

DRAFT

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT

**100 AREA
(Operable Unit No.13)**

VOLUME I OF III

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

ENVIRONMENTAL RESTORATION PROGRAM

MAY 11, 1992

ADMIN RECORD

A-OU13-000014

REVIEWED FOR CLASSIFICATION/UCM
By K. J. Gallagher (initials)
Date 5/10/92

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**ENVIRONMENTAL MANAGEMENT
PROGRAM**
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area

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Operable Unit 13

Approved By:

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LIST OF ACRONYMS

AEC	U.S. Atomic Energy Commission
AIP	Agreement in Principle
APEN	Air Pollution Emissions Notice
ARAR	Applicable or Relevant and Appropriate Requirement
ASI	Advanced Sciences, Inc.
BRA	Baseline Risk Assessment
BRAP	Baseline Risk Assessment Plan
CA	Controlled Area
CAD	Corrective Action Decision
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
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
COC	Contaminants of Concern
CPS	Cancer Potency Slopes
CWAD	Clean Water Act Division
DCA	Dichloroethane
DCE	Dichloroethene
DCG	Derived Concentration Guide
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.
EIS	Environmental Impact Statement
EMD	Environmental Management Division
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERDA	Energy Research and Development Administration
ERP	Environmental Restoration Program
FFCA	Federal Facilities Compliance Act
FS	Feasibility Study
FSAP	Field Sampling and Analysis Plan
FSP	Field Sampling Plan
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/Mass Spectrometer
GRRASP	General Radiochemistry and Routine Analytical Services Protocol

LIST OF ACRONYMS - Continued

HEAST	Health Effects Assessment Summary Tables
HSL	Hazardous Substance List
HRR	Historical Release Report
IAG	Interagency Agreement
IARC	International Agency for Research on Cancer
IHSS	Individual Hazardous Substance Site
IRIS	Integrated Risk Information System
LWA	Lee Wan & Associates
MEK	Methyl Ethyl Ketone
MetSta	Meteorological Station
MSL	Mean Sea Level
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
OPWL	Original Process Waste Line
OU	Operable Unit
PA	Protected Area
PAH	Polycyclic Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCE	Tetrachloroethene
PM	Particulate Matter
PSZ	Perimeter Secured Zone
PU&D	Property Utilization and Disposal
PWL	Process Waste Lines
QA	Quality Assurance
QAA	Quality Assurance Addendum
QAPjP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RfD	Risk Reference Dose
RFEDS	Rocky Flats Environmental Database System
RFI	RCRA Facility Investigation
RFP	Rocky Flats Plant
RI	Remedial Investigation
ROD	Record of Decision
SID	South Interceptor Ditch
SSH&SP	Site Specific Health and Safety Plan
STP	Sewage Treatment Plant
SWD	Surface Water Division
SWMU	Solid Waste Management Unit
TCA	Trichloroethane

LIST OF ACRONYMS - Continued

TCE	Trichloroethylene
TLL- α	Total Long-Lived Alpha
TSP	Total Suspended Particulates
UBC	Under Building Area of Concern
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WQCC	Water Quality Control Commission
WWE	Wright Water Engineers, Inc.

EXECUTIVE SUMMARY

This document presents the Work Plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit No. 13 (OU13) at the U.S. Department of Energy (DOE) Rocky Flats Plant (RFP) in Jefferson County, Colorado. The Work Plan was prepared to satisfy the requirements of the Interagency Agreement of January 22, 1991 (IAG). OU13 was originally configured by Individual Hazardous Substance Sites (IHSSs) located on the south side of the Rocky Flats main plant complex. The IHSSs are potentially contaminated areas that have been identified based on previous investigations and historical accounts of site usage. The Phase I RFI/RI Investigation of OU13 will examine the suspected relationship of the IHSSs to soil and groundwater contamination at the site. OU13 IHSSs consist of the following:

- The North Chemical Storage Site (IHSS 117.1) is located north of the intersection of Sage Avenue and Seventh Street. Past use of the site includes storage of building construction debris, other nonradioactive waste, and scrap metal. Automotive batteries may have been included in the stored materials. No chemicals were stored at this site.
- The Middle Chemical Storage Site (IHSS 117.2) is located south of IHSS 117.1, south of Sage Avenue and west of Seventh Street. It is east of the northern part of Building 551. The area has been used as a multi-purpose storage facility including warehouse storage, nonradioactive chemical storage, and storage for pallets, cargo containers, and new drums. It is still used as a storage area.
- The South Chemical Storage Site (IHSS 117.3) is located south of IHSS 117.2, south of Central Avenue and west of Seventh Street. It was used for storage of various unidentified material from 1964, or earlier, until 1970. About four gallons of radioactively contaminated oil was reported to have leaked from a waste box that was transferred to the site in 1965. The contaminated ground was immediately removed. A large fuel oil storage tank (Tank 224) was constructed in the area in 1973.

