for implementing IAG-related activities. The content of the QAPjP was driven by Department of Energy (DOE) RFP Standard Operating Procedure (SOP) 5700.6B, which requires a QA program to be implemented for all RFP activities based on American Society of Mechanical Engineers (ASME) NQA-1, "Quality Assurance Requirements for Nuclear Facilities," as well as the IAG, which specifies that a QAPjP for IAG-related activities be developed in accordance with the Environmental Protection Agency (EPA), "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," (QAMS-005/80). The 18-element format of NQA-1 was selected as the basis for both the QAPjP and subsequent QAA with the applicable elements of QAMS-005/80 incorporated where appropriate. Figure 2-1 of the QAPjP illustrates where the 16 QA elements of QAMS-005/80 are integrated into the QAPjP and also into this QAA. Section 2.0 of the QAPjP also identifies other DOE Orders and QA requirements documents to which the QAPjP and this QAA are responsive.

The controls and requirements addressed in the QAPjP are applicable to OU12 activities, unless specified otherwise in this QAA. Where sitewide actions are applicable to OU12 activities, the applicable section of the QAPjP is referenced in this QAA. This QAA addresses additional and site-specific QA controls and requirements that are applicable to OU12 activities that may not have been addressed on a sitewide basis in the QAPjP. Many of the QA requirements specific to OU12 are addressed in the OU12 work plan and are referenced in this QAA.

10.2.1 Training

Personnel qualification and training requirements for RFP ER Program activities are addressed in Section 2.0 of the QAPjP. Personnel qualifications and training required to perform the EMD SOPs that are applicable to OU12 investigations are specified within the respective procedures. The EMD SOPs are identified in Table 10.1.

10.2.2 Quality Assurance Reports to Management

A QA summary report shall be prepared annually or at the conclusion of these activities (whichever is more frequent) by the EMD Quality Assurance Project Manager (QAPM) or designee. This report shall include a summary of field operation and laboratory inspections, surveillance, and audits and a report on data verification and validation results.

10.3 DESIGN CONTROL AND CONTROL OF SCIENTIFIC INVESTIGATIONS

10.3.1 Design Control

The OU12 work plan describes the investigation activities that will be implemented during the characterization of the OU12 IHSSs. The OU12 work plan identifies the objectives of the investigations; specifies the sampling, analysis, and data generation requirements; and identifies applicable operating procedures that will provide controls for the investigations. As such, the OU12 work plan is considered the investigation control plan for OU12 RFI/RI activities.

10.3.2 Data Quality Objectives

Data needs and data quality objectives (DQOs) for OU12 investigations are addressed in Sections 4.0 and 8.0. Identification of data needs and objectives assist decision makers in determining what the quality of the data should be, which in turn dictates the type of quality controls that are necessary to ensure that data of appropriate quality are generated. The

DQOs for the OU12 investigations were established in accordance with Appendix A of the QAPjP. Data quality can be measured in terms of precision, accuracy, representativeness, comparability and completeness (also referred to as PARCC parameters). These parameters are defined in Appendix A of the QAPjP.

PARCC parameter goals are established prior to initiating investigations in order to assist decision makers in determining if DQOs for measurement data have been met. Historical precision and accuracy measures for EPA Contract Laboratory Program (CLP) analytical methods have been determined. These historical measures have been selected as the goals for all Analytical Level IV data. Analytical levels are defined and discussed in Appendix A of the QAPjP and Section 4.0 of this work plan. The precision and accuracy goals for Analytical Level III, IV, and V data for EPA Target Analyte List, Target Compound List, and several indicator analytes are listed in Appendix B of the QAPjP. Precision and accuracy goals for Analytical Level I and II data, which consist of field screening and analysis measurements, have been established for several parameters and are also presented in Appendix B of the QAPjP. Table 4.3 of the OU12 work plan identifies the analytical levels for each type of data to be generated during field investigations. Goals for representativeness, comparability, and completeness for the RFP ER Program investigations, including OU12 investigations, are discussed in Appendix A of the QAPjP.

The ecological characterization activities inherent in Section 9.0 are to be accomplished in the OU12 EE. These characterization data typically require Analytical Level I and II data. Data quality for these characterization activities shall be controlled by adhering to the field sampling operating procedures used in the OU12 EE.

10.3.3 Sampling Locations and Sampling Procedures

Sampling locations and frequencies for radiological surveys, soil gas, asphalt/concrete samples, soil, and ground water for OU12 IHSSs are addressed in Section 6.3 and summarized in Table 6.1. Sampling equipment and procedures for this sampling are identified in Section 6.4. The SOPs that are applicable to OU12 field activities and the particular activities to which they are applicable are summarized in Table 10.1. SOPs for the Environmental Evaluation in OU12 are presented in the OU9 Phase I RFI/RI Work Plan.

10.3.4 Analytical Procedures

The analytical program for the OU12 RFI/RI investigation is discussed in Section 6.5. The analytes of interest and the specified detection limits are identified in Table 6.2. The analytical methods that shall be adhered to are those that are specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B. These methods are referenced in Section 3.0 of the QAPjP. Specific analytical methods for each analyte identified in Section 6.5 are referenced in Appendix B of the QAPjP.

10.3.5 Equipment Decontamination

Non-dedicated sampling equipment (i.e., sampling equipment that is used at more than one location) shall be decontaminated between sampling locations in accordance with SOP FO.3, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, hydrogeologic/geologic testing, boring, sample collection, etc. shall also be decontaminated as specified in EMD SOP FO.4, Heavy Equipment Decontamination.

10.3.6 Air Quality

Air monitoring shall be conducted during implementation of field activities that have the potential to create windblown dispersion of contaminants, including drilling, coring, and installation of boreholes and monitoring wells. Air monitoring will ensure that OU12 RFI/RI activities comply with the RFP Interim Plan for Prevention of Contaminant Dispersion. Air Monitoring shall be conducted according to EMD SOP FO.1, Wind Blown Contaminant Dispersion Control.

10.3.7 Quality Control

To ensure the quality of the field sampling techniques, collection and/or preparation of field quality control (QC) samples are incorporated into the sampling scheme. Field QC samples and collection frequencies for OU12 are addressed in Section 6.7 and identified in Table 6.5. A specific sampling schedule shall be prepared by the sampling subcontractor for approval by the EG&G Project Manager, prior to sampling.

10.3.7.1 Objectives for Field QC Samples

Equipment rinseate blanks are considered acceptable, if the concentration of analytes of interest is less than three times the required detection limit for each analyte as specified in Table 6.2. Field duplicate samples shall agree with 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples.

Field preservation blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits presented in Table 6.2. The Laboratory Analysis Task Leader, shown in the organization chart on Figure 10-1, is responsible for verifying these criteria and shall be responsible for checking to see if they are met and for qualifying data.

10.3.7.2 Laboratory QA

Laboratory QA procedures are used to provide measures of internal consistency of analytical and storage procedures. The laboratory contractor shall submit written SOPs to the Laboratory Analysis Task Leader for approval. The interlaboratory SOPs shall be consistent with EPA-CLP QC procedures or provide acceptance criteria for those analytical methods and compounds than do not have specific CLP procedures. The laboratory SOPs must cover the following areas in sufficient detail and reflect actual operating conditions in effect during analysis of EG&G RFP samples:

- Sample receipt and log-in;
- Sample storage and security;
- Facility security;
- Sample tracking (from receipt to sample disposition);
- Sample analysis method references;
- Data reduction, verification, and reporting;
- Document control (including submitting documents to EG&G);
- Data package assembly (see Section 111.A of the GRRASP);
- Qualifications of personnel;
- Preparation of standards;
- Equipment maintenance and calibration;
- List of instrumentation and equipment (including date purchased, date installed, model number, manufacturer, and service contracts, if any);

- Instrument detection limits;
- Acceptance criteria for non-CLP analyses; and
- Laboratory QC checks applicable to each analytical method.

Laboratory QC techniques to ensure consistency and validity of analytical results (including detecting potential laboratory contamination of samples) include using reagent blanks, field blanks, internal standard reference materials, laboratory replicate analysis, and field duplicates. The laboratory contractor shall follow the standard evaluation guidelines and QC procedures, including frequency of QC checks, that are applicable to the particular type of analytical method being used as specified in Parts A and B of the GRRASP and Section 3.0 of the QAPjP. All data packages shall be forwarded to the Laboratory Analysis Task Leader, the project manager or the validation contractor, shown organizationally on Figure 10-1 for review and verification.

10.3.8 Quality Assurance Monitoring

To assure the overall quality of the RFI/RI activities discussed in the OU12 work plan, field inspections shall be conducted daily and audits and surveillance will be conducted at various intervals. The intervals will be determined by the importance and complexity of each activity. Intervals will also be based on the schedule contained in Section 7.0. At a minimum, each of the field sampling activities described in Sections 6.3 shall be monitored by an independent surveillance team at least once during the sampling process. EG&G will conduct audits of the laboratory contractor(s) as specified in the GRRASP, Parts A and B. The audits and surveillance, and activity Readiness Reviews are discussed further in Section 10.18.

10.3.9 Data Reduction, Validation, and Reporting

10.3.9.1 Analytical Reporting Turnaround Times

Analytical reporting turnaround times are as specified in Table 3.1 of Section 3.0 of the QAPjP.

10.3.9.2 Data Reduction

Reduction of laboratory measurements shall be in accordance with the methods specified for each analytical method. Laboratory data shall be compiled into sample data packages by the laboratory contractor. A sample data package shall be developed for each sample delivery group or sample batch, with separate data packages for each type of analysis (e.g., a data package for organics, one for inorganics, one for water quality parameters, and one for radionuclides). The sample data package shall consist of a cover sheet/transmittal letter, a case narrative, data summary forms, and copies of the data checklists found in Attachments I in Parts A and B of the GRRASP. The reduced data will be used in the data validation process to verify that the laboratory control and the overall system DQOs have been met.

10.3.9.3 Data Validation

Validation activities consist of reviewing and verifying field and laboratory data and evaluating these verified data for data quality. Data quality is determined by precision, accuracy, representativeness, comparability, and completeness of the data. The field and laboratory data validation activities and guidelines are described and referenced in Section 3.0 of the QAPjP. The process for validating the quality of the data is illustrated graphically in Figure 3-1 of Section 3.0 of the QAPjP, and is also included as part of the sample collection, chain-of-custody, and analysis process illustrated in Figure 8-1 of

Section 8.0 of the QAPjP. The criteria for determining the validity of ER data at Rocky Flats are described in Section 3.3.7 of the QAPjP.

10.3.9.4 Data Reporting

Depending on the data validation process, data shall be flagged as either "valid," "acceptable with qualifications," or "rejected." The results of the data validation shall be reported in ER Department Data Assessment Summary reports. The usability of data (the criteria of which is also described in Section 3.3.7 of the QAPjP) shall also be addressed by the RFI Project Manager.

10.4 PROCUREMENT DOCUMENT CONTROL

Procurement documents for items and services, including services for conducting field investigations and analytical laboratories, shall be prepared, handled, and controlled in accordance with the requirements and methods specified in Section 4.0 of the QAPjP.

10.5 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

The OU12 work plan describes the activities to be performed. The OU12 work plan shall be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined in Section 5.0 of the QAPjP.

EMD SOPs approved for use are identified in Table 10.1, which also indicates their applicability. Any additional quality-affecting procedures proposed for use but not identified in Table 10.1 will be developed and approved as required by Section 5.0 of the QAPjP prior to performing the affected activity.

Changes and variances to approved operating procedures and the OU12 work plan shall be documented through preparation of Document Change Notices (DCNs), which will be prepared, reviewed, and approved in accordance with requirements specified in Section 5.0 of the QAPjP. (Note: DCNs were referred to as Procedure Change Notices in Revision 0 of the QAPjP).

10.6 DOCUMENT CONTROL

The following documents shall be controlled in accordance with Section 6.0 of the QAPjP:

- RFI/RI Work Plan, Operable Unit No. 12;
- Rocky Flats Plant Sitewide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities (QAPjP);
- Quality Assurance Addendum (QAA) to the Rocky Flats Sitewide QAPjP for Operable Unit No. 12, RFI/RI Activities; and
- EMD Standard Operating Procedures (all operating procedures specified in the QAPjP, this QAA, and to-be-developed laboratory SOPs).

10.7 CONTROL OF PURCHASED ITEMS AND SERVICES

Contractors that provide services to support the OU12 work plan activities shall be selected and evaluated as outlined in Section 7.0 of the QAPjP. This includes preaward evaluation and audit of proposed contractors as well as periodic audit of the acceptability of contractor performance during the life of the contract. Any items or materials that are purchased for use during the OU12 investigations that have the ability to affect the quality of the data shall be inspected upon receipt.

10.8 IDENTIFICATION AND CONTROL OF ITEMS, SAMPLES, AND DATA

10.8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for water and soil samples are presented in Table 6.3.

10.8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with Section 8.0 of the QAPjP and EMD SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Samples shall have unique identification that traces the sample to the appropriate IHSS, and indicates the method(s), date, the sampler(s), and conditions prevailing at the time of sampling.

10.8.3 Chain-of-Custody

Sample chain-of-custody shall be maintained through the application of EMD SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples, and as illustrated in Figure 8-1 of the QAPjP for all environmental samples collected during field investigations.

10.9 CONTROL OF PROCESSES

The overall process of collecting samples, performing analyses, and inputting the data into a database is considered a process that requires control. The process is controlled through a series of written procedures that govern and document the work activities. A process diagram is shown in Section 8.0 of the QAPjP.

10.10 INSPECTION

Procured materials and construction activities (e.g., ground water monitoring well installation) shall be inspected (as applicable) in accordance with the requirements specified in Section 10.0 of the QAPjP.

10.11 TEST CONTROL

Test control requirements specified in Section 11.0 of the QAPjP will be followed during the conduct of slug tests in monitor wells at OU12 IHSS investigations.

10.12 CONTROL OF MEASURING AND TEST EQUIPMENT (M&TE)

10.12.1 Field Equipment

Specific conductivity, temperature, pH, dissolved oxygen content, oxidation-reduction potential, and turbidity of water samples shall be measured in the field. Hexavalent chromium, nitrate, and sulfate will also be determined in the field for selected samples. Field measurements shall be taken, and the instruments will be calibrated as specified in EMD SOP SW.2, Field Measurements of Surface Water Parameters. Measurements shall be made using the following equipment (or EG&G-approved alternates):

- Temperature: mercury-filled, teflon-coated, safety-type thermometer (VWR Catalogue No. 6107-832 or equivalent) or digital readout thermistor (VWR Catalogue No. 61017-562 or equivalent);
- Specific Conductivity: HACH 44600 Conductivity/TDS Meter or YSI Model 3500 flow through cell;
- Dissolved Oxygen: HACH or YSI Model 3500 flow through cell;
- pH: HACH One pH Meter (this meter may also be used for temperature measurements) or YSI Model 3500 flow through cell;

- Oxidation-reduction potential: platinum redox electrode;
- Sulfate and Turbidity: HACH DR2000 spectrophotometer;
- Alkalinity: HACH digital titrator;
- Hexavalent Chromium: Chemetrics K-2810 Chemets kit; and
- Nitrate: Chemetrics K-6902 Chemets kit.

In addition to the field measurements for water quality, field measurements for radiation, soil gas, and volatile organics in soil and ground water shall also be made. The following instruments will be used for these measurements.

- Radiological field readings for field survey grid locations, soil samples, and drill cuttings, core, and samples: A high purity germanium (HPGe) gamma ray detector. Use, calibration, and maintenance will be according to EMD SOP currently in development; and
- Field measurements of volatile organics in soil gas, soil, and ground water: A mobile laboratory equipped with gas chromatographs with multiple detectors. Use, calibration, and maintenance will be according to procedures described in Appendix H.

Each piece of field equipment shall have a file that contains:

- Specific model and instrument serial number;
- Operating instructions;
- Routine preventative maintenance procedures, including a list of critical spare parts to be provided or available in the field;

- Calibration methods, frequency, and description of the calibration solutions; and
- Standardization procedures (traceability to nationally-recognized standards).

The above information shall, in general, conform to the manufacturer's recommended operating instructions or shall explain the deviation from said instructions.

10.12.2 Laboratory Equipment

Laboratory analyses will be performed by contracted laboratories. The equipment used to analyze environmental samples shall be calibrated, maintained, and controlled in accordance with the requirements contained in the specific analytical protocols used as specified in the GRRASP. This information shall be supplied to EG&G as a laboratory SOP.

10.13 HANDLING, STORAGE, AND SHIPPING

Samples shall be packaged, transported, and stored in accordance with SOP FO.13, Containerizing, Preserving, Handing, and Shipping of Soil and Water Samples. Maximum sample holding times, sample preservation, sample volumes, and sample containers are specified in Table 8.1 of the QAPjP. Sample handling and storage controls at the laboratory shall be provided as a laboratory SOP.

10.14 STATUS OF INSPECTION, TEST, AND OPERATIONS

The requirements for the identification of inspection, test, and operating status shall be implemented as specified in Section 14.0 of the QAPjP. A log specifying the status of all boreholes and ground water monitoring wells shall be maintained by the Field Activities Task Leader, which shall include well/borehole identification number, ground elevation, casing depth of hole, depth to bedrock, static water level (as applicable), depth to top and

bottom of screen (as applicable), diameter of hole, diameter of casing, and top/bottom of casing.

10.15 CONTROL OF NONCONFORMANCES

The requirements for the identification, control, evaluation, and disposition of nonconforming items, samples, and data shall be implemented as specified in Section 15.0 of the QAPjP. Nonconformances identified by the implementing contractor shall be submitted to EG&G for processing as outlined in the QAPjP.

10.16 CORRECTIVE ACTION

The requirements for the identification, documentation, and verification of corrective actions for conditions adverse to quality will be implemented as outlined in Section 16.0 of the QAPjP. Conditions adverse to quality identified by the implementing contractor shall be documented and submitted to EG&G for processing as outlined in the QAPjP.

10.17 QUALITY ASSURANCE RECORDS

QA records shall be controlled in accordance with EMD SOP FO.2, Field Document Control. QA records to be generated during OU12 RFI/RI activities include, but are not limited to:

- Field Logs and Data Record Forms (e.g., sample collection notebooks/logs for water, soil, and air);
- Calibration Records;
- Sample Collection and Chain-of-Custody Records;
- Laboratory Sample Data Packages;

- Drilling Logs;
- Work Plan/Field Sampling Plan;
- QAPjP/QAA;
- Audit/Surveillance/Inspection Reports;
- Nonconformance Reports;
- Corrective Action Documentation;
- Data Validation Results;
- Data Reports;
- Procurement/Contracting Documentation;
- Training/Qualification Records; and
- Inspection Records.

10.18 QUALITY VERIFICATION

The requirements for the verification of quality shall be implemented as specified in Section 18.0 of the QAPjP. EG&G shall conduct audits of the laboratory contractor as specified in the GRRASP, Parts A and B. The EMD QAPM shall develop a surveillance schedule with the surveillance intervals based on the importance and complexity of each sampling/analytical activity. Intervals will also be based on the schedule contained in Section 7.0.

Examples of some specific tasks that shall be monitored by the surveillance program are as follows:

- Soil borings and well installation (approximately 10 percent of the holes);
- Field sampling (approximately 5 percent of each type of sample collected);
- Records management (a surveillance will be conducted once at the initiation of OU12 activities and monthly thereafter); and
- Data verification, validation, and reporting.

Audits of contractors providing field investigation, construction, and analytical support services shall be performed at least annually or once during the life of the project, whichever is more frequent.

A Readiness Review shall be conducted by the EMD QAPM prior to the implementation of OU12 field investigation activities. The readiness review will determine if all activity prerequisites have been met that are required to begin work. The applicable requirements of the QAPjP and this QAA shall be addressed.

10.19 SOFTWARE CONTROL

The requirements for the control of software shall be implemented as specified in Section 19.0 of the QAPjP. Only database software is anticipated to be used for the OU12 work plan activities. Operating procedures applicable to the use of the database storing environmental data can be found in EMD SOP FO.14, Field Data Management.

TABLE 10.1
STANDARD OPERATING PROCEDURES AND FIELD ACTIVITIES FOR WHICH THEY ARE APPLICABLE

EMD SOP Reference Number	Standard Operating Procedure	Field Screening Surveys[a]	Surface Soil Sampling	Sediment Sampling	Well Drilling Completion, Development	Subsurface Soil/Mst. Sampling	Ground Water Sampling
FO.1	Wind Blown Contaminant Dispersion Control				xx	xx	
FO.2	Field Document Control	xx	xx	xx	xx	xx	xx
FO.3	General Equipment Decontamination	xx	xx	xx	xx	xx	xx
FO.4	Heavy Equipment Decontamination		xx	xx	xx	xx	xx
FO.5	Handling of Purge and Development Water				xx		xx
FO.6	Handling of Personal Protective Equipment	xx	xx	xx	xx	xx	xx
FO.7	Handling of Decontamination Water & Wash Water	xx	xx	xx	xx	xx	xx
FO.8	Handling of Drilling Fluids & Cuttings			xx	xx	xx	
FO.9	Handling of Residual Samples		xx			xx	
FO.10	Receiving, Labelling, and Handling Waste Containers				xx	xx	xx
FO.11	Field Communications	xx	xx	xx	xx	xx	xx
FO.12	Decontamination Facility Operations	xx	xx	xx	xx	xx	xx
FO.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples		xx	xx		xx	xx
FO.14	Field Data Management	xx	xx	xx	xx	xx	xx
FO.15	Use of PIDs and FIDs		xx	xx	xx	xx	xx
FO.16	Field Radiological Measurements & Walk-Over Surveys	xx	xx	xx	xx	xx	xx
FO.18	Environmental Sample Radioactivity Content Screening		xx	xx		xx	xx
GW.1	Water Level Measurements in Wells and Piezometers				xx		xx
GW.2	Well Development				xx		

TABLE 10.1
STANDARD OPERATING PROCEDURES AND FIELD ACTIVITIES FOR WHICH THEY ARE APPLICABLE

EMD SOP Reference Number	Standard Operating Procedure	Field Screening Surveys[a]	Surface Soil Sampling	Sediment Sampling	Well Drilling Completion, Development	Subsurface Soil/Mst. Sampling	Ground Water Sampling
GW.5	Measurements for Ground Water Field Parameters						xx
GW.6	Ground Water Sampling						xx
GT.1	Logging Alluvial and Bedrock Material				xx	xx	
GT.2	Drilling and Sampling Using Hollow-Stem Auger Techniques				xx	xx	
GT.3	Isolating Bedrock from the Alluvium with Surface Casing				xx	xx	
GT.4	Rotary Drilling and Rock Coring				xx	xx	
GT.5	Plugging and Abandonment of Boreholes				xx	xx	
GT.6	Monitoring Well and Piezometer Installation				xx		
GT.8	Surface Soil Sampling		xx				
GT.9	Soil Gas Sampling and Field Analysis	xx					
GT.10	Borehole Cleaning					xx	
GT.11	Plugging and Abandonment of Wells				xx		
GT.17	Land Surveying				xx	xx	
SW.6	Sediment Sampling			xx			

- New SOPs may need to be developed for the proposed HPGe radiological survey and verification sampling, the subsurface soil and ground water screening, and the installation and use of vadose zone sampling equipment.

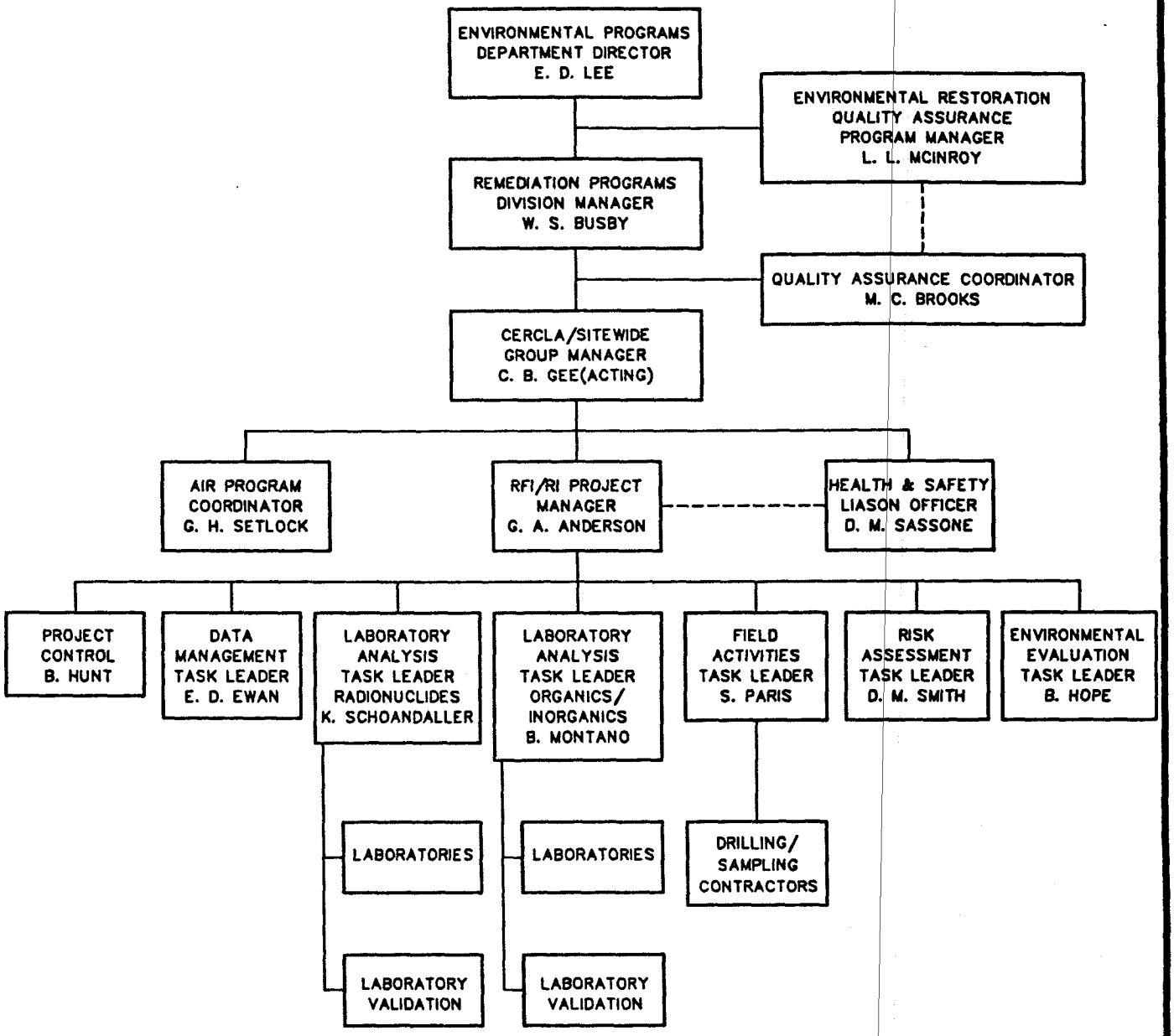

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FIGURE 10-1
PROJECT MANAGEMENT CHART FOR OU12

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MAY 27 1994

Approved by:

Manager, Remediation Programs 2/18/94

RI Project Manager 2/18/94

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JUNE 11, 1991

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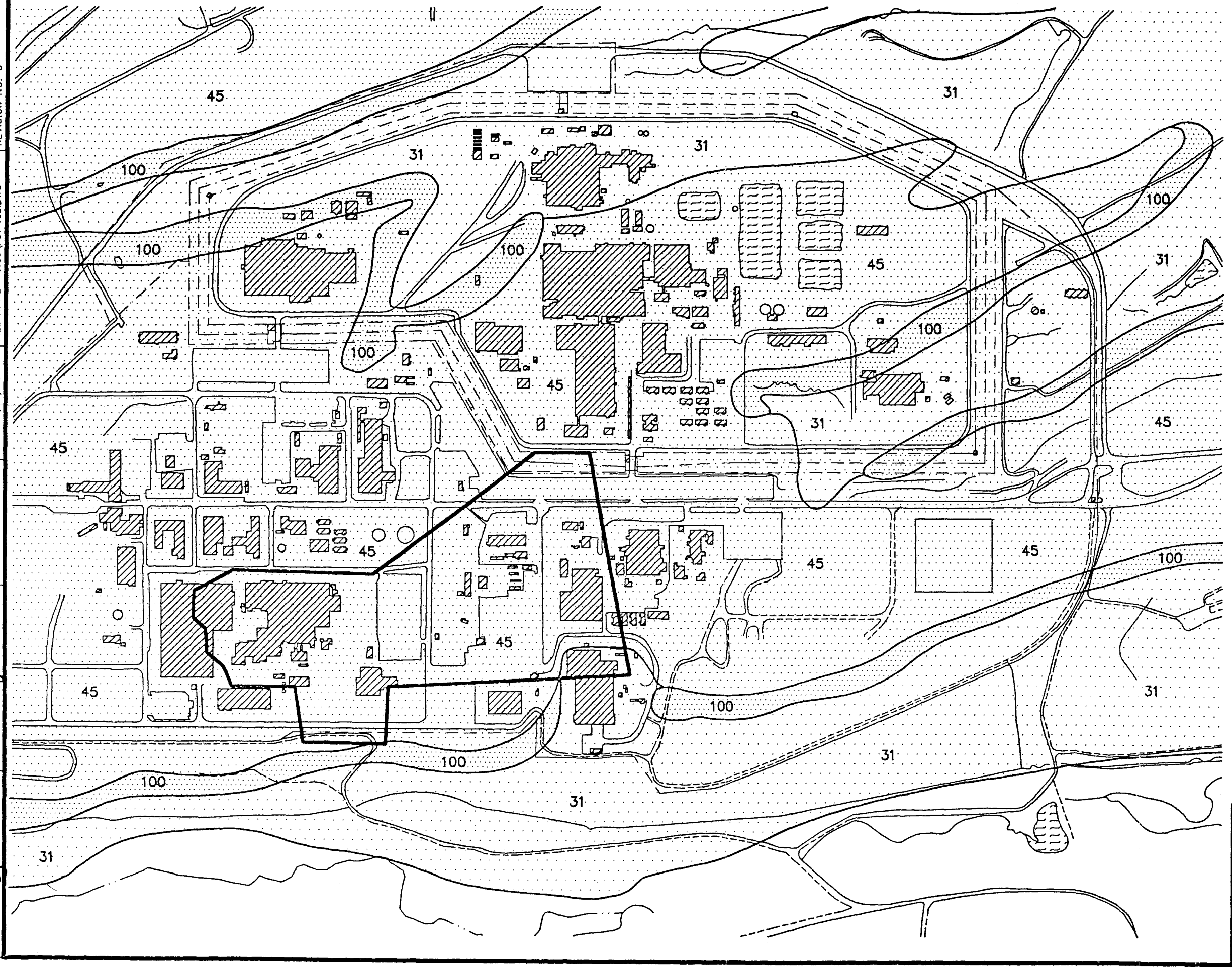

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FIGURE 1-8
SOILS IN THE VICINITY OF ROCKY FLATS PLANT

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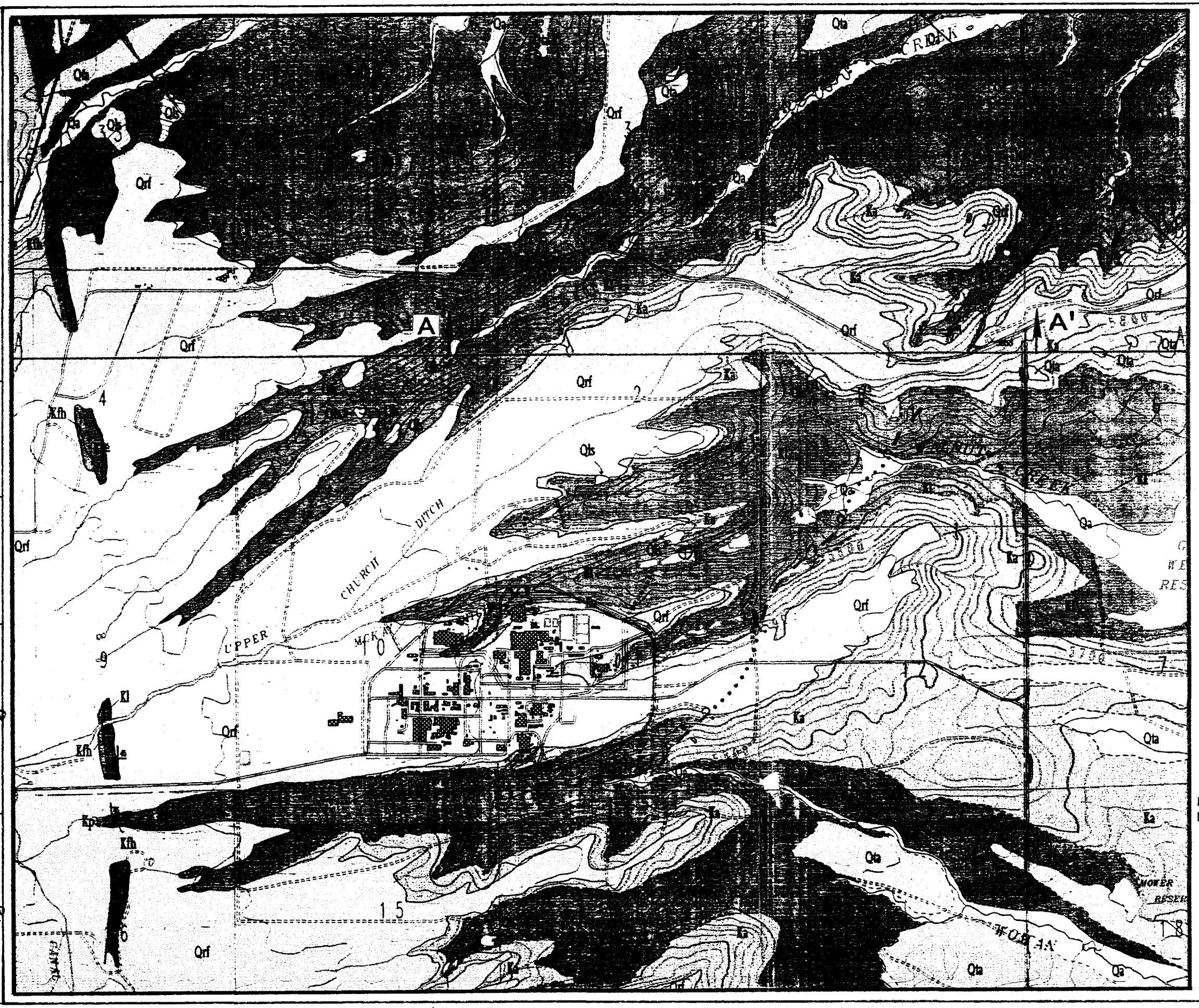

EXPLANATION

- Af Artificial Fill (RECENT)
- Qa Valley Fill Alluvium (RECENT)
- Qls Landslide Slump (RECENT)
- Qta Undiff. Terrace Alluvium (PLEISTOCENE)
- Qrf Rocky Flats Alluvium (PLEISTOCENE)
- Ka Arapahoe Formation (CRETACEOUS)
- Kl Laramie Formation (CRETACEOUS)
- Kfh Fox Hills Sandstone (CRETACEOUS)
- Kp Pierre Shale (CRETACEOUS)

Strike and dip of bedding planes in bedrock

50 inclined — vertical — 20 overturned — horizontal

A A' CROSS SECTION A-A'

Gravel, sand, or clay pit — BM Benchmark

Area of bedrock exposure

Contact
dashed where approx. located
dotted where concealed

Fault
dashed where approx. located
dotted where concealed
U, upthrown side; D, downthrown side

SCALE 1" = 2000'

2000' 0 2000'

MODIFIED FORM: PHASE II GEOLOGIC CHARACTERIZATION DATA ACQUISITION, EG&G 1992b

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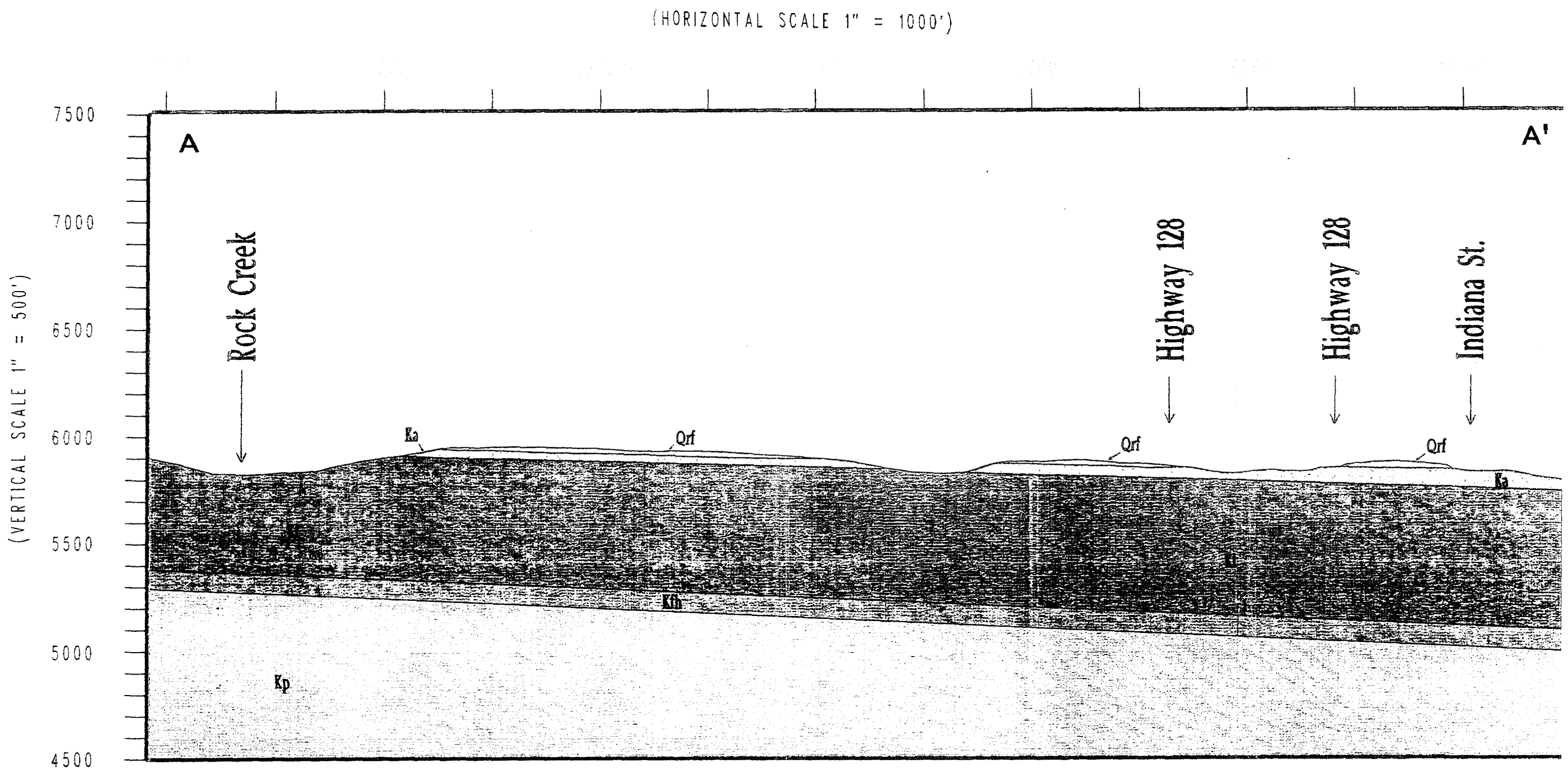
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 1-11
GEOLOGIC STRUCTURE IN THE VICINITY OF ROCKY FLATS PLANT

REVISION NO. 0 | FILE NAME 40103\F01-111.DWG | DATE 4/30/92 | DRAWN BY JAA | APPROVED BY BTN | CHECKED BY BTN



EXPLANATION

- af Artificial Fill (RECENT)
- Qa Valley Fill Alluvium (RECENT)
- Qls Landslide Slump (RECENT)
- Qta Undiff. Terrace Alluvium (PLEISTOCENE)
- Qrf Rocky Flats Alluvium (PLEISTOCENE)
- Ka Arapahoe Formation (CRETACEOUS)
- Kl Laramie Formation (CRETACEOUS)
- Kfh Fox Hills Sandstone (CRETACEOUS)
- Kp Pierre Shale (CRETACEOUS)

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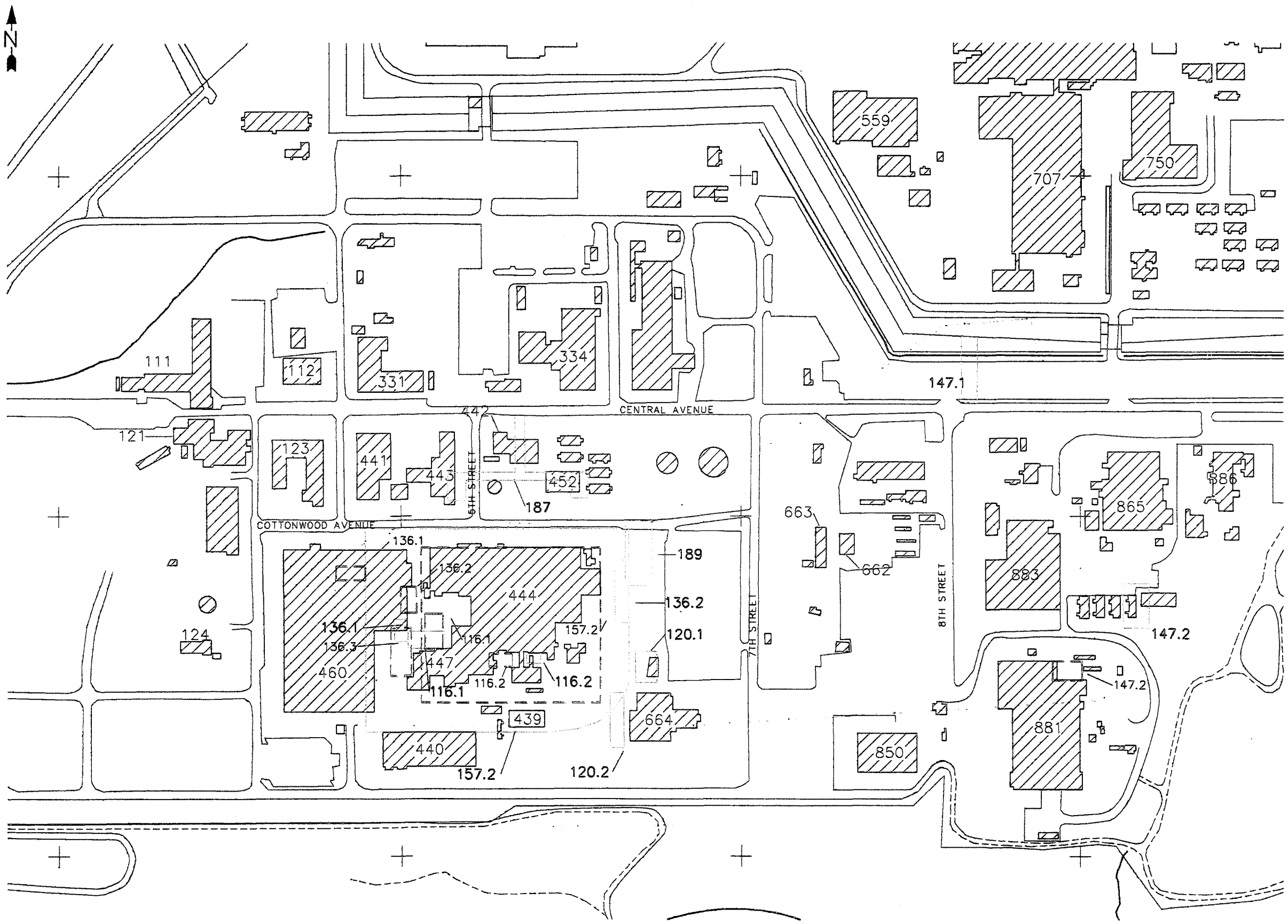
GOLDEN, COLORADO

FIGURE 1-12
REGIONAL GEOLOGIC CROSS SECTION IN THE VICINITY OF ROCKY FLATS PLANT

REVISION NO. 0 | FILE NAME 40103\F01-112.DWG | DATE 5/1/92 | DRAWN BY JAA | APPROVED BY BM | CHECKED BY BM



EXPLANATION

OU12 BOUNDARY

IHSS BOUNDARY

PREVIOUS IHSS BOUNDARY

KEY TO IHSS LOCATIONS

116.1	WEST LOADING DOCK, BUILDING 447
116.2	SOUTH LOADING DOCK, BUILDING 444
136.1	COOLING TOWER POND WEST OF BUILDING 444
136.2	COOLING TOWER POND EAST OF BUILDING 444
157.2	RADIOACTIVE SITE SOUTH AREA
187	SULFURIC ACID SPILL
120.1	FIBERGLASSING AREA NORTH OF BUILDING 664
120.2	FIBERGLASSING AREA WEST OF BUILDING 664
189	NITRIC ACID TANKS
147.1	PROCESS WASTE LINE LEAKS(TRANSFERRED TO OU9)
147.2	BUILDING 881 CONVERSION ACTIVITY