- The Oil Burn Pit No. 1 Waste Leak (IHSS 128) is located north of building 335 and beneath Sage Avenue, east of the Fourth Street intersection. It is the site of reported disposal of about 200 gallons of contaminated (depleted uranium) waste oils by burning in a pit in 1956. The pit was backfilled after the oil was burned. The area is now almost entirely covered by Sage Avenue, which was constructed in 1969 and 1970.
- The Lithium Metal Destruction Site (IHSS 134) is located in an area that extends from the location of IHSS 128 southward to the eastern wing of Building 331. Waste lithium was destroyed in this area by burning oil and lithium in 55-gallon drums. The residue containing oxidized lithium was probably sent to the Original Landfill (IHSS 115). The approximate duration of these activities was 1963 to 1966.
- The Waste Spills (IHSS 148) is located at Building 123, west of Fourth Street between Central and Cottonwood Avenues. It is a result of reported small spills of nitrate-bearing wastes around the outside of Building 123 and possible leakage of original process waste lines beneath the building, which were abandoned about 1975. The wastes may have contained radionuclides.
- The Fuel Oil Tank 221 Spills site (IHSS 152) is located west of Seventh Street, between Central and Cottonwood Avenues east of Building 452. The spills are associated with an 800,000-gallon fuel oil storage tank. The tank was constructed in 1973 and fuel oil leaks have occurred there.
- The North Area Radioactive Site (IHSS 157.1) is located at Building 442, southwest of the intersection of Central Avenue and Fifth Street. Building 442 was used as a laundry from 1952 until about 1972, when it was converted to a filter test laboratory. The laundry received contaminated clothing and rags, which contained uranium and possibly beryllium. An example of potential contamination is leakage from a barrel of contaminated rags stored outside of the building.
- The Building 551 Radioactive Site (IHSS 158) is beneath the north wing of Building 551, and includes Building 554 which was the train loading facility. The area is potentially contaminated from leakage of radioactive materials from containers stored and loaded there.

- The Solvent Burning Ground (IHSS 171) is located near building 335. The yard to the east of the building has been used to practice extinguishing fires since 1969. Diesel fuel, gasoline, propane, and possibly solvents have been ignited in metal pans. Some of this material may have spilled onto the ground.
- The Valve Vault 12 (IHSS 186) is located north of Sage Avenue, northwest of Building 552. It is a part of the existing process waste system. Process waste may contain a large range of constituents, including uranium, americium, and plutonium. In 1986 a leak was detected in a process waste line west of Valve Vault 12. The leak was cleaned-up by removing contaminated soil.
- The Caustic Leak (IHSS 190) involved a leak of raw (not waste) sodium hydroxide from an above-ground, 3,000-gallon tank located east of Building 443. The sodium hydroxide entered the Central Avenue Ditch. Alum was used to neutralize water in the ditch.
- The Hydrogen Peroxide Spill (IHSS 191) occurred in 1981, when a drum of raw (not waste) hydrogen peroxide burst after it fell from a pallet being transported by warehouse personnel. The spill occurred near the corner of Fifth Street and Central Avenue. The spill was diluted with water.

The general setting of these spills and leaks includes an area that has been gradually industrially developed. The natural soils have been disturbed, replaced by fill, or covered by pavement and structures. The soils, fill, pavement, and structures are underlain by Rocky Flats Alluvium except where the alluvium has been excavated to bedrock and replaced by fill. The Rocky Flats Alluvium in the OU13 area varies in thickness to about 38 feet and is composed of poorly- to moderately-sorted clay, silt, sand, and gravel. The Cretaceous Arapahoe Formation underlies the surficial material. It is mainly claystone and silty claystone with sandstone bodies present. Recent mapping suggests that the Arapahoe is generally less than 50 feet thick. The Arapahoe is underlain by an upper claystone unit of the Laramie Formation. These bedrock units dip gently to the east. The unconformity between the Arapahoe Formation and the Rocky

Flats alluvium is a pediment surface that contains paleotopographic highs and lows of the pre-Rocky Flats Alluvium drainage system.