150 0 150 300 FEET

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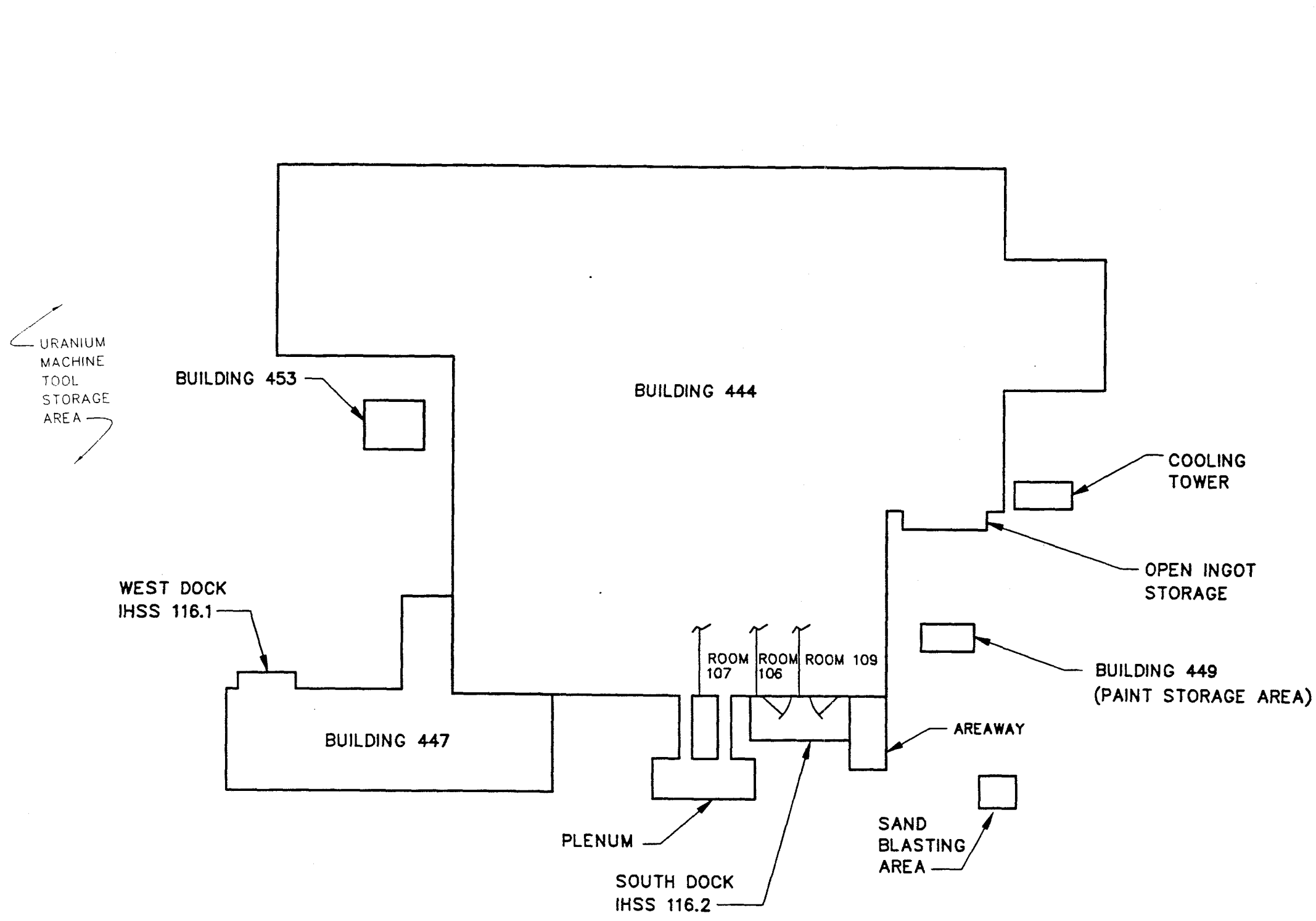
FIGURE 2-1
LOCATION OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES IN OU12

REVISION NO. 0 | FILE NAME 40103\F01-201.DWG | DATE 9/15/92 | DRAWN BY JAA | APPROVED BY BN | CHECKED BN



MODIFIED FROM: HISTORICAL RELEASE REPORT, JUNE 1992

NOT TO SCALE

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GOLDEN, COLORADO

FIGURE 2-2
BUILDING 444, 447, AND 453 LAYOUT

REVISION NO. 0 | FILE NAME 40103\F01-202.DWG | DATE 9/15/92 | DRAWN BY JAA | APPROVED BY BTN | CHECKED BY BTN

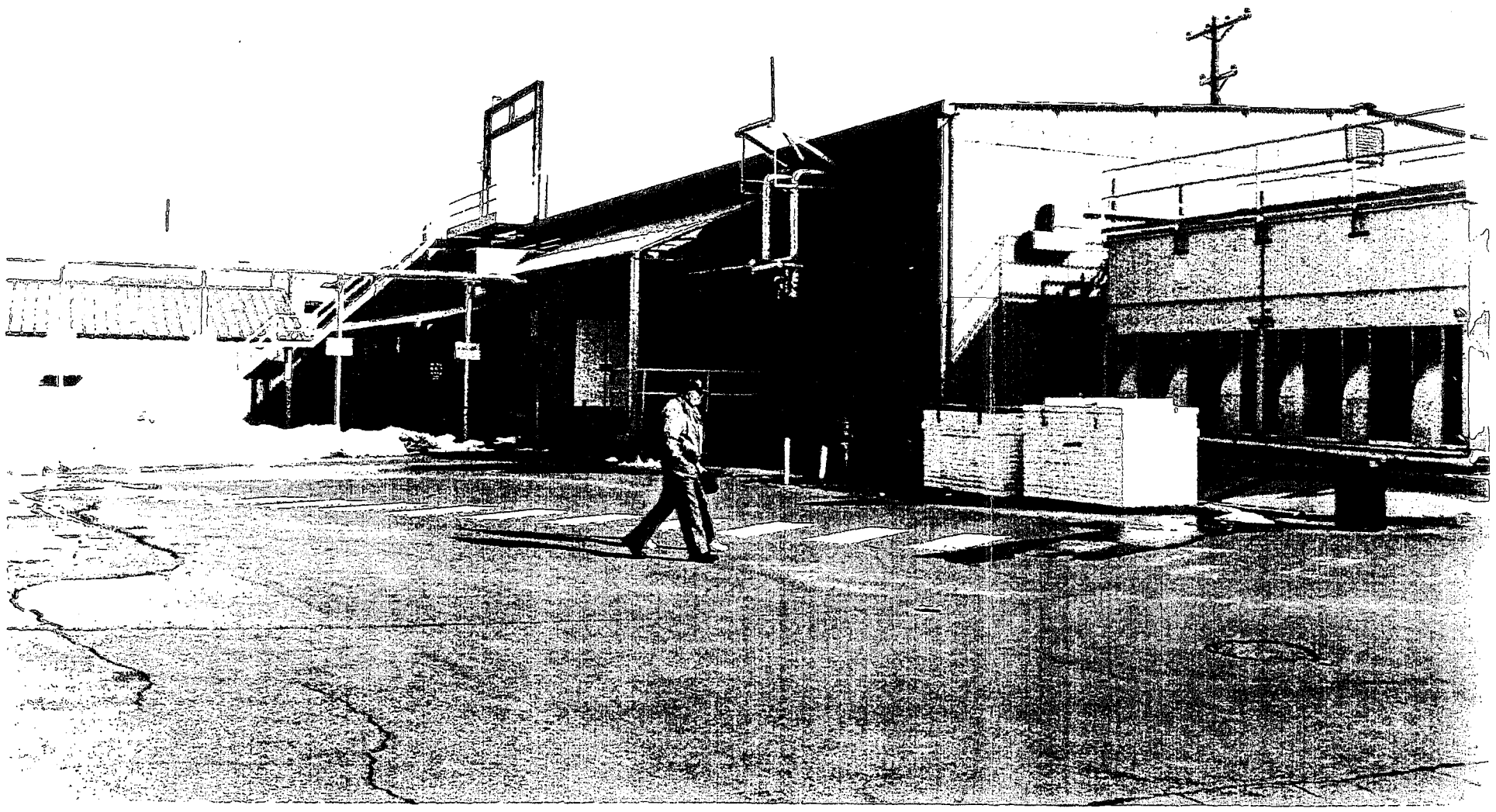

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FIGURE 2-4
SITE PHOTO
IHSS 116.1

CHECKED BY BJN	APPROVED BY BJN	DRAWN BY JAA	DATE 4/29/92 AC	FILE NAME 40103\F01-204.DWG	REVISION NO. 0

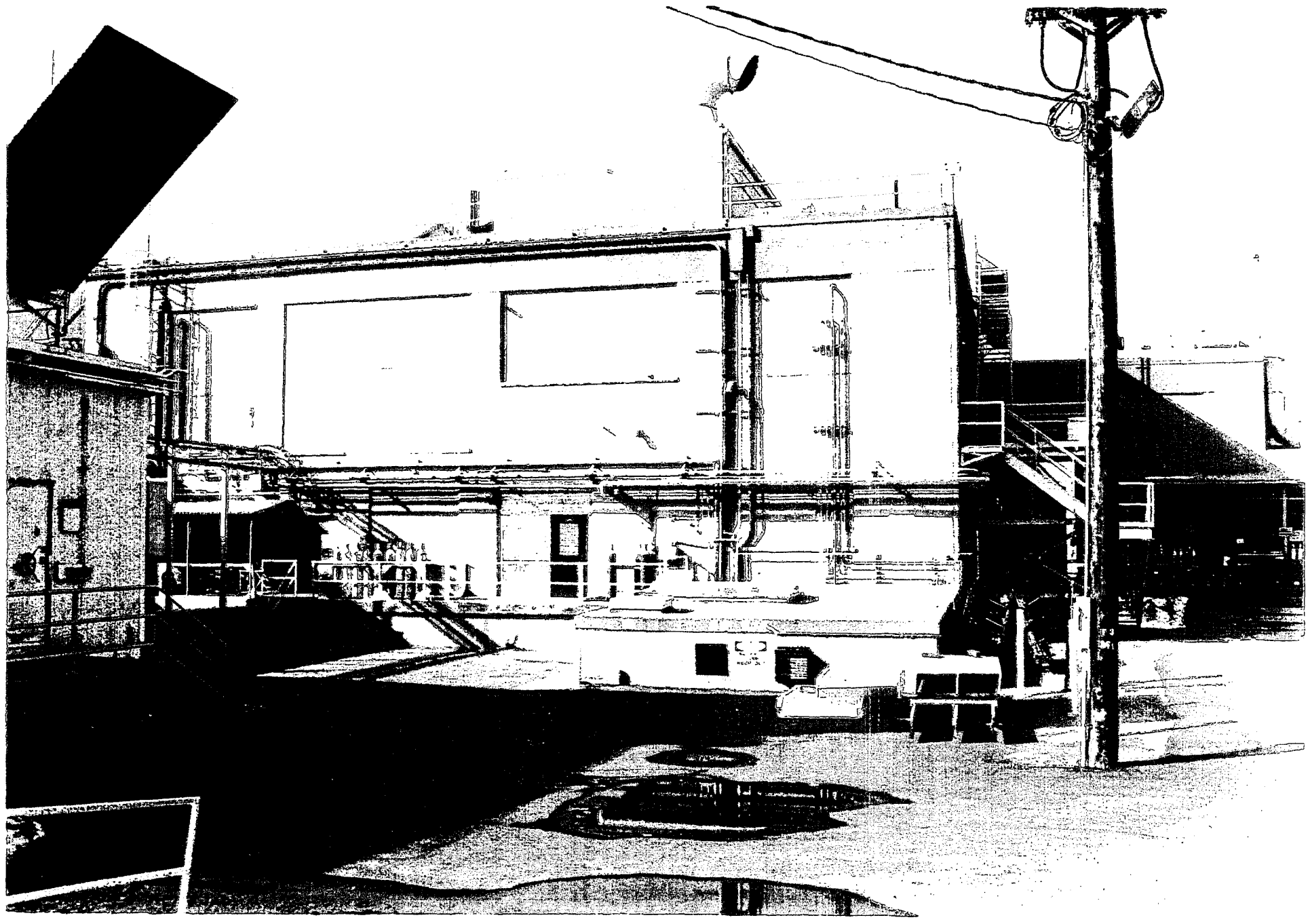

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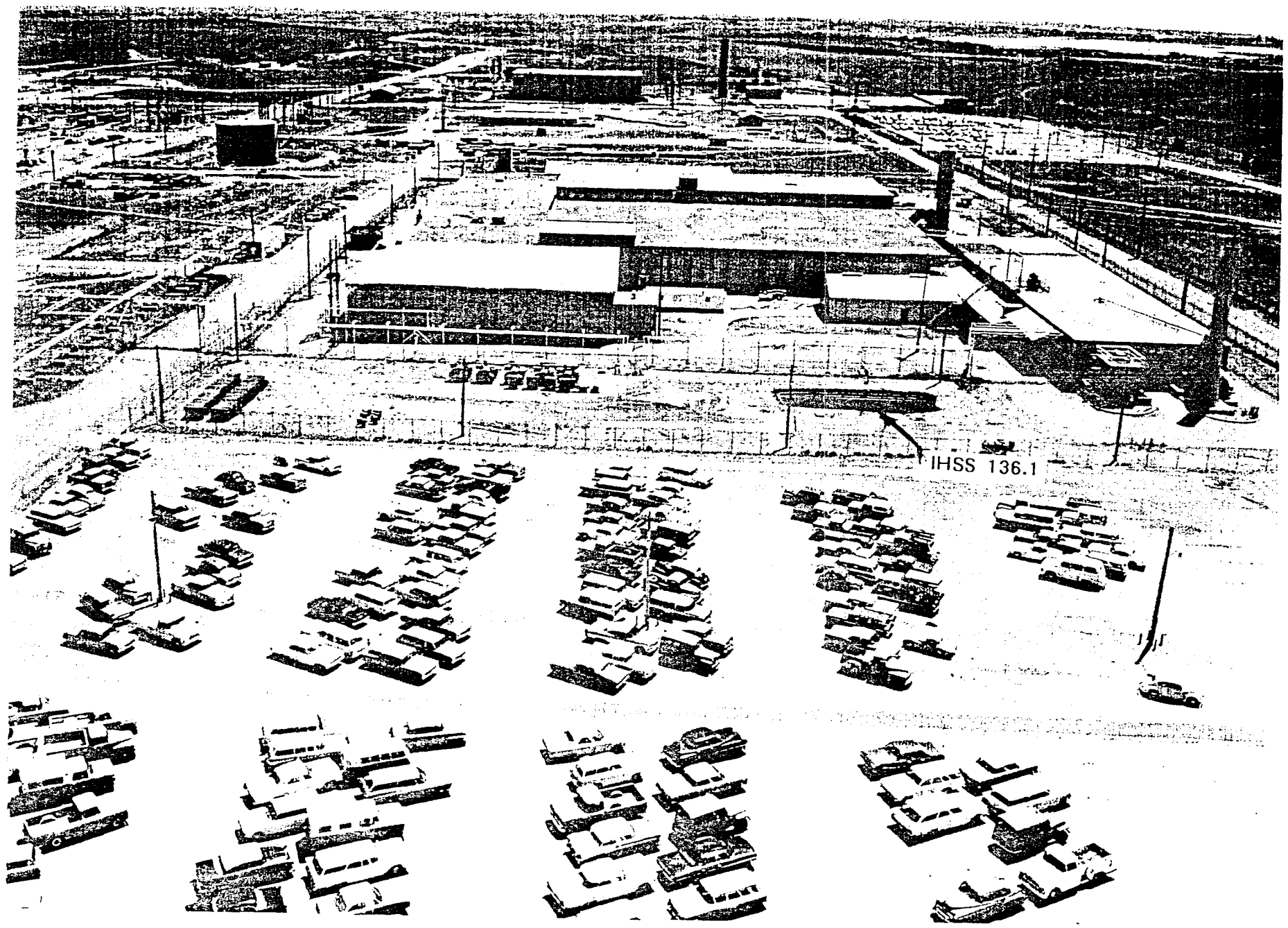
FIGURE 2-6
SITE PHOTO
IHSS 116.2

CHECKED BY	APPROVED BY	DRAWN BY	DATE	FILE NAME	REVISION NO.
BTN	BTN	JAA	4/29/92 RC	40103\F01-206.DWG	0



APPROXIMATE
NORTH

EG&G ROCKY FLATS PHOTOGRAPH
10620-17

PREPARED FOR
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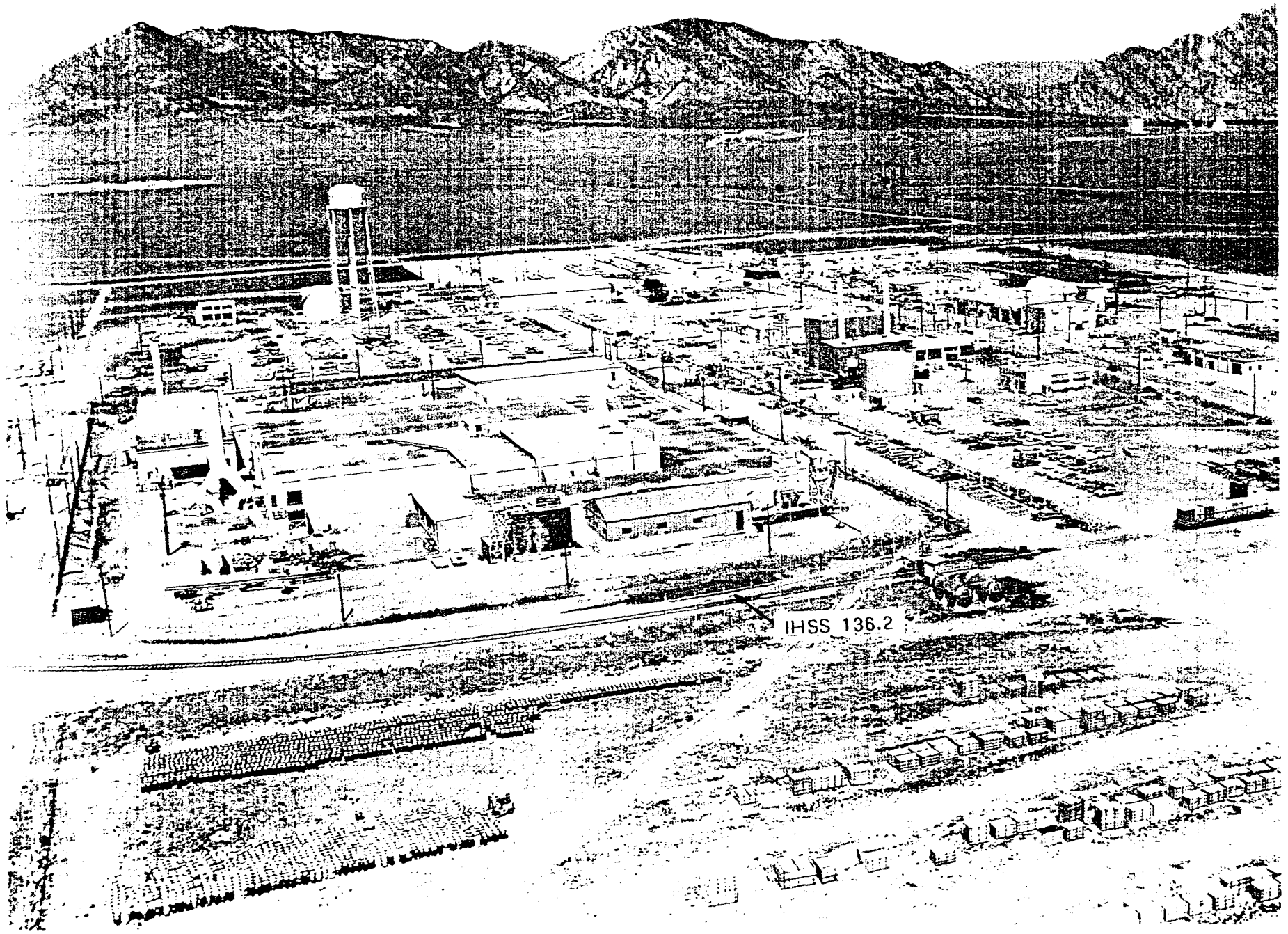
GOLDEN, COLORADO

FIGURE 2-8
HISTORICAL PHOTO
IHSS 136.1
JUNE 25, 1965

REVISION NO.	
FILE NAME	40103\F01-208.DWG
DATE	9/15/92
DRAWN BY	EMH
APPROVED BY	BTN
CHECKED BY	BTN



APPROXIMATE NORTH

EG&G ROCKY FLATS PHOTOGRAPH
13677-08

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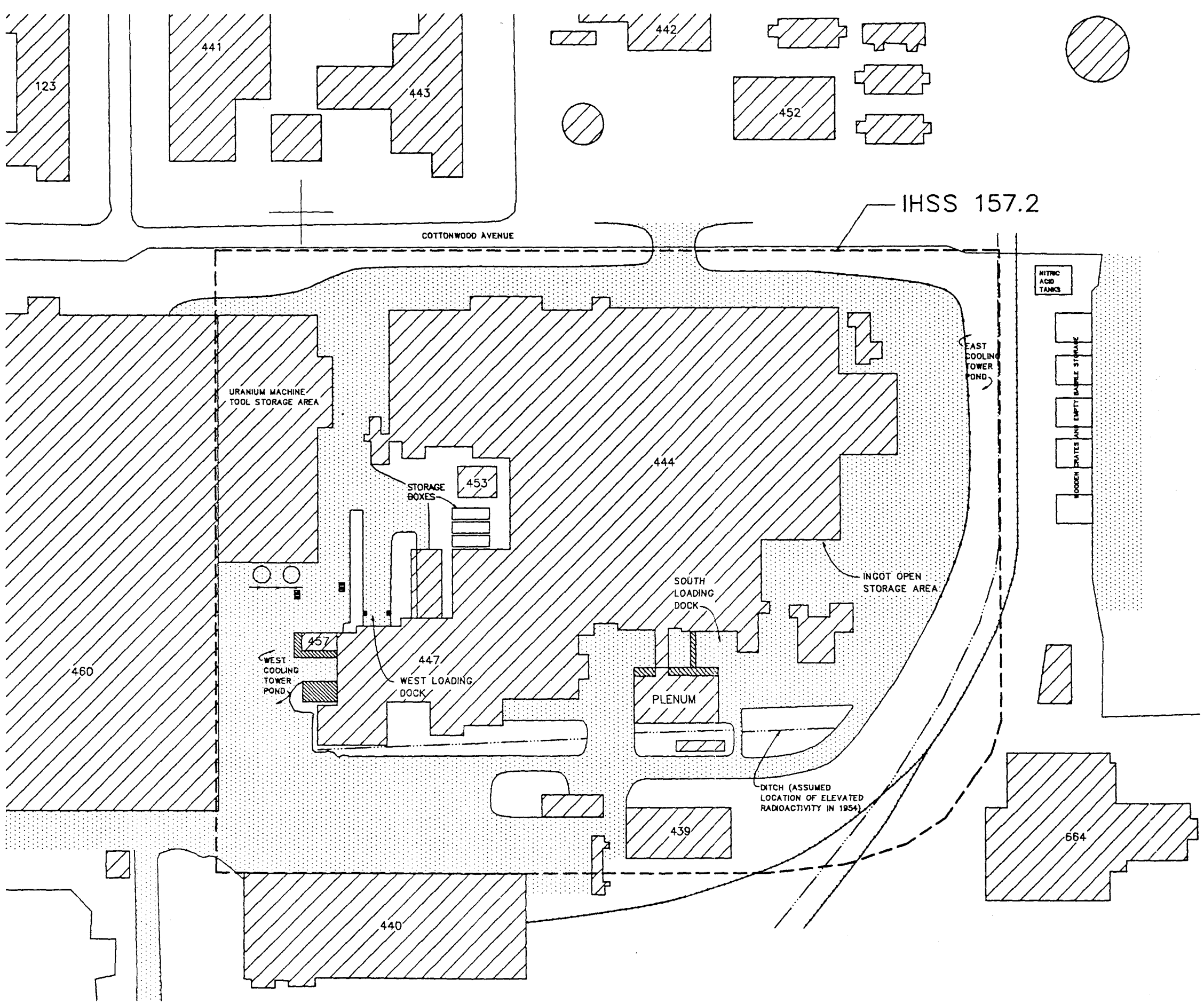
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 2-10
HISTORICAL PHOTO
IHSS 136.2
JUNE 5, 1969

DRAWN BY	EMH	DATE 9/15/92	FILE NAME 40103\F01-210.DWG	REVISION NO. 0
APPROVED BY	BJN			
CHECKED BY	BJN			



EXPLANATION

- BUILDING
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- RAILROAD
- FENCE

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

50 0 50 100 FEET

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FIGURE 2-11
LOCATION OF IHSS 157.2
RADIOACTIVE SITE
SOUTH AREA

REVISION NO. 0 | FILE NAME 40103\F01-211.DWG | DATE 9/29/92 | DRAWN BY JAA | APPROVED BY | CHECKED BY

APPROXIMATE NORTH

EG&G ROCKY FLATS PHOTOGRAPH
13676-10

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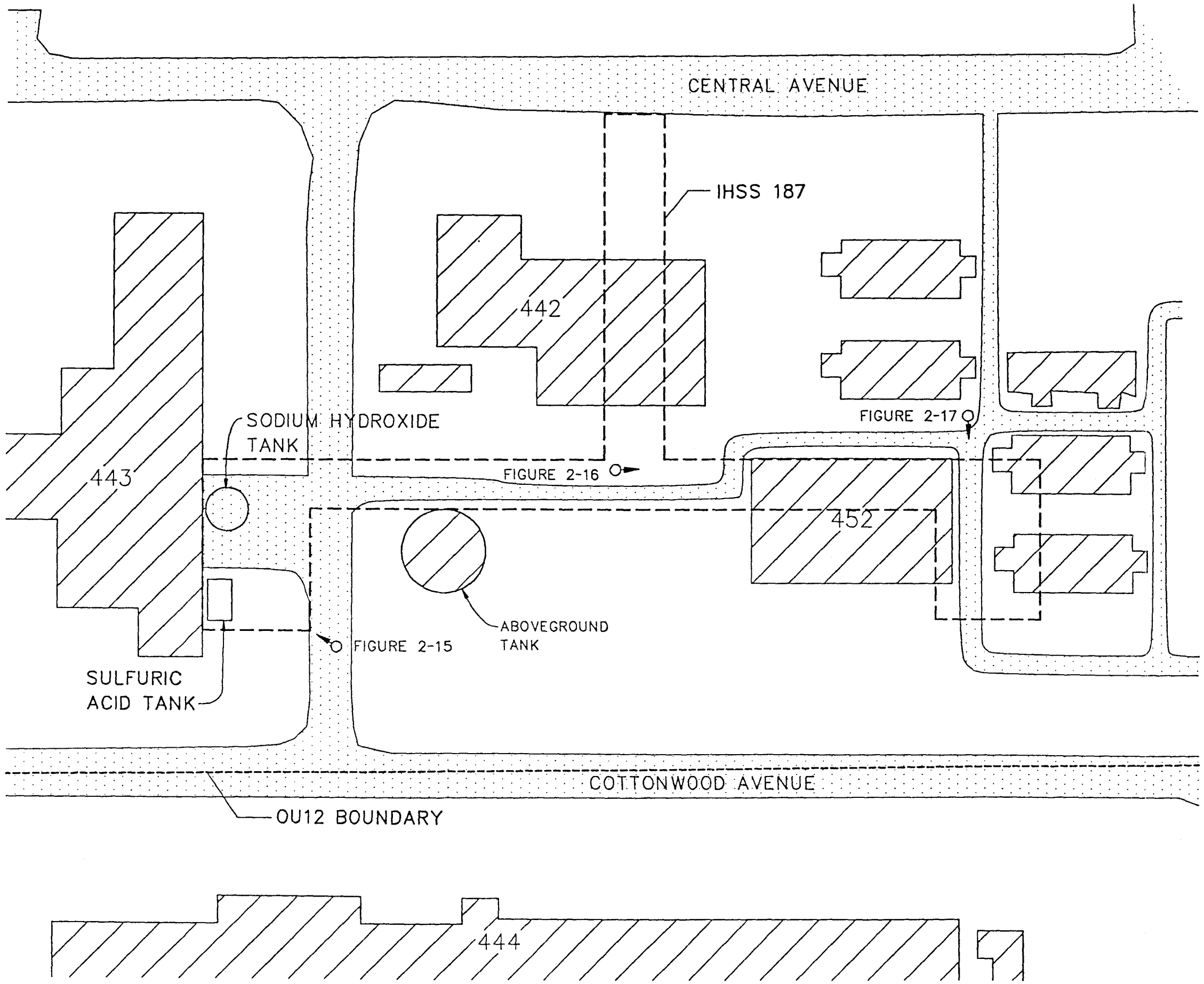
FIGURE 2-12
HISTORICAL PHOTO
IHSS 157.2
JUNE 5, 1969

CHECKED BY	APPROVED BY	DRAWN BY	FILE NAME	DATE	REVISION NO.
BJJ	BJJ	EMH	40103\F01-212.DWG	9/15/92	0



EXPLANATION

- BUILDING
- PHOTO VANTAGE POINT
- IHSS BOUNDARY
- OVERHEAD PIPING
- PAVEMENT
- SOIL OR GRAVEL

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

25 0 25 50 FEET

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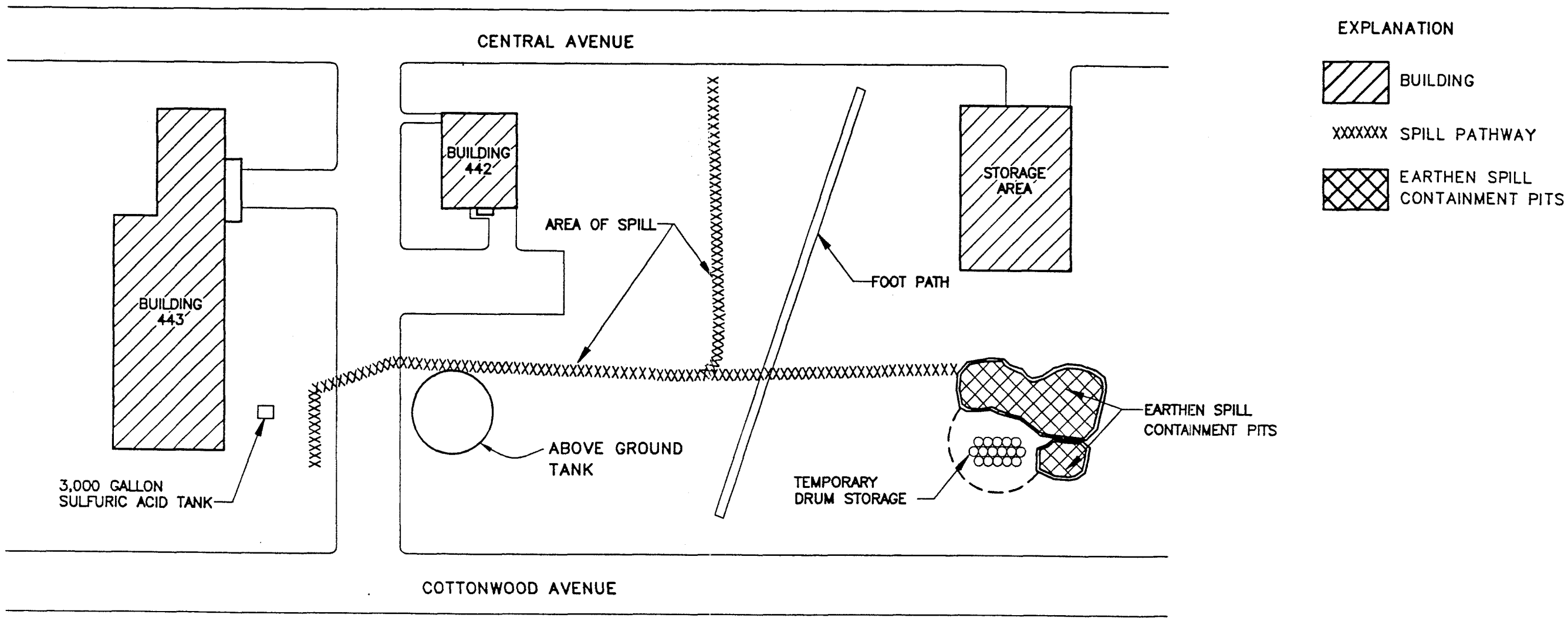
FIGURE 2-13
LOCATION OF IHSS 187 SULFURIC ACID SPILL

REVISION NO. 0 | FILE NAME 40103\F01-213.DWG | DATE ~~9/15/92~~ | DRAWN BY JAA | APPROVED BY BJN | CHECKED BY BJN



NOT TO SCALE

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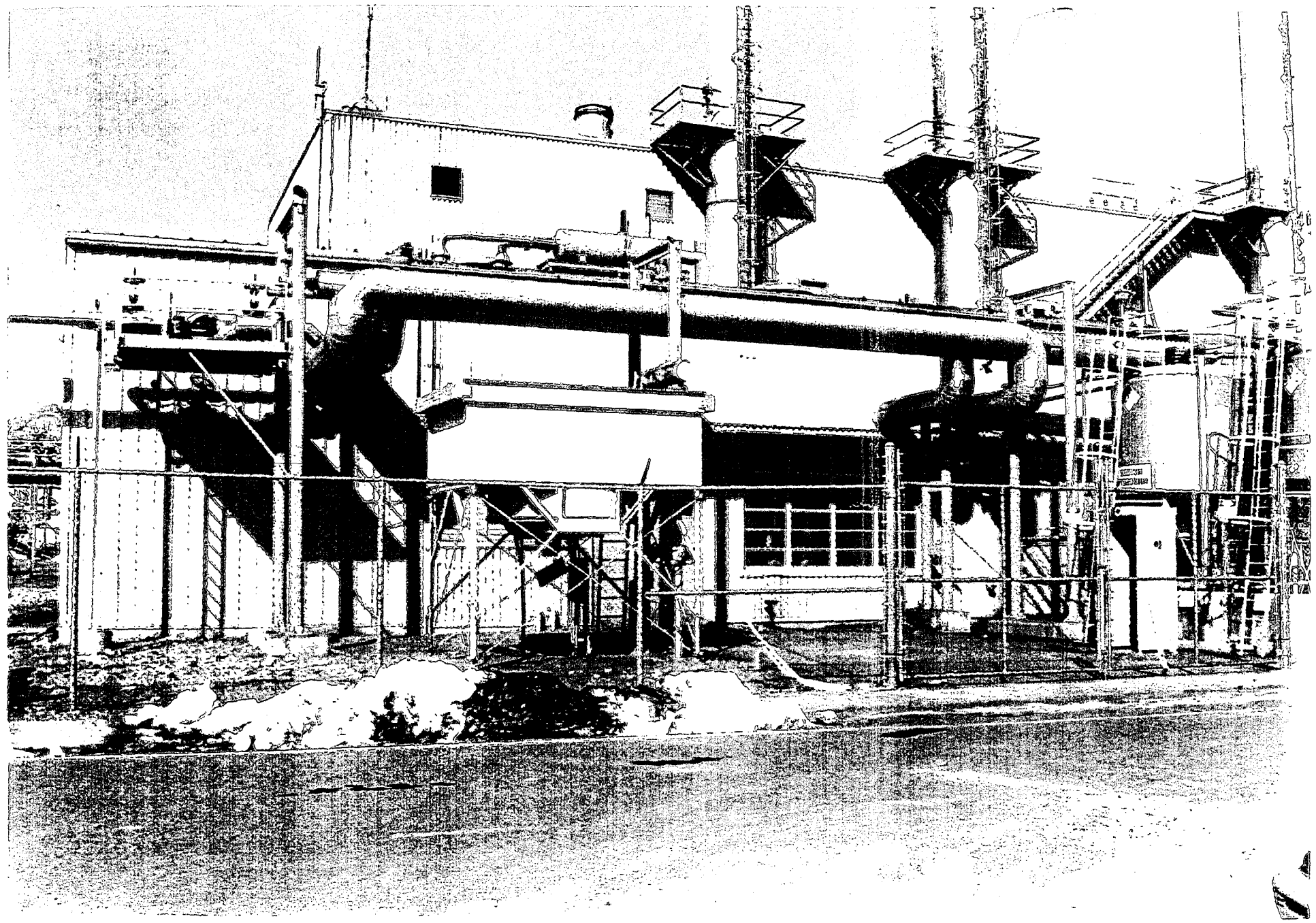
FIGURE 2-14
HISTORICAL PATH OF SULFURIC ACID SPILL (IHSS 187)

REVISION NO. B | FILE NAME 40103\F01-214.DWG | DATE ~~9/15/92~~ | DRAWN BY EMH | APPROVED BY BJN | CHECKED BY BJN



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GOLDEN, COLORADO

FIGURE 2-15
SITE PHOTO
IHSS 187

CHECKED BY BN	APPROVED BY BN	DRAWN BY JAA	DATE 4/29/92	FILE NAME 40103\F01-215.DWG	REVISION NO. 0

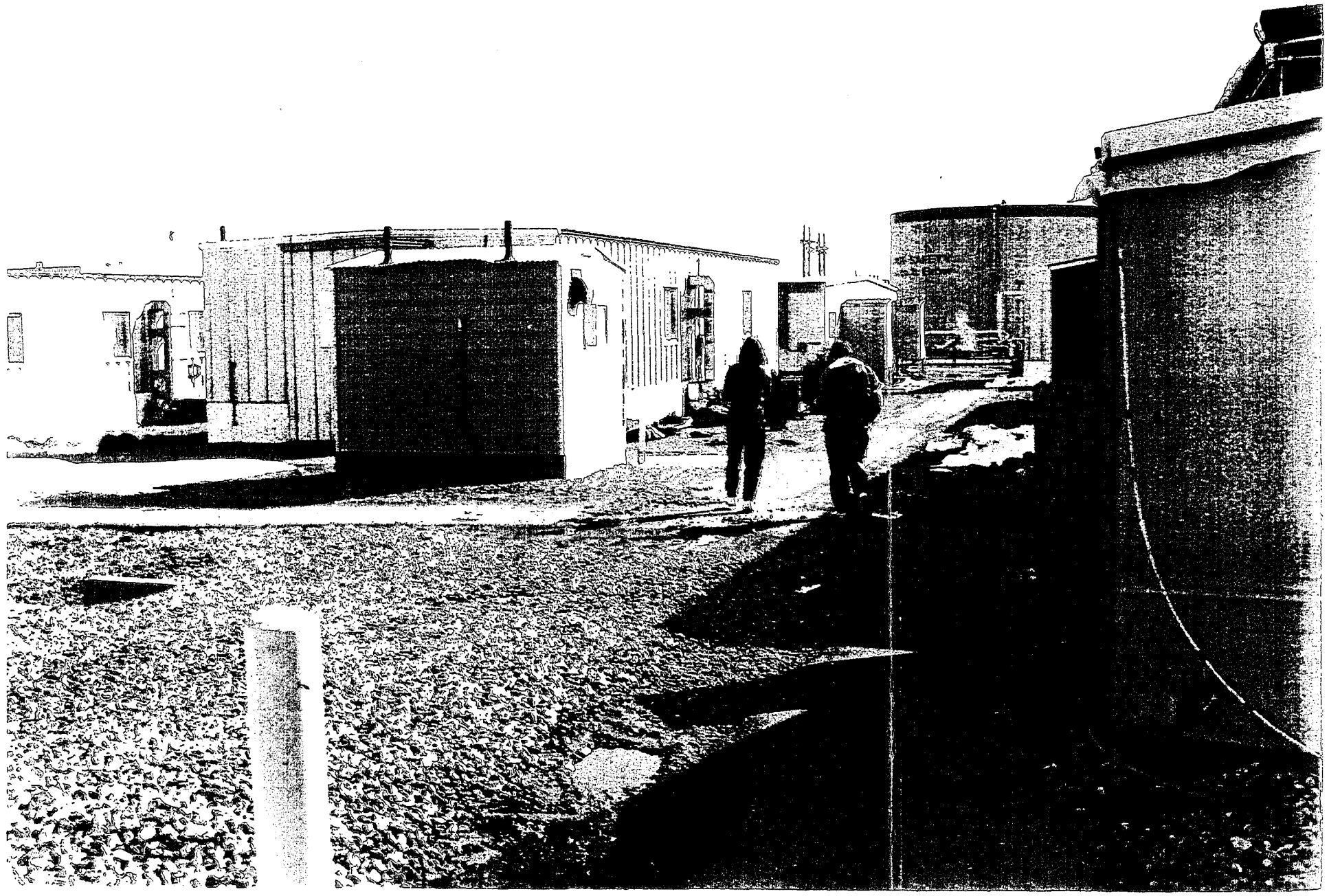

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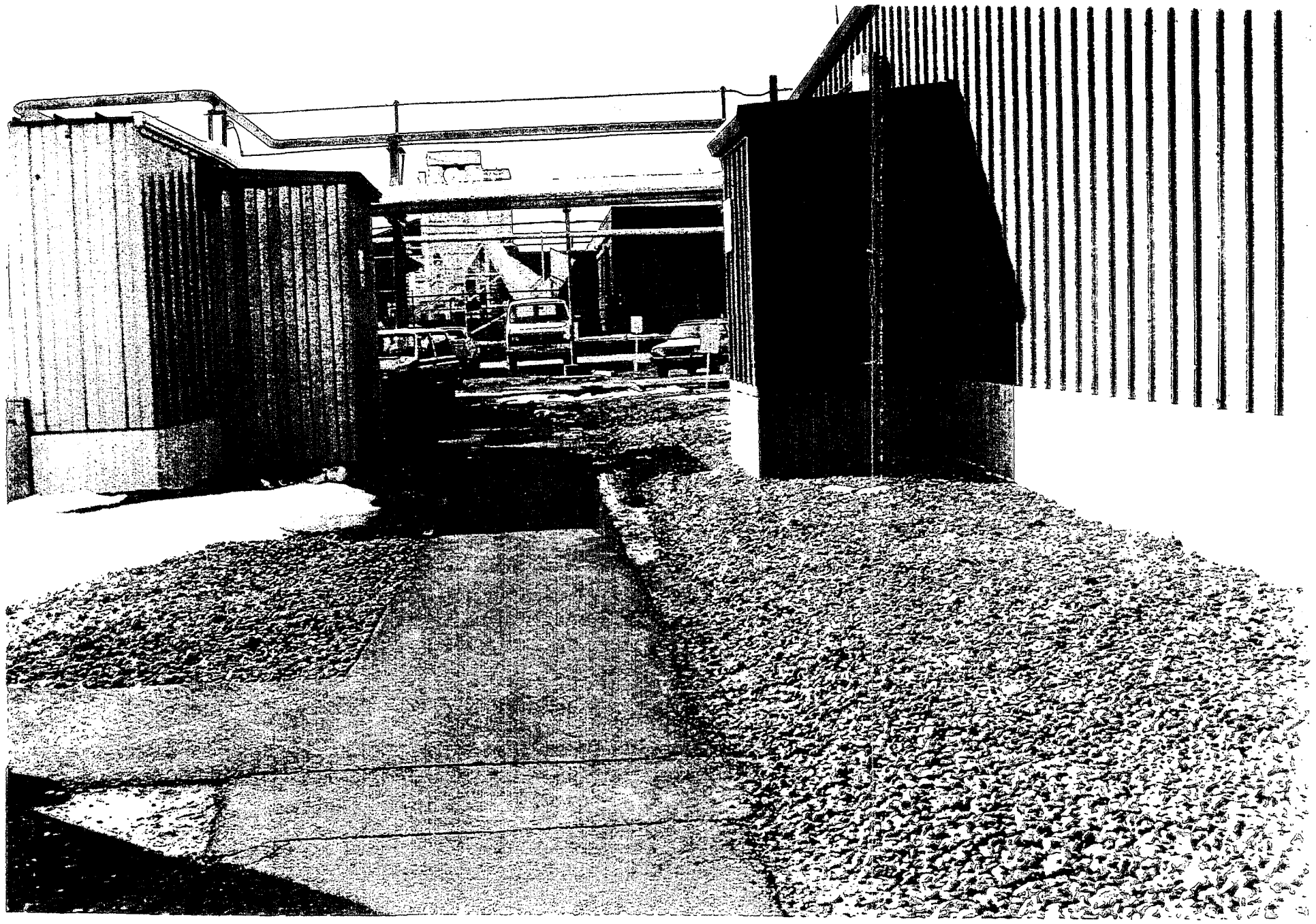
FIGURE 2-16
SITE PHOTO
IHSS 187

CHECKED BY	APPROVED BY	DRAWN BY	DATE	FILE NAME	REVISION NO.
BTN	BN	JAA	4/29/92	40103\F01-216.DWG	0



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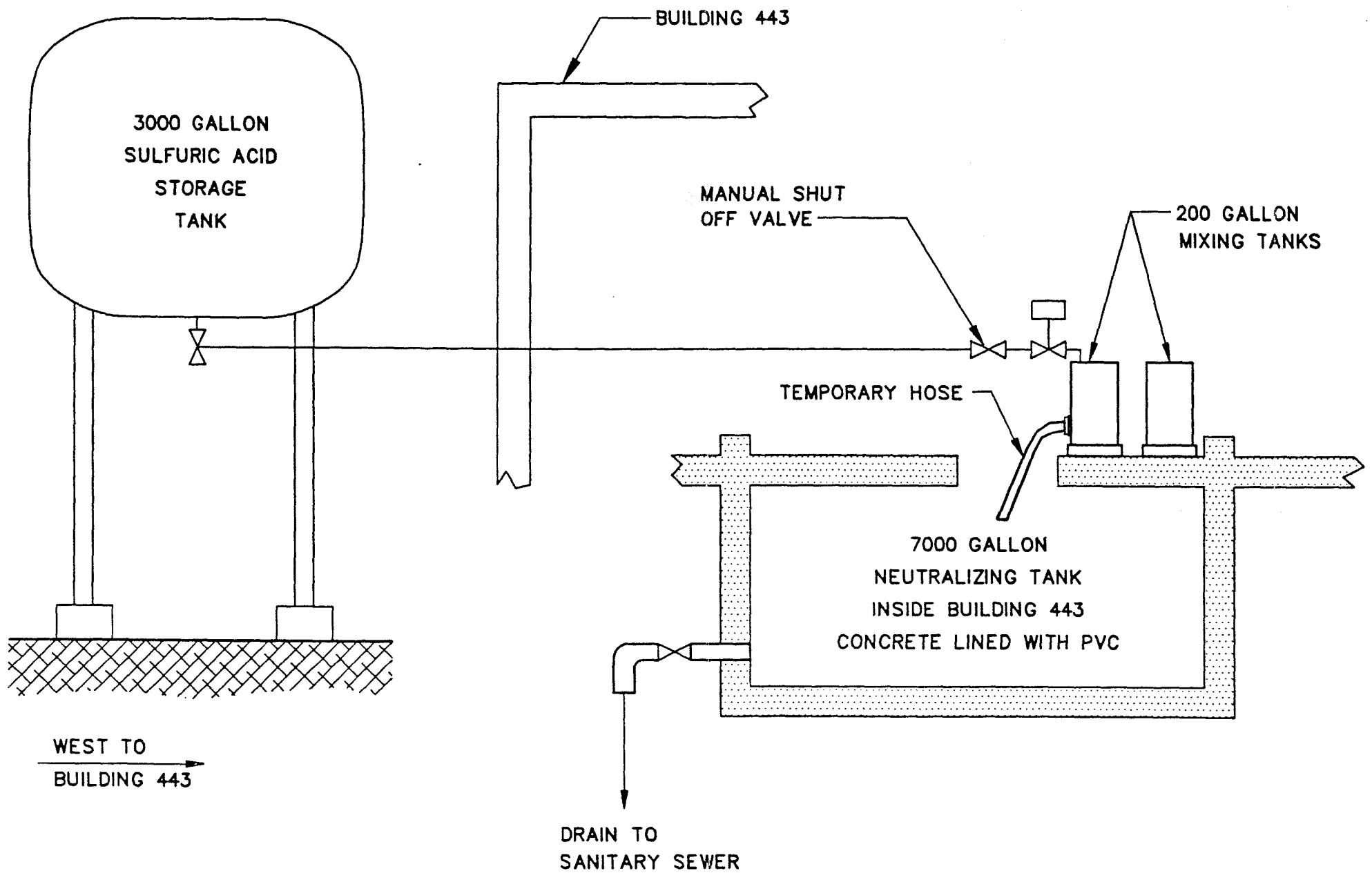
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 2-17
SITE PHOTO
IHSS 187

CHECKED BY	APPROVED BY	DRAWN BY	DATE	FILE NAME	REVISION NO.
BTW	BTW	JAA	4/29/92	40103\F01-217.DWG	0



NOT TO SCALE

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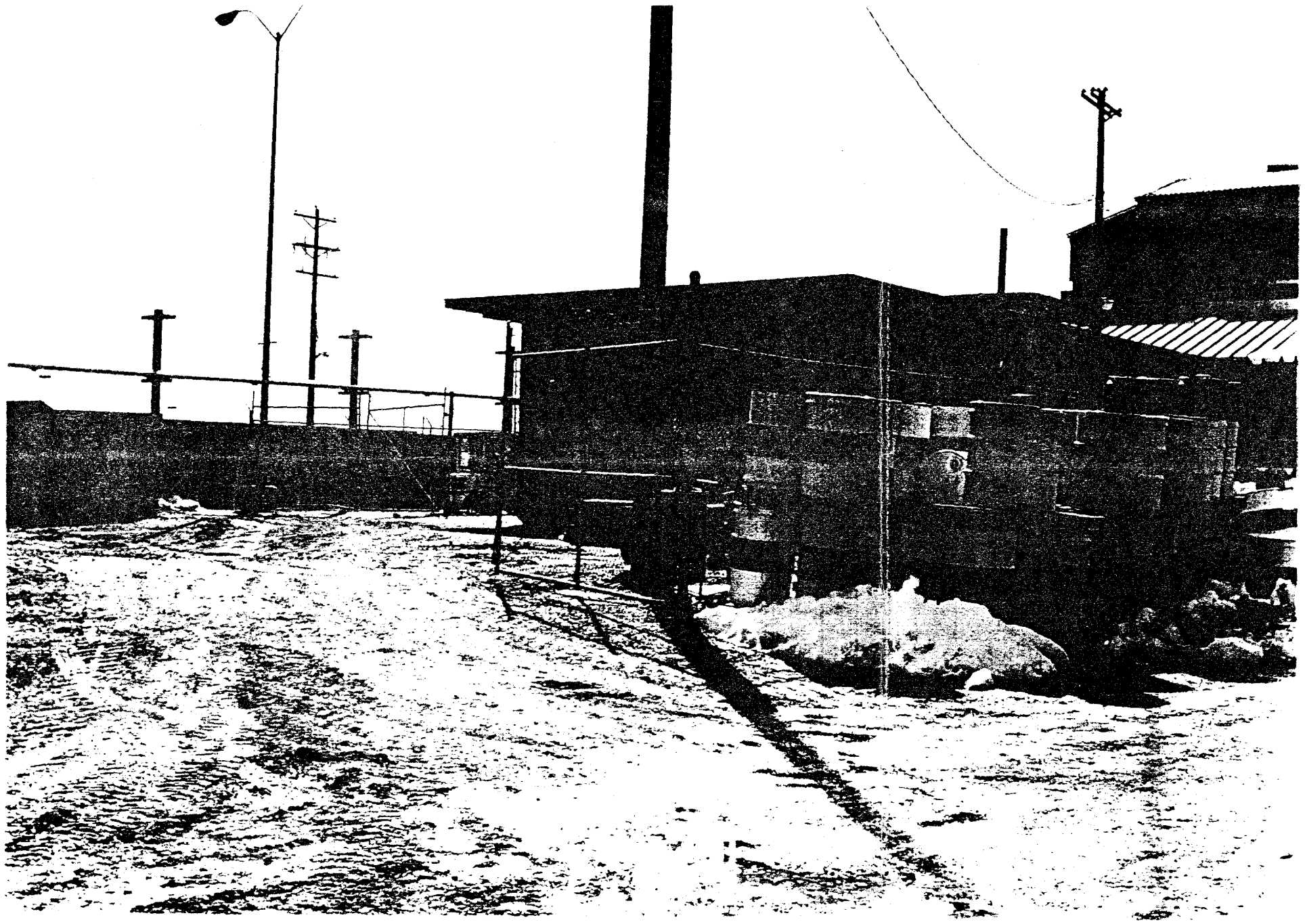
ROCKY FLATS PLANT
GOLDEN, COLORADO

FIGURE 2-18
ACID PIPING SCHEMATIC
IHSS 187

REVISION NO. 0
FILE NAME 40103\F01-218.DWG
DATE 9/10/92
DRAWN BY JAA
APPROVED BY BN
CHECKED BY BN



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GOLDEN, COLORADO

FIGURE 2-20
SITE PHOTO
IHSS 120.1

CHECKED BY	APPROVED BY	DRAWN BY	DATE	FILE NAME	REVISION NO.
		JAA	4/29/92	40103\F01-220.DWG	0

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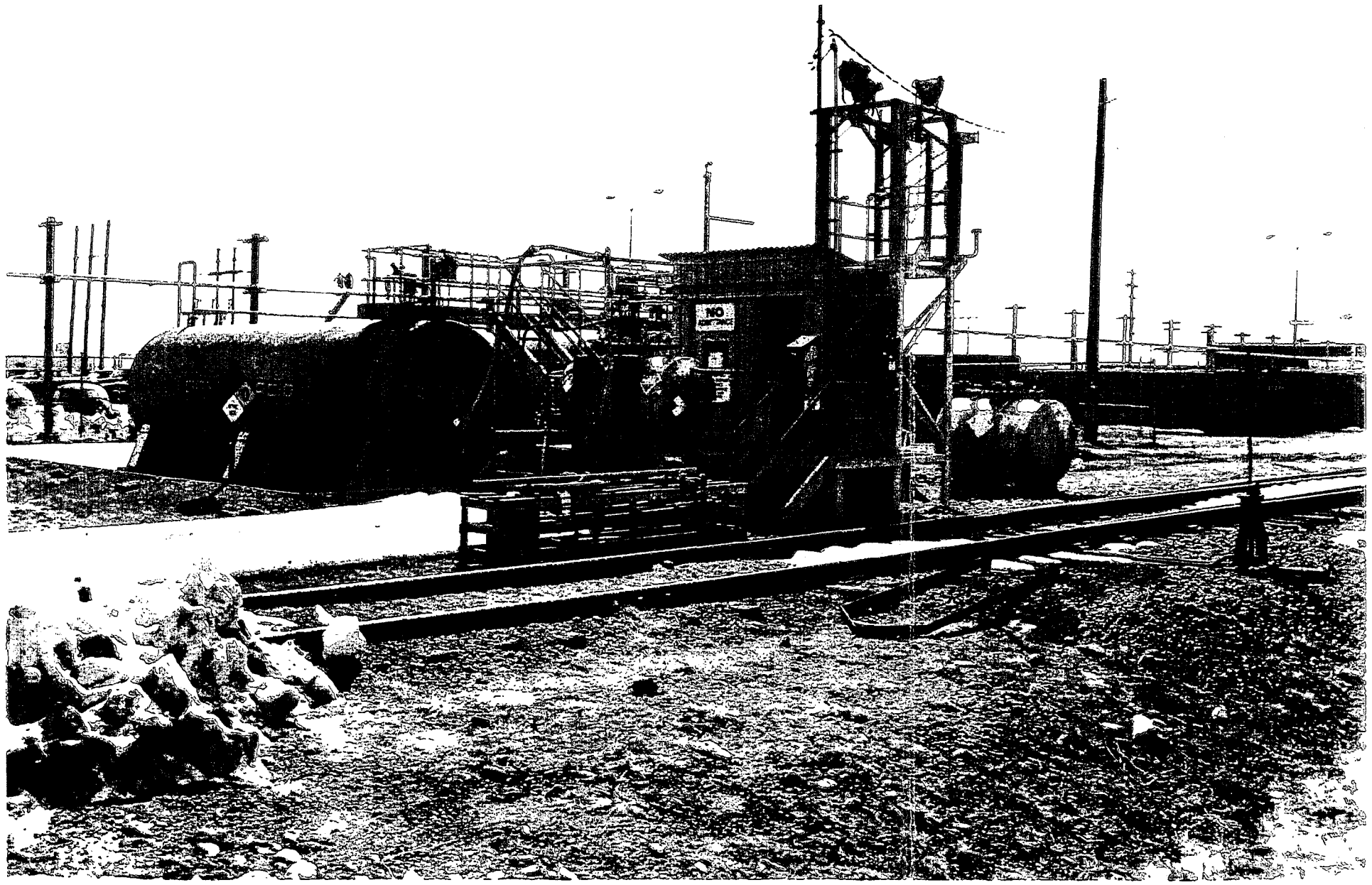
GOLDEN, COLORADO

FIGURE 2-22
SITE PHOTO
IHSS 120.2

CHECKED BY	APPROVED BY	DRAWN BY	DATE	FILE NAME	REVISION NO.
	BTN	JAA	4/29/92	40103\F01-222.DWG	0



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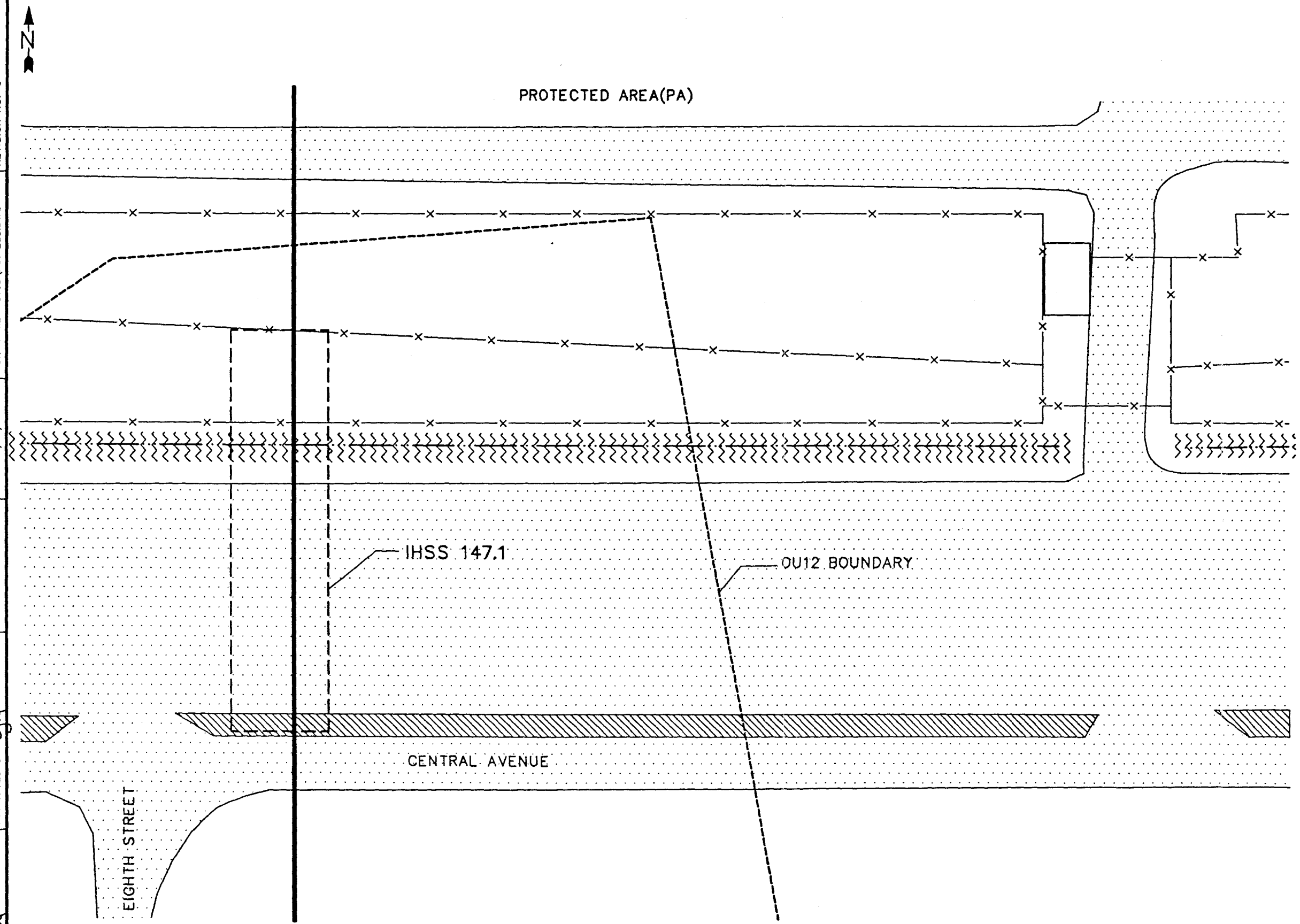
GOLDEN, COLORADO

FIGURE 2-24
SITE PHOTO
IHSS 189

CHECKED BY BN	APPROVED BY BN	DRAWN BY JAA	DATE 4/28/92 PC	FILE NAME 40103\F01-224.DWG	REVISION NO. 0



EXPLANATION

- ORIGINAL PROCESS WASTE LINE
- BUILDING
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- RIP-RAPPED CHANNEL
- FENCE

25 0 25 50 FEET

NOTE:
THIS IHSS HAS BEEN TRANSFERRED TO OU9

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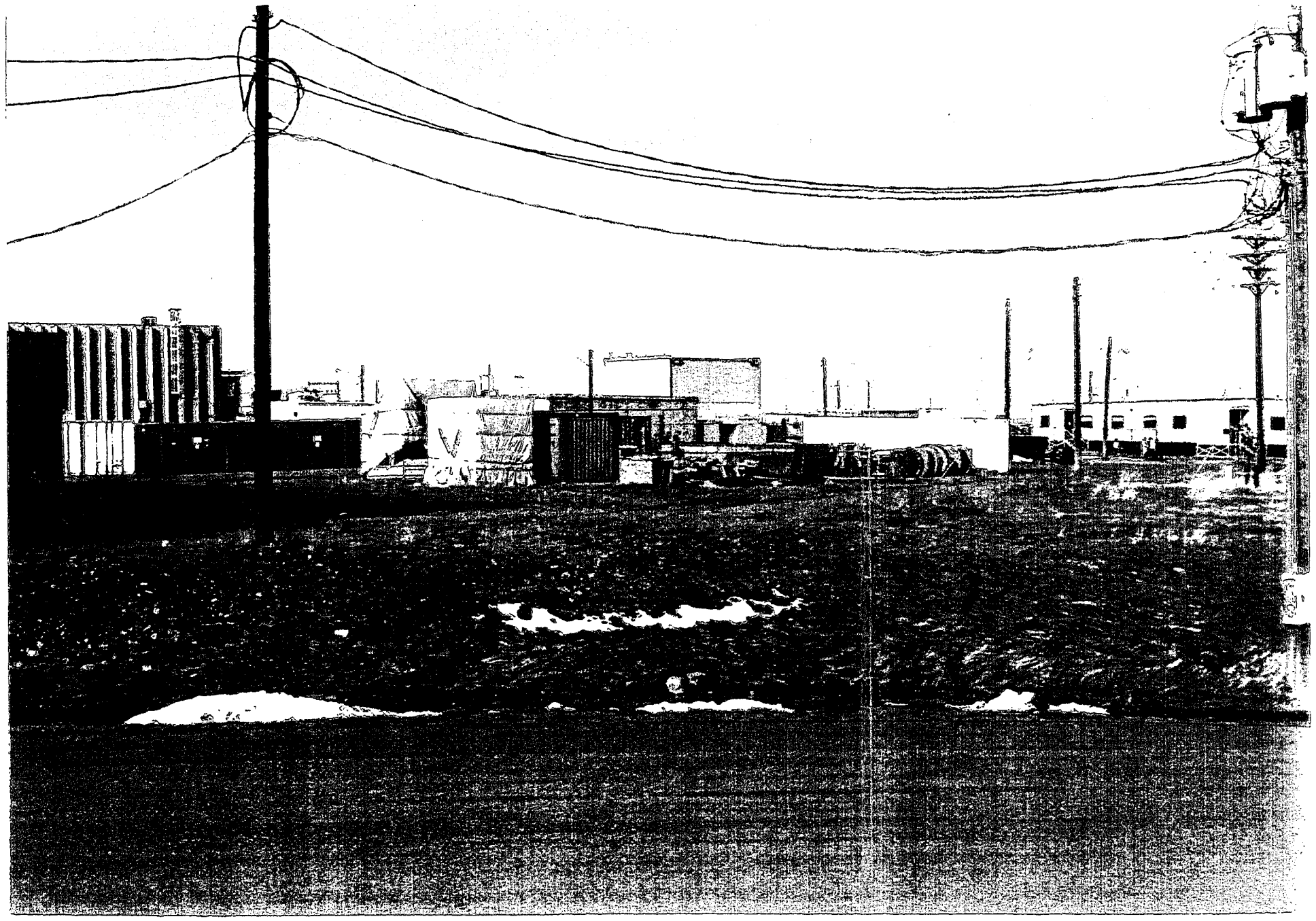
GOLDEN, COLORADO

FIGURE 2-25
LOCATION OF IHSS 147.1
PROCESS WASTE
LINE LEAKS

REVISION NO. 0
FILE NAME 40103\F01-225.DWG
DATE 9/15/92
DRAWN BY JAA
APPROVED BY BTN
CHECKED BY BTN



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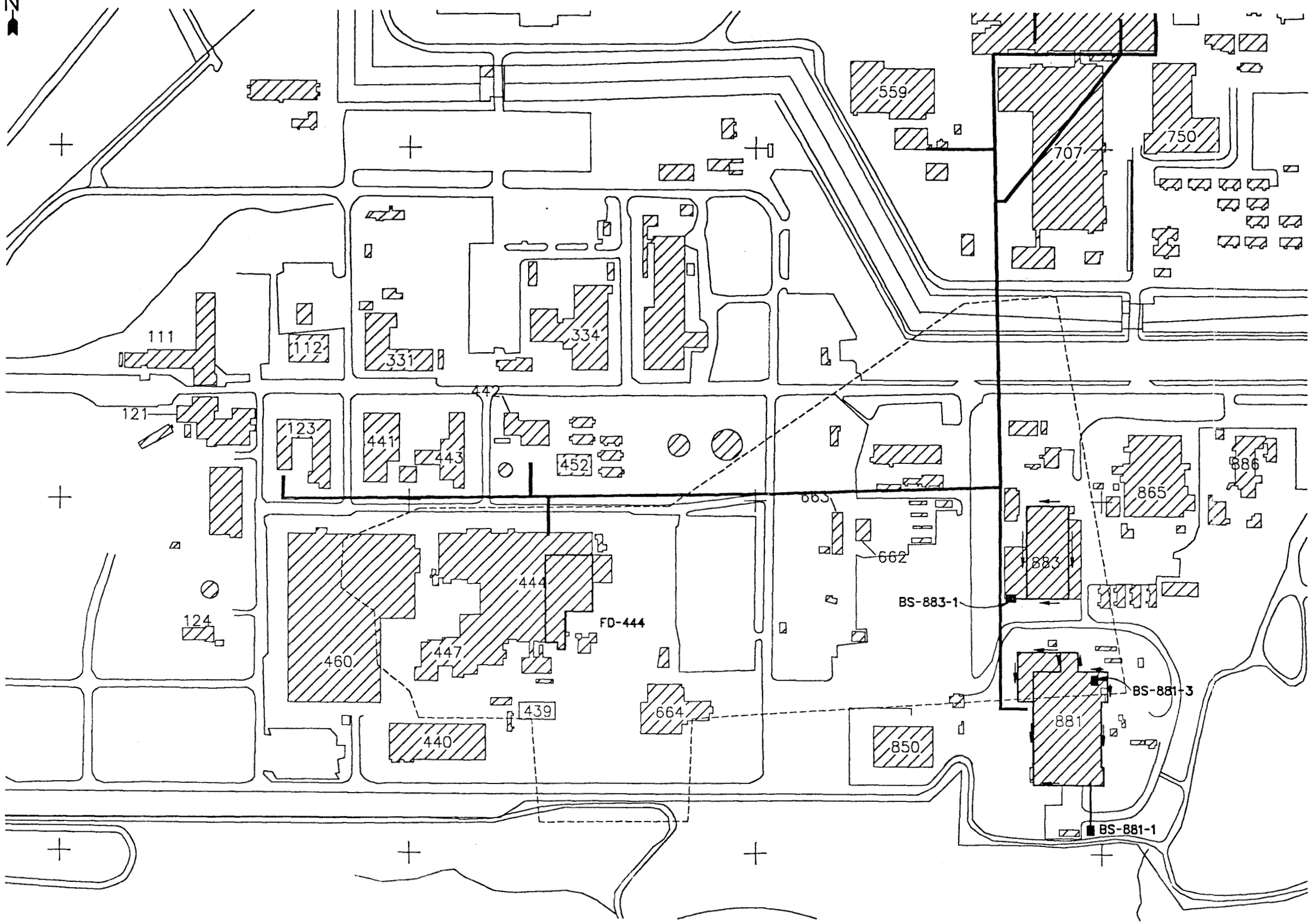
GOLDEN, COLORADO

FIGURE 2-27
SITE PHOTO
IHSS 147.2

CHECKED BY BJN	APPROVED BY BJN	DRAWN BY JAA	DATE 4/29/92	FILE NAME 40103\F01-227.DWG	REVISION NO. 0



EXPLANATION

------- OU12 BOUNDARY

ORIGINAL PROCESS WASTE LINE

FOOTING DRAIN FLOW DIRECTION

BUILDING SUMP

BS-883-1

SUMP NUMBER

BUILDING NUMBER

SAMPLE TYPE BUILDING SUMP (BS) OR FOOTING DRAIN (FD)

* SINCE 3/89 BUILDING 444 BUILDING SUMP DISCHARGES TO PROCESS WASTE INSTEAD OF SANITARY SEWER

150 0 150 300 FEET

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GOLDEN, COLORADO

FIGURE 2-28
ORIGINAL PROCESS WASTE LINES AND BUILDING SUMPS IN OU12 AREA

REVISION NO. CHECK PRINT B | FILE NAME 40103\F01-228.DWG | DATE 9/15/92 | DRAWN BY EMH | APPROVED BY BN | CHECKED BY BN

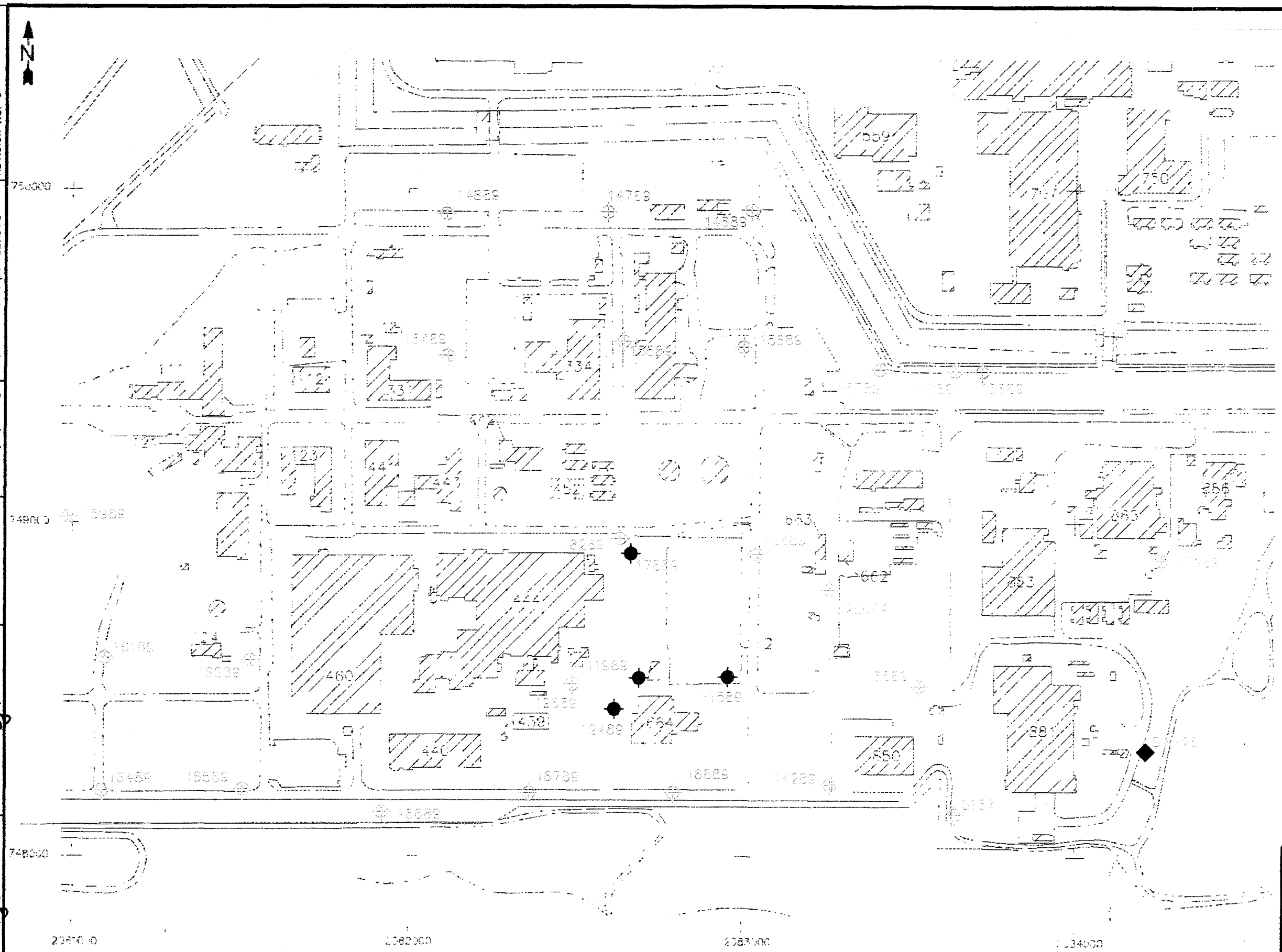

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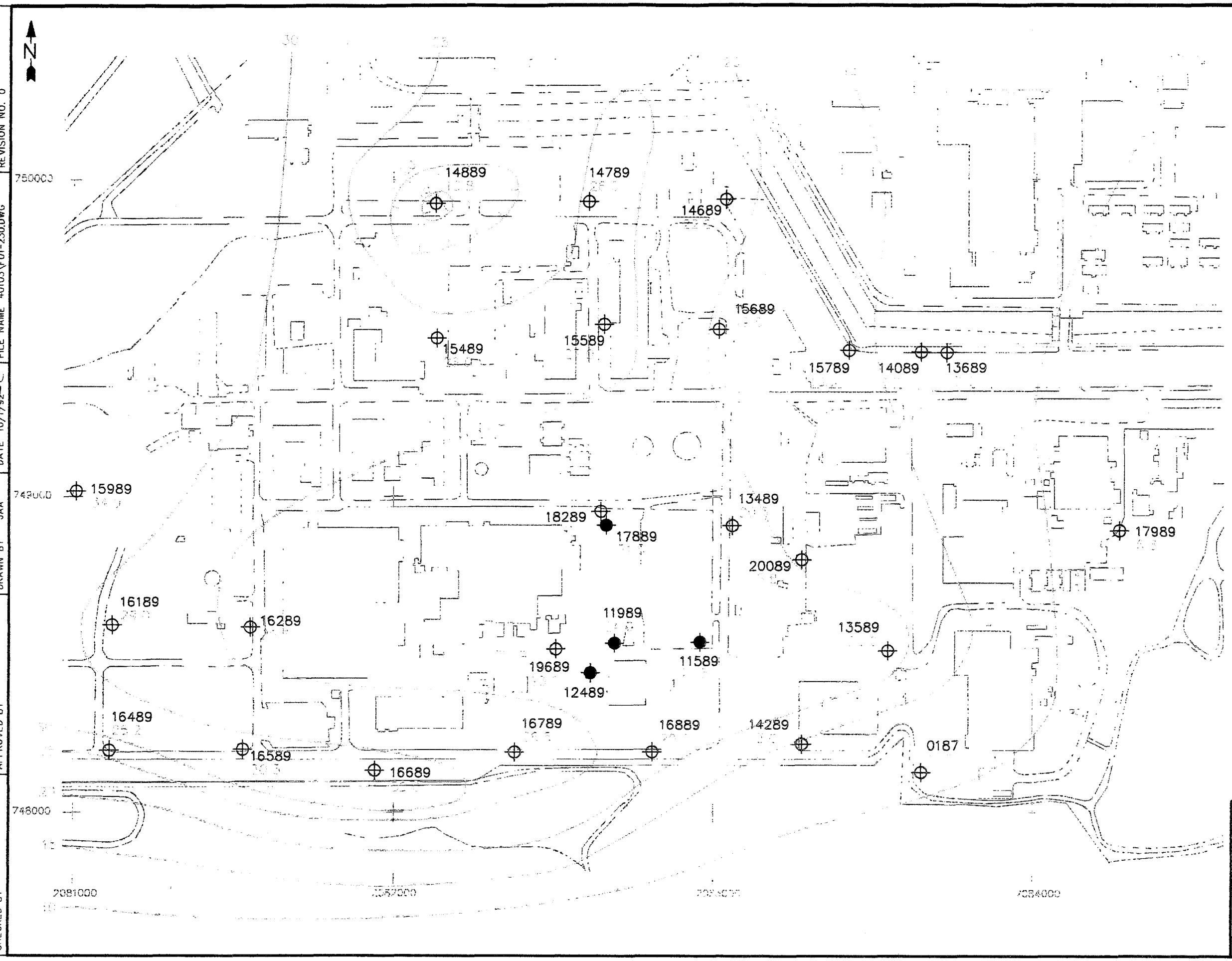
FIGURE 2-29
MONITORING WELL AND SURFACE WATER STATION LOCATION MAP

REVISION NO. 0	FILE NAME 40103\F01-229.DWG	DATE 9/15/92	DRAWN BY JAA	APPROVED BY BN	CHECKED BY BN



EXPLANATION

14689 MONITORING WELL LOCATION

16889 ABANDONED MONITORING WELL LOCATION

ALLUVIAL THICKNESS (FEET)

ALLUVIAL THICKNESS CONTOUR (FEET)

150 0 150 300 FEET

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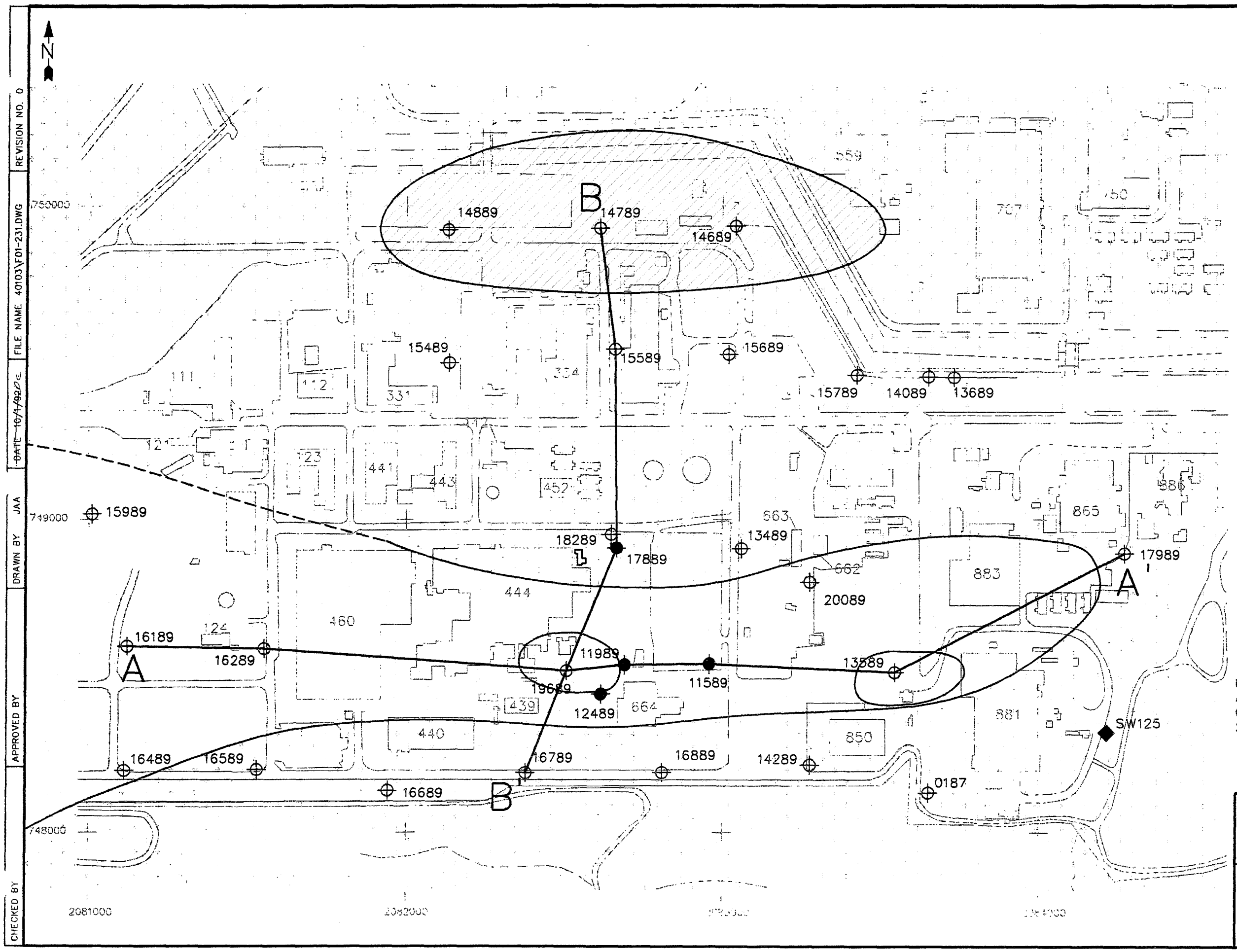
GOLDEN, COLORADO

FIGURE 2-30

ALLUVIUM ISOPACH MAP

REVISION NO. 0
FILE NAME 40103\F01-230.DWG
DATE 10/1/92
DRAWN BY JAA
APPROVED BY
CHECKED BY



EXPLANATION

14689 MONITORING WELL LOCATION

16689 ABANDONED MONITORING WELL LOCATION

A — A' CROSS SECTION LOCATION

ARAPAHOE FORMATION SANDSTONE

ARAPAHOE FORMATION SILTY/SANDY CLAYSTONE

ARAPAHOE FORMATION CLAYSTONE

NOTE: LOCATIONS 11589, 11989 AND 17889 ARE SOIL BORINGS USED TO GENERATE GEOLOGIC CRROSS SECTIONS, SEE FIGURES 2-32 AND 2-33

150 0 150 300 FEET

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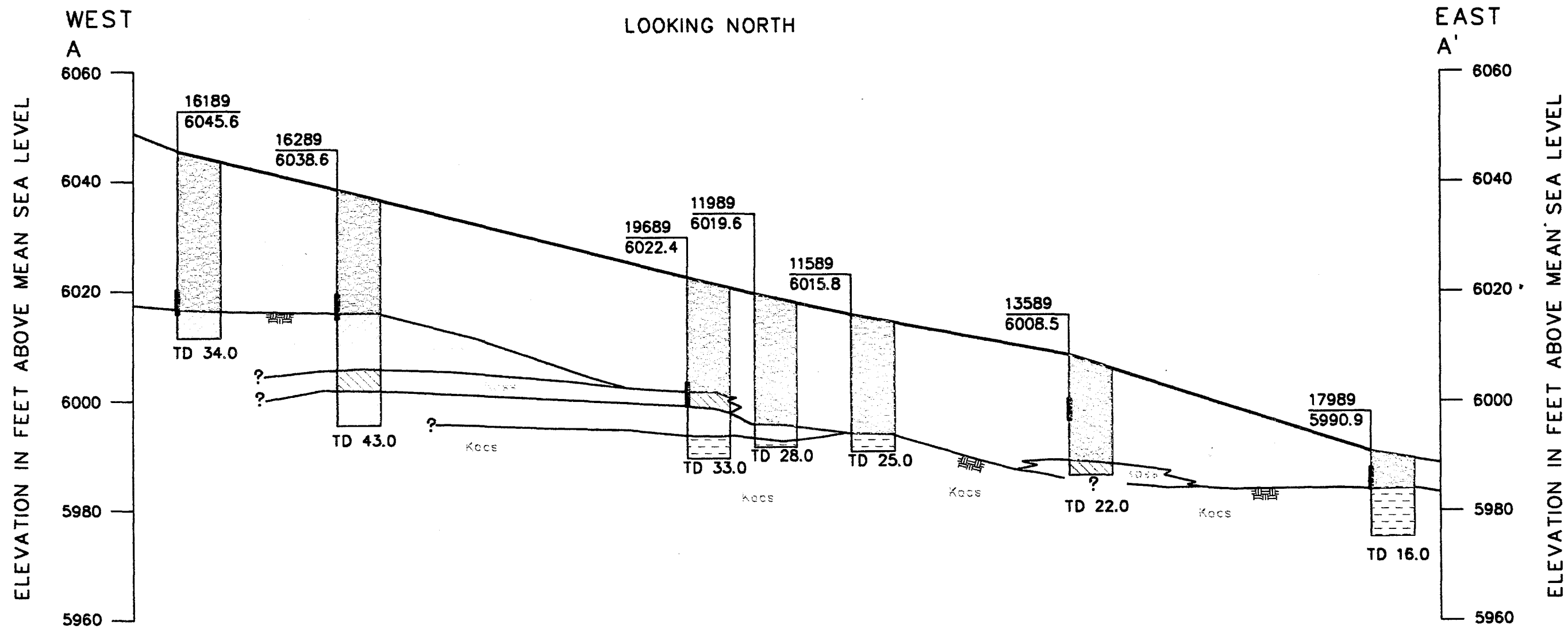
GOLDEN, COLORADO

FIGURE 2-31
BEDROCK GEOLOGY AND GEOLOGIC CROSS SECTION LOCATION MAP

REVISION NO. 0
FILE NAME 40103\F01-231.DWG
DATE 10/4/92
DRAWN BY JAA
APPROVED BY
CHECKED BY



EXPLANATION

16189
6045.6 — WELL IDENTIFICATION; GROUND SURFACE ELEVATION(FT)

APPROXIMATE GROUND SURFACE

SCREENED INTERVAL

APPROXIMATE BEDROCK CONTACT

TD 34.0 TOTAL DEPTH DRILLED

NOTE: LOCATIONS 11989 AND 11589 ARE SOIL BORING LOCATIONS

QUATERNARY

Qrf — ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass — ARAPAHOE SANDSTONE

Kasc — ARAPAHOE SILTY CLAYSTONE

Kacs — ARAPAHOE CLAYSTONE

150 0 150 300 FEET
HORIZONTAL SCALE

10 0 10 20 FEET
VERTICAL SCALE

VERTICAL EXAGGERATION = 1:15

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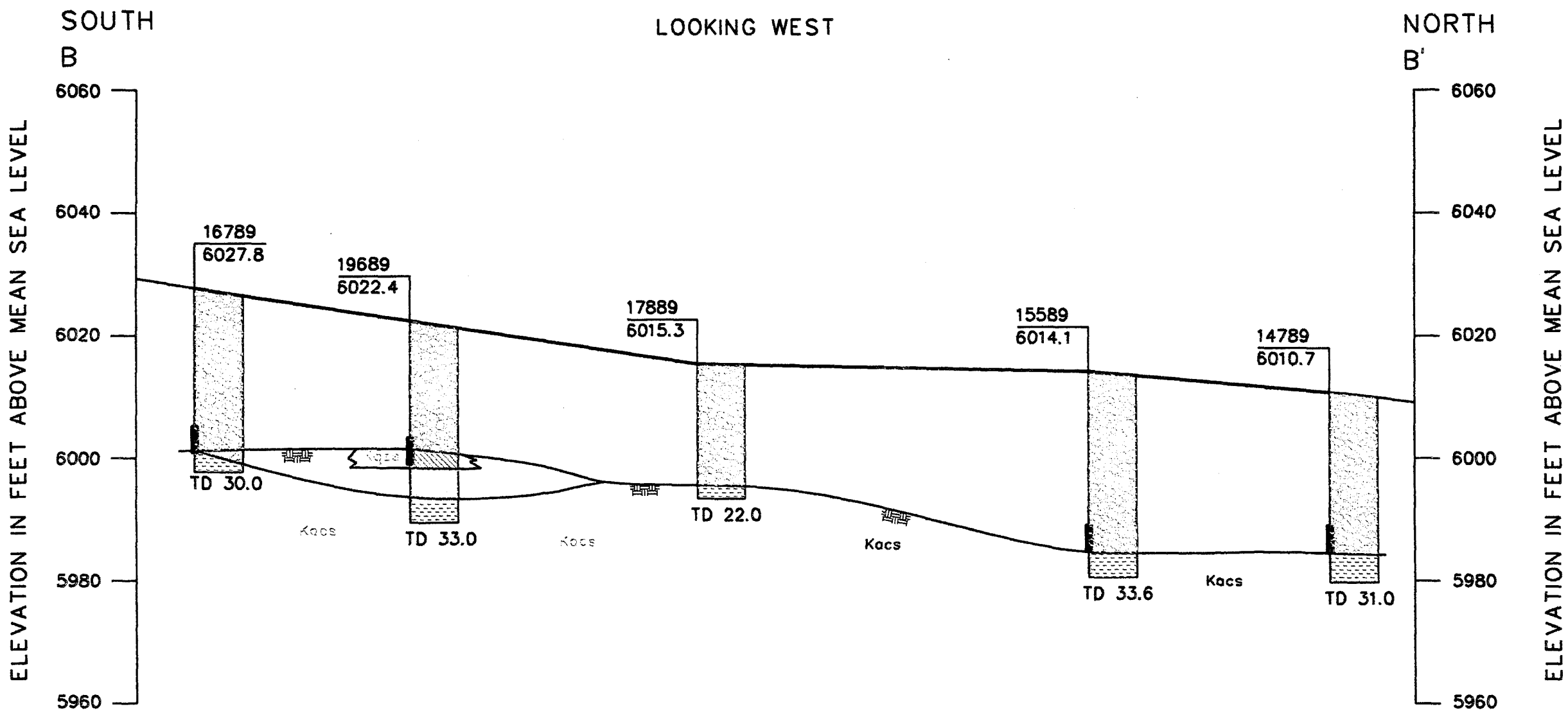
FIGURE 2-32
GEOLOGIC CROSS SECTION A-A'

REVISION NO. 0 | FILE NAME 40103\F01-232.DWG | DATE 5/4/92 | DRAWN BY JAA | APPROVED BY BJN | CHECKED BY BJN



EXPLANATION

16189 / 6045.6 — WELL IDENTIFICATION / GROUND SURFACE ELEVATION(FT)

APPROXIMATE GROUND SURFACE

SCREENED INTERVAL

APPROXIMATE BEDROCK CONTACT

TD 34.0 TOTAL DEPTH DRILLED

NOTE: LOCATION 17889 IS A SOIL BORING LOCATION

QUATERNARY

Qrf — ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass — ARAPAHOE SANDSTONE

Kasc — ARAPAHOE SILTY CLAYSTONE

Kacs — ARAPAHOE CLAYSTONE

100 0 100 200 FEET
HORIZONTAL SCALE

10 0 10 20 FEET
VERTICAL SCALE

VERTICAL EXAGGERATION = 1:10

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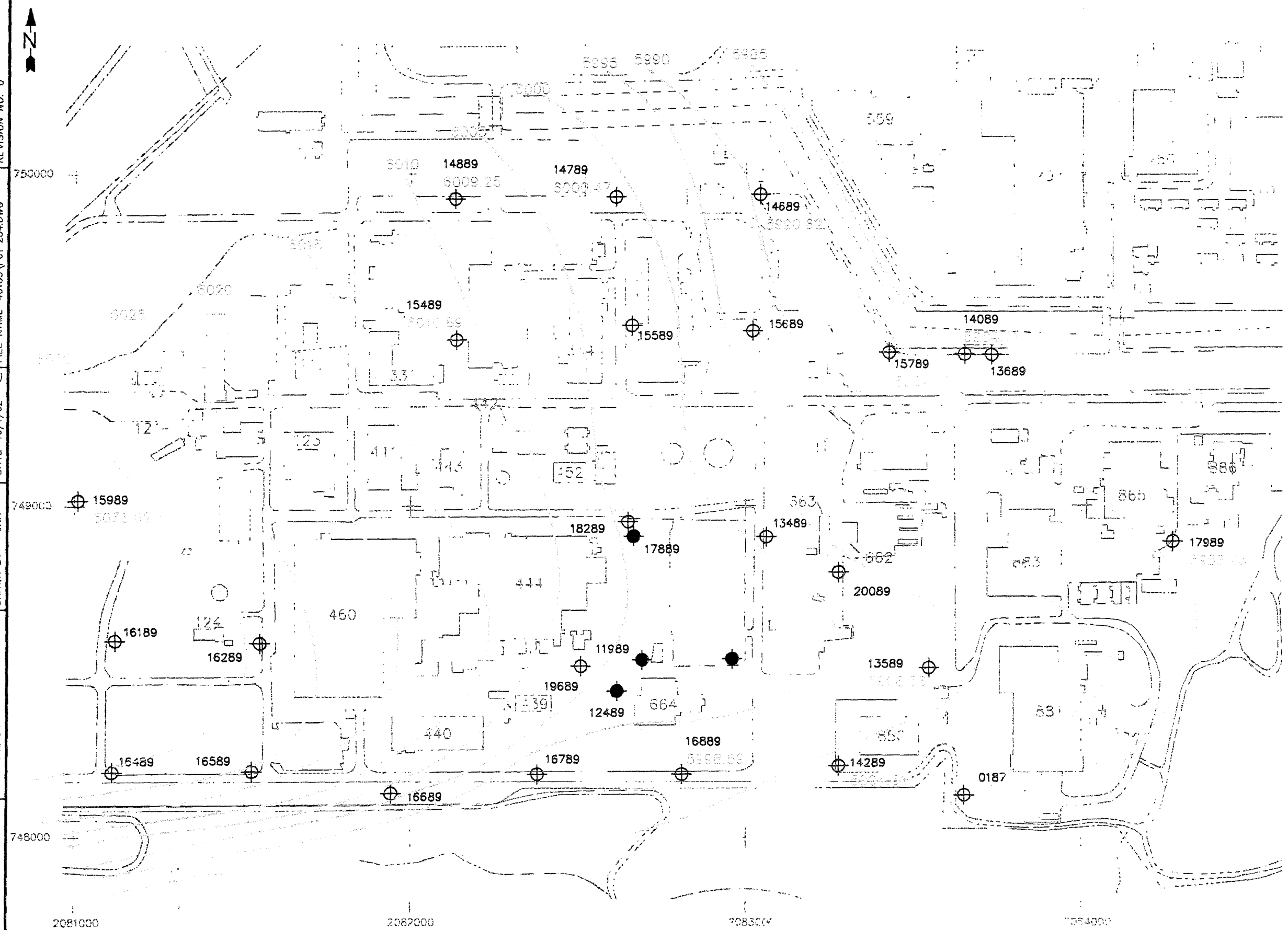
GOLDEN, COLORADO

FIGURE 2-33
GEOLOGIC CROSS SECTION B-B'

REVISION NO. 0 | FILE NAME 40103\F01-233.DWG | DATE 4/29/92 | DRAWN BY JAA | APPROVED BY BN | CHECKED BY BN



EXPLANATION

14689 MONITORING WELL LOCATION

16889 ABANDONED MONITORING WELL LOCATION

WATER TABLE ELEVATION (FEET ABOVE MEAN SEA LEVEL)

ELEVATION CONTOUR (DASHED WHERE INFERRED)

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FIGURE 2-34
WATER TABLE CONTOUR MAP
APRIL 1991

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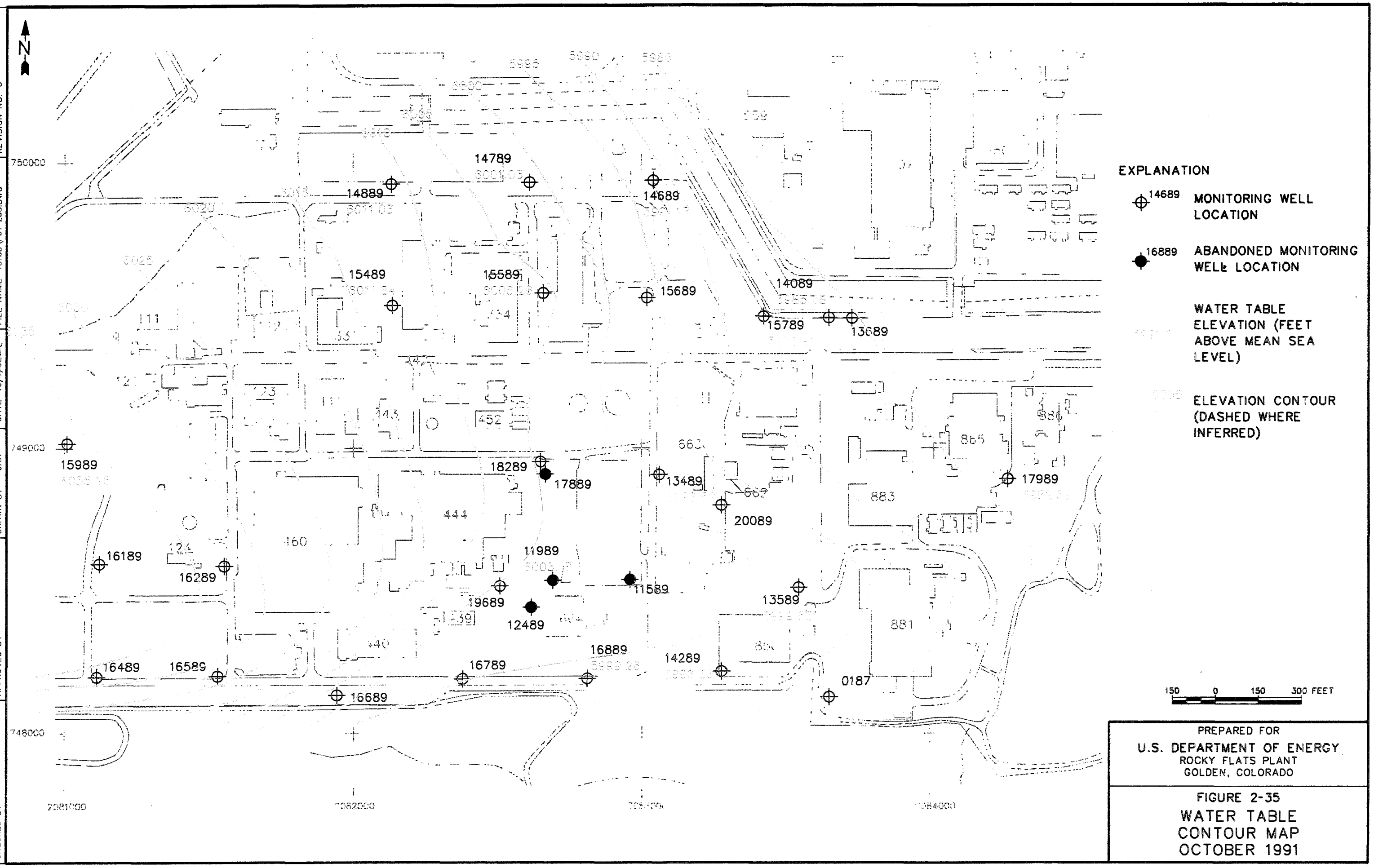

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FIGURE 2-35
WATER TABLE CONTOUR MAP
OCTOBER 1991

REVISION NO. 0
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DATE 10/1/92
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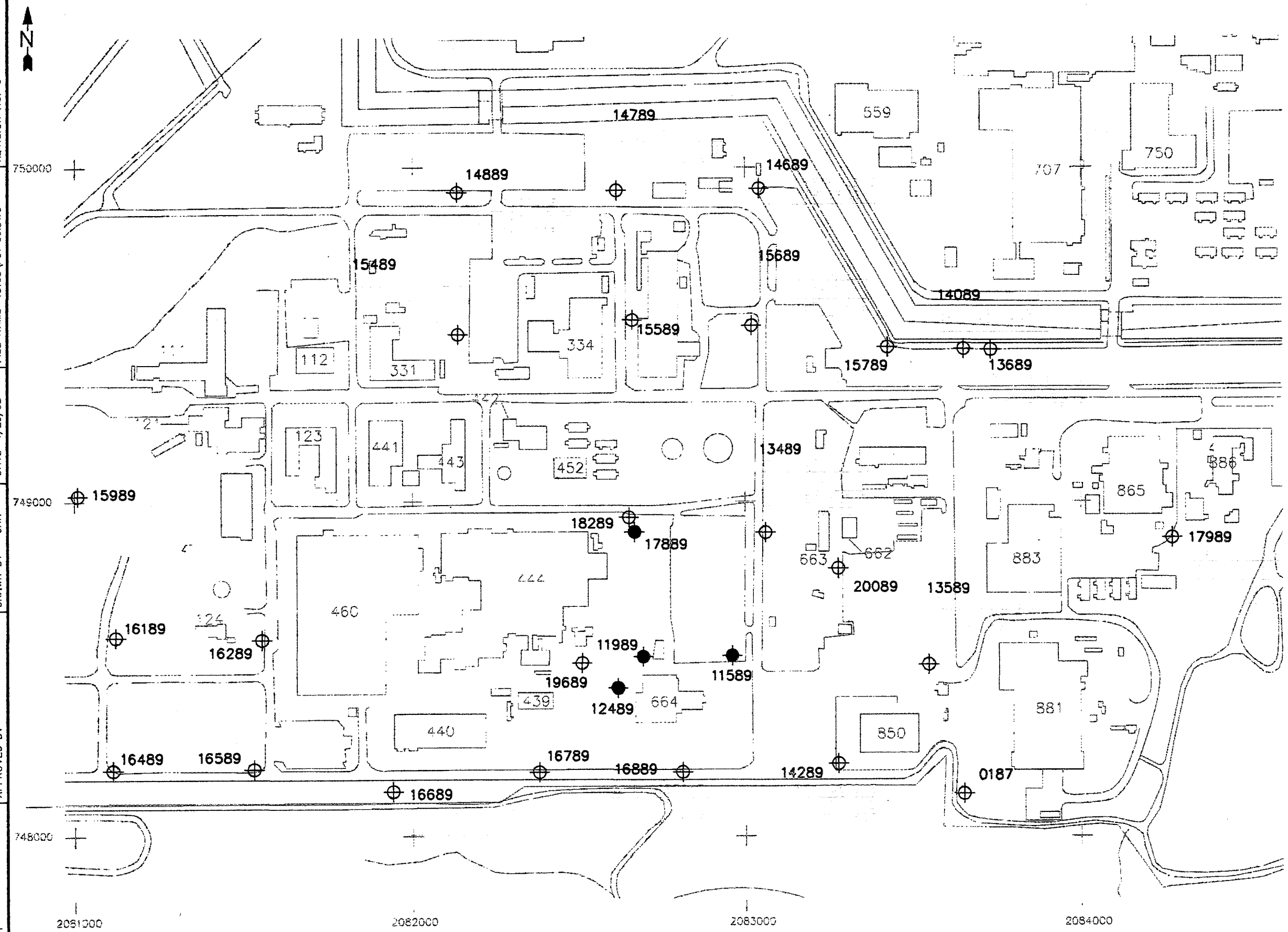

EXPLANATION

13489 MONITORING WELL LOCATION

16889 ABANDONED MONITORING WELL LOCATION

COMPOUND DETECTED IN BLANK SAMPLE

COMPOUND DETECTED AT LESS THAN CONTRACT REQUIRED DETECTION LIMIT, BUT AT GREATER THAN INSTRUMENT DETECTION LIMIT

NOTE:
ONLY COMPOUND DETECTIONS FROM TABLE 2-4 ARE PLOTTED

150 0 150 300 FEET

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FIGURE 2-36
SELECT VOLATILES DETECTED IN SHALLOW SOILS(0-2 FEET DEPTH)

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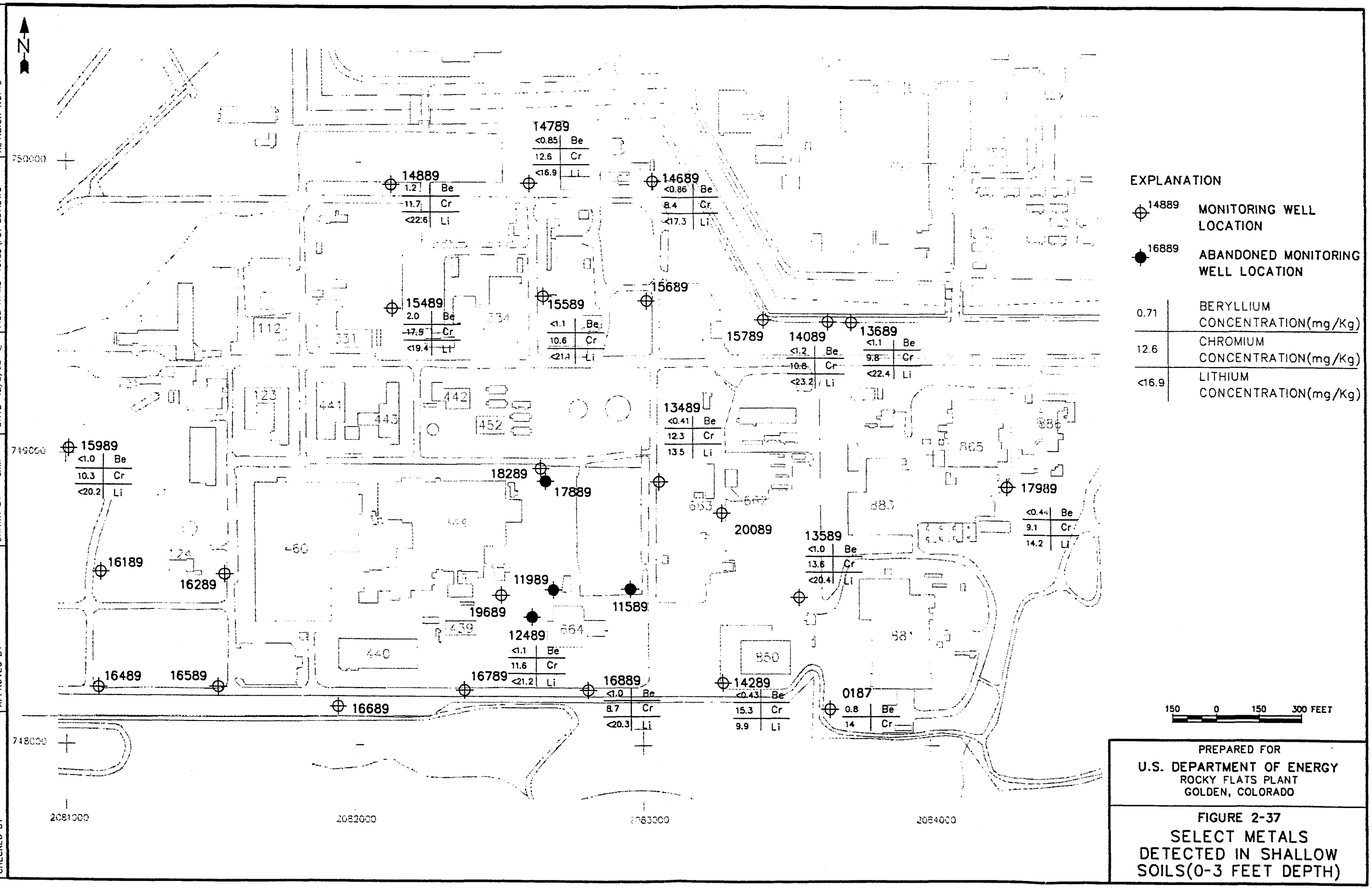

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FIGURE 2-37
SELECT METALS DETECTED IN SHALLOW SOILS(0-3 FEET DEPTH)

REVISION NO. 0
FILE NAME 40103\FG1-237.DWG
DATE 12/2/92
DRAWN BY emh
APPROVED BY
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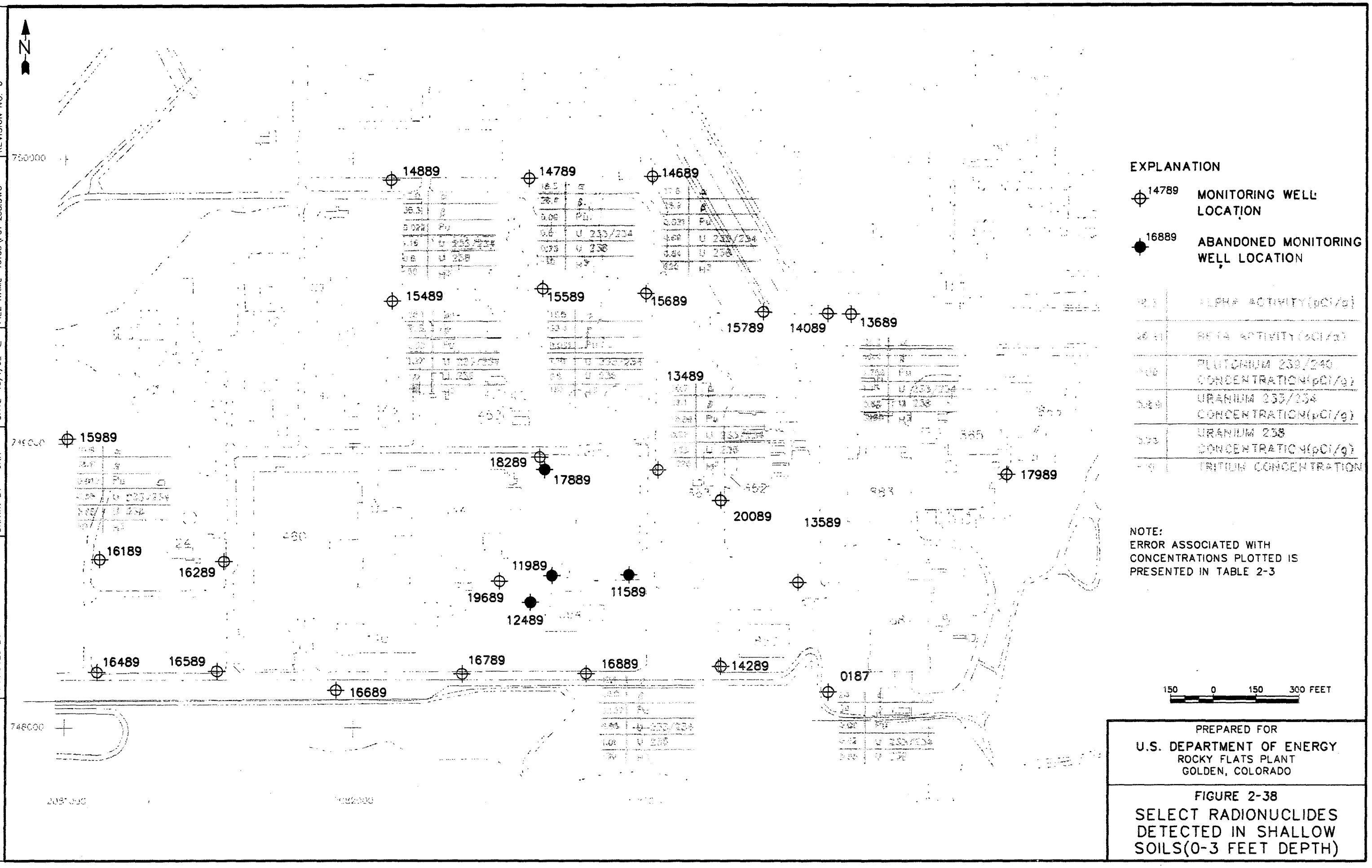
N
750000
748000
14889
14789
14689
15489
15589
15689
15789
14089
13689
13489
15989
18289
17889
17989
20089
13589
16189
16289
11989
19689
12489
11589
16489
16589
16689
16789
16889
14289
0187
EXPLANATION
14789 MONITORING WELL LOCATION
16889 ABANDONED MONITORING WELL LOCATION
ALPHA ACTIVITY(pCi/g)
BETA ACTIVITY(pCi/g)
PLUTONIUM 239/240 CONCENTRATION(pCi/g)
URANIUM 233/234 CONCENTRATION(pCi/g)
URANIUM 238 CONCENTRATION(pCi/g)
TRITIUM CONCENTRATION
NOTE:
ERROR ASSOCIATED WITH CONCENTRATIONS PLOTTED IS PRESENTED IN TABLE 2-3
150 0 150 300 FEET
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FIGURE 2-38
SELECT RADIONUCLIDES DETECTED IN SHALLOW SOILS(0-3 FEET DEPTH)
REVISION NO. 0
FILE NAME 40103\F01-238.DWG
DATE 10/7/92
DRAWN BY JAA
APPROVED BY
CHECKED BY

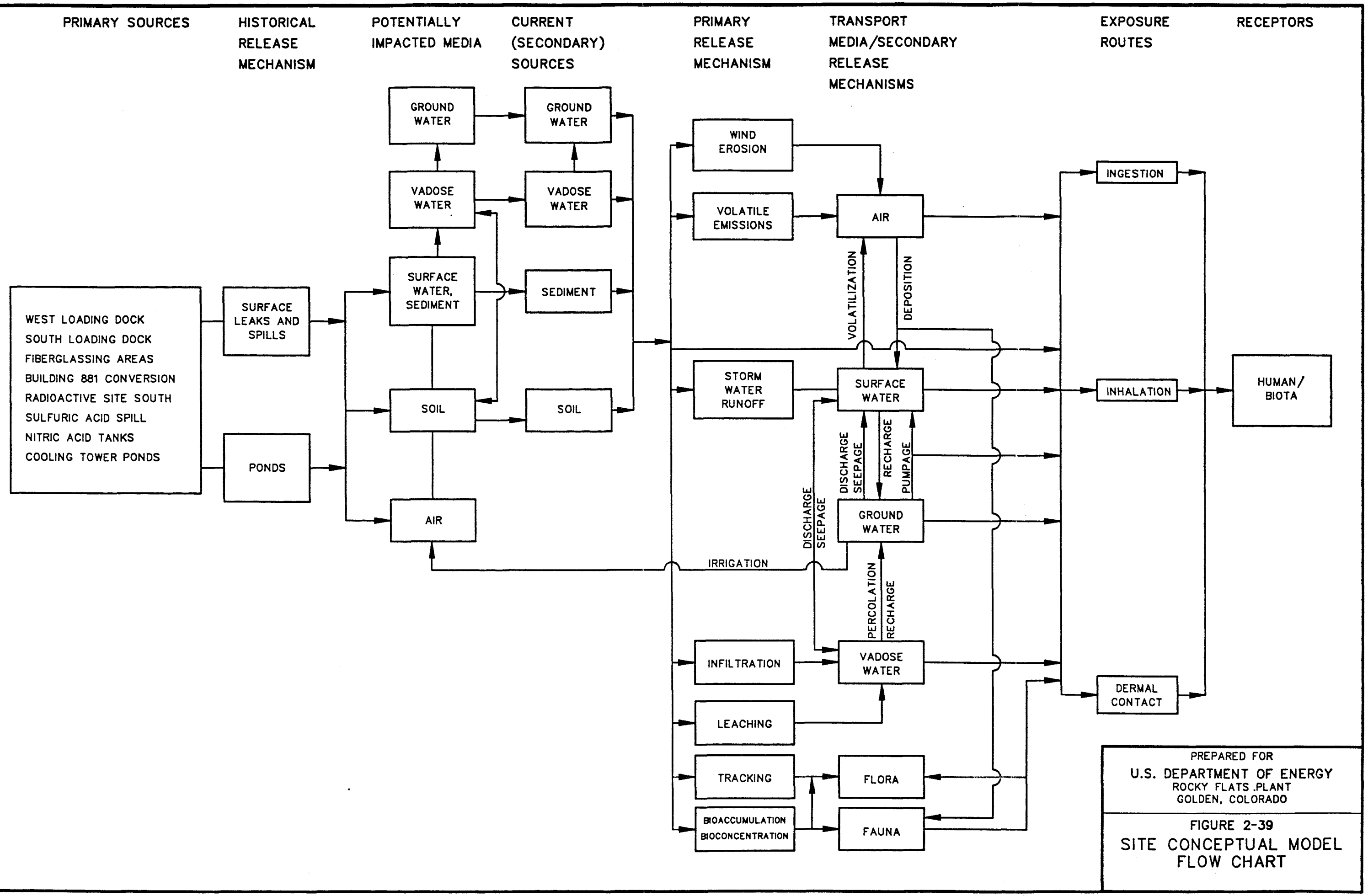

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FIGURE 2-39
SITE CONCEPTUAL MODEL FLOW CHART

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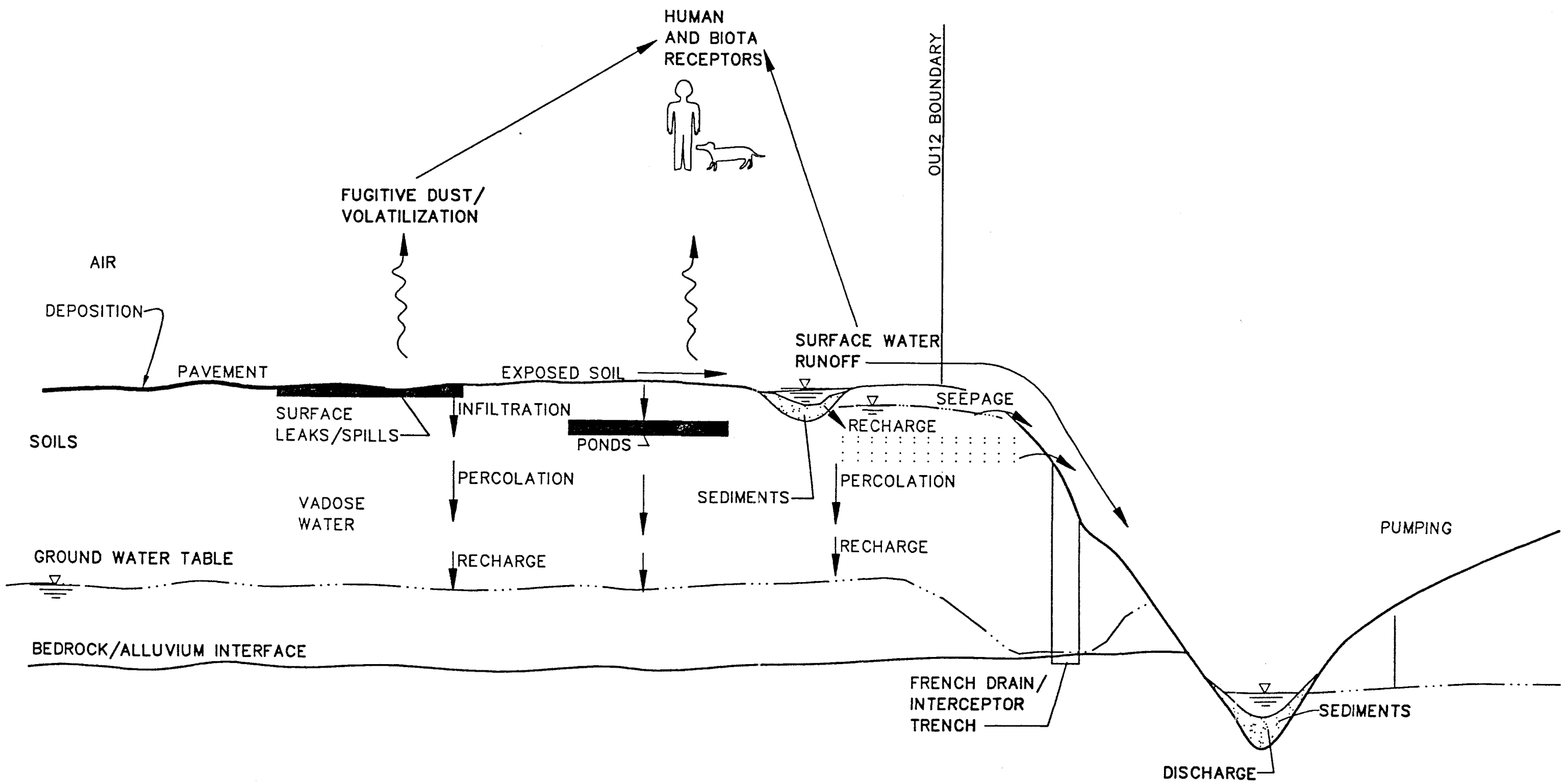

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FIGURE 2-40
SITE CONCEPTUAL MODEL
GRAPHIC

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FILE NAME 40103\F01-240.DWG
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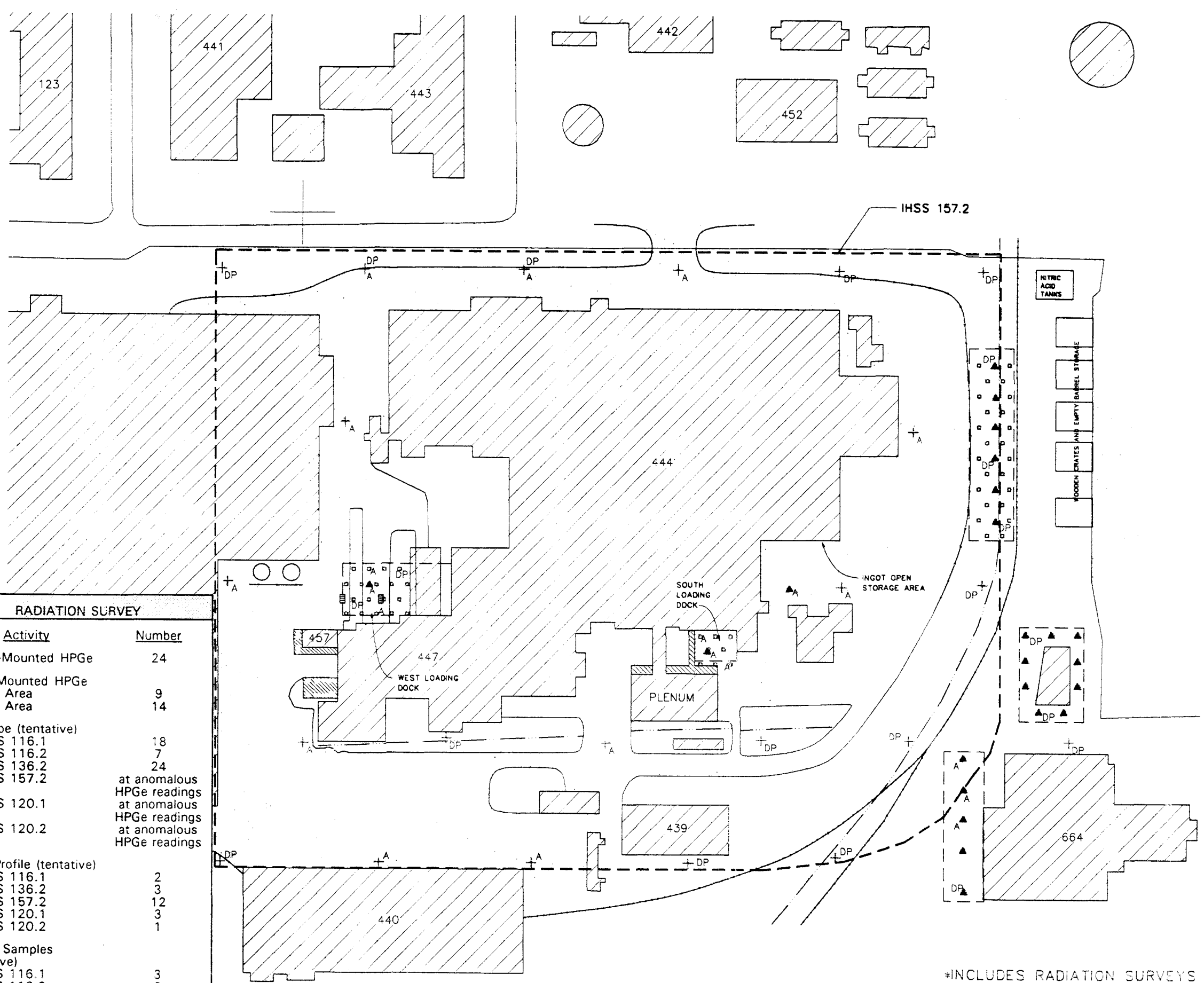

RADIATION SURVEY

Activity	Number
Vehicle-Mounted HPGe	24
Tripod-Mounted HPGe	
400 Area	9
600 Area	14
NaI Probe (tentative)	
IHSS 116.1	18
IHSS 116.2	7
IHSS 136.2	24
IHSS 157.2	at anomalous HPGe readings
IHSS 120.1	at anomalous HPGe readings
IHSS 120.2	at anomalous HPGe readings
Depth Profile (tentative)	
IHSS 116.1	2
IHSS 136.2	3
IHSS 157.2	12
IHSS 120.1	3
IHSS 120.2	1
Asphalt Samples (tentative)	
IHSS 116.1	3
IHSS 116.2	3
IHSS 157.2	12
IHSS 120.2	3

EXPLANATION

- BUILDING
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- RAILROAD
- FENCE
- + PROPOSED VEHICLE-MOUNTED HPGE SURVEY LOCATION (150 FT GRID)
- ▲ PROPOSED TRIPOD MOUNTED HPGE SURVEY LOCATION
- ▫ NaI SCINTILLATION DETECTOR MEASUREMENT LOCATION
- A ASPHALT SAMPLE
- DP DEPTH PROFILE SAMPLE (0 TO 2, 2 TO 4, 4 TO 6 INCH)

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

50 0 50 100 FEET

*INCLUDES RADIATION SURVEYS FOR IHSSs 116.1, 116.2, 136.2, 120.1 AND 120.2

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FIGURE 6-1
PROPOSED HPGE RADIATION SURVEY FOR 400/600 BUILDING AREAS*

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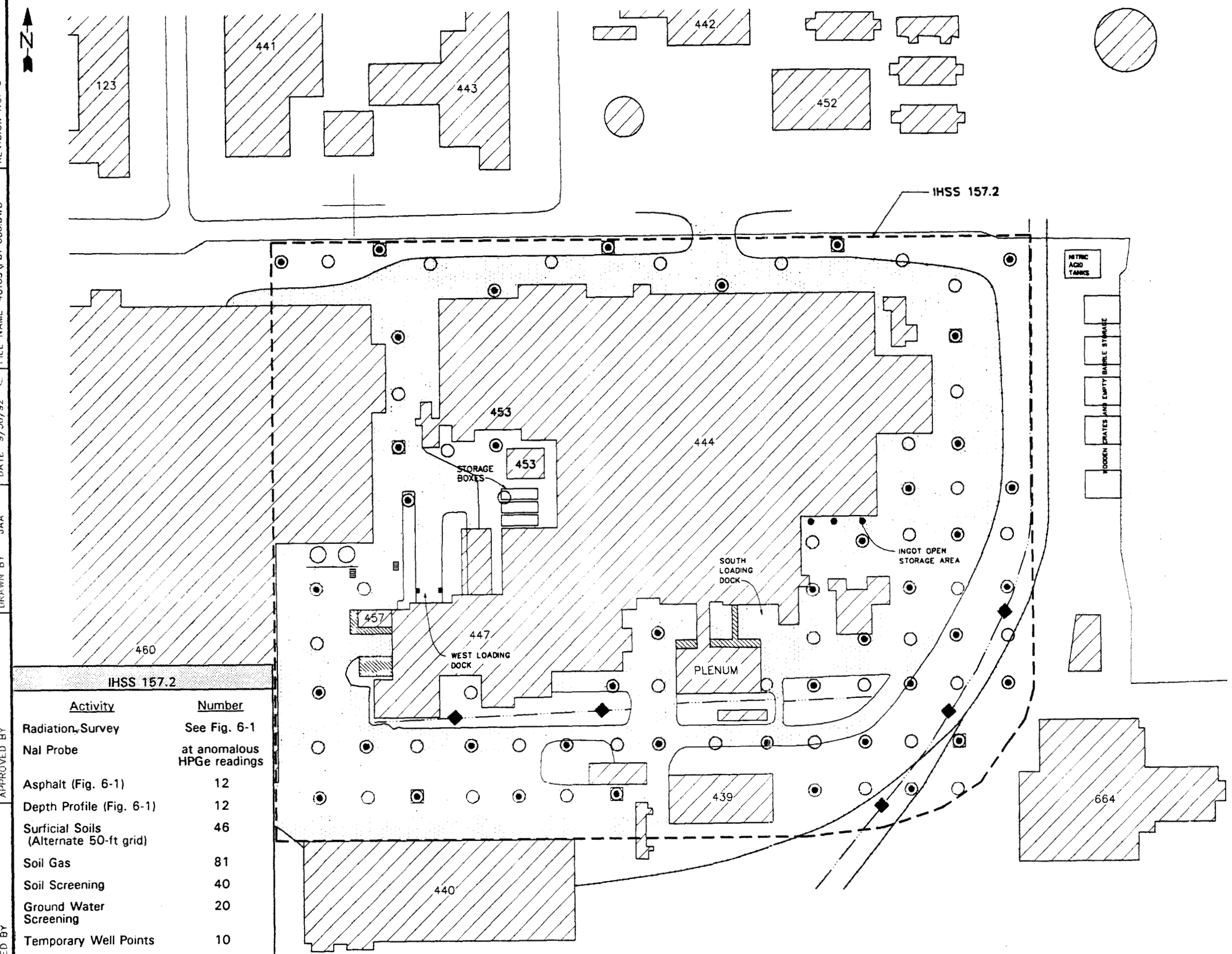

IHSS 157.2	
Activity	Number
Radiation Survey	See Fig. 6-1
NaI Probe	at anomalous HPGe readings
Asphalt (Fig. 6-1)	12
Depth Profile (Fig. 6-1)	12
Surficial Soils (Alternate 50-ft grid)	46
Soil Gas	81
Soil Screening	40
Ground Water Screening	20
Temporary Well Points	10
Sediment	5
Soil Borings	8

EXPLANATION

- BUILDING
- IHSS BOUNDARY
- DRAINAGE
- PAVEMENT
- CONCRETE
- SOIL OR GRAVEL
- RAILROAD
- FENCE
- SURFICIAL SOIL SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION
- SOIL GAS SURVEY LOCATION
- SOIL BORING LOCATION (TENTATIVE)

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

50 0 50 100 FEET

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FIGURE 6-6
FIELD SAMPLING PLAN FOR IHSS 157.2-RADIOACTIVE SITE SOUTH AREA

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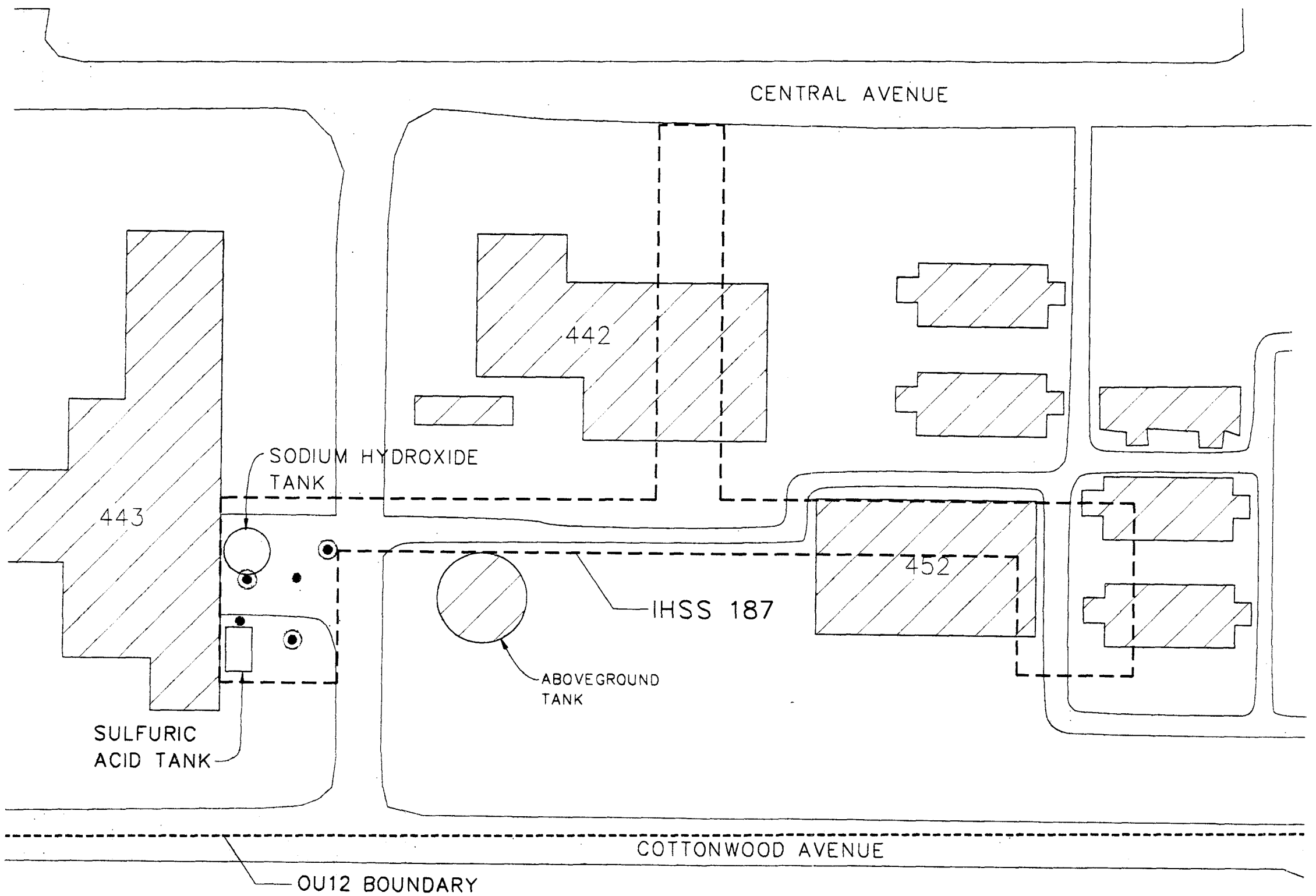

EXPLANATION

- BUILDING
- IHSS BOUNDARY
- OVERHEAD PIPING
- PAVEMENT
- SOIL OR GRAVEL
- ● SURFICIAL SOIL SAMPLING LOCATION
- ○ HYDRAULIC PROBE LOCATION

NOTE: LOCATION OF PHYSICAL SITE FEATURES ARE APPROXIMATE

25 0 25 50 FEET

IHSS 187	
Activity	Number
Surficial Soils (pH only)	5
Ground Water Screening (sulfate and pH only)	3

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FIGURE 6-7
FIELD SAMPLING PLAN FOR IHSS 187 SULFURIC ACID SPILL

REVISION NO. 0 | FILE NAME 40103\F01-607.DWG | DATE 9/30/92 PC | DRAWN BY JAA | APPROVED BY | CHECKED BY

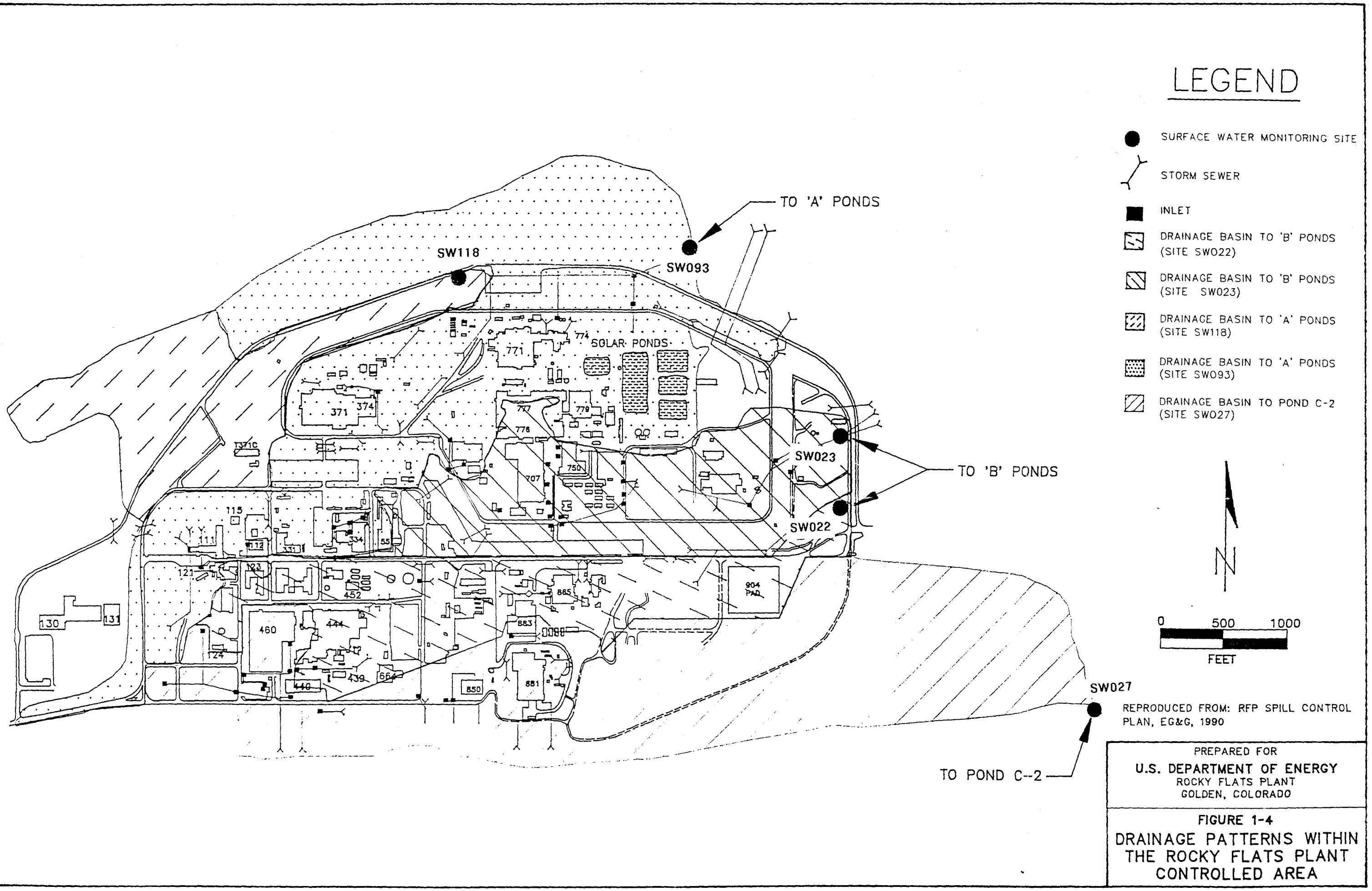

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FIGURE 1-4
DRAINAGE PATTERNS WITHIN THE ROCKY FLATS PLANT CONTROLLED AREA

REVISION NO. 0 | FILE NAME 40103\F01-104.DWG | DATE 4/30/92 | DRAWN BY JAA | APPROVED BY BJN | CHECKED BY BJN