The water table is generally within the alluvium in the OU13 area, but may approach or pass beneath the bedrock boundary at certain places during dry seasons. Groundwater flow beneath OU13 is generally eastward, but local deviations may occur due to the effect of bedrock paleotopography during dry seasons and due to the effect of lenticular sandstones in the Arapahoe Formation. The alluvium is more permeable than the bedrock. Consequently, the groundwater tends to flow through the more permeable surficial material above the contact with the less permeable Arapahoe Formation.

Since the IHSSs involve spills and leaks that enter the subsurface, the conceptual models of contaminant migration involve percolation downward through the vadose zone (generally less than 10 feet thick) to the water table and then in the direction of groundwater flow. Contaminants may be lost during transit due to volatilization (which may release contaminants to the atmosphere), biodegradation, and radioactive decay. Contaminants may be immobilized by chemical precipitation and retarded by adsorption. Contaminant concentrations are reduced by dispersion as they move through the porous media. Mobile contaminants carried by the groundwater may eventually reach the ground surface and surface water at such discharge points as seeps, springs, and gaining reaches of nearby streams. Eroded surficial material from OU13 may enter ditches and eventually reach detention ponds.

The field sampling and analysis plan is designed to meet the Data Quality Objectives. The rationale for the sampling is based on a staged approach. Stage 1 will address the presence of contamination and will involve primarily screening level surveys. Stage 2 will confirm the results of Stage 1 and verify the presence

of contamination in the vadose zone and groundwater. Stage 3, if necessary, will address the extent of contamination and the potential migration of contaminants from each IHSS.

Types of activities to be conducted during Stage 1 include surface radiation surveys, soil gas surveys, and groundwater sampling from existing wells and piezometers. Activities to be conducted under Stage 2 include borehole sampling, surface scrape sampling, and groundwater sampling. Upon completion of Stage 2, all data collected will be evaluated to determine whether further investigation of each IHSS is required.

The field sampling and analysis plan presents detailed procedures for each IHSS for Stage 1 and Stage 2 sampling. Stage 2 will consist of drilling one to three boreholes at locations indicated by Stage 1 sampling. Where boreholes are being drilled at the location of the highest level of contamination detected in Stage 1 surveys, groundwater samples will be collected as the borehole is advanced. Hydropunch®, or equivalent, technology will be used to collect the groundwater samples. For scoping purposes, it is assumed that two alluvial groundwater monitoring wells will be required in Stage 3 at each IHSS determined to be a source of contamination in Stages 1 and 2. One monitoring well will be located up-gradient and one down-gradient.

Lists of compounds to be analyzed for at each stage of the investigation are based upon the requirements of the IAG and on historical data obtained during the preparation of this work plan.

The data collected during the field sampling and analysis will be used for site characterization and risk assessment. The Human Health Risk Assessment considers risks from both radiological and non-radiological contaminants. Source

related contaminants present at IHSSs will be evaluated to identify Contaminants of Concern. Adequate documentation will be prepared to justify including or excluding specific contaminants. An exposure assessment will be performed that will identify exposure pathways, potentially exposed populations, and the dynamics of the population exposures. A toxicity assessment will describe the contaminants relative to their potential to cause harm. Risk characterization will involve exposure assumptions and toxicity information to quantitatively estimate the risk of adverse health effects. Uncertainties in the risk assessment procedure will be identified and the reliability of the risk assessment will be evaluated.

The OU13 Environmental Evaluation (EE) will be coordinated with OU9 and OU6 evaluations due to overlapping of study areas. OU9, the Original Process Lines network that extends throughout much of the production area, will address all habitat description necessary within the industrial area. The OU9 EE Work Plan defines an ecological risk assessment within the production study area. Areas of concern in OU13 which bridge the boundary between the RFP site buffer-zone and the production area are incorporated in OU6.

The Quality Assurance Addendum to this work plan provides detailed procedures for the conduct of the work including training; sampling; logging; analytical procedures; equipment control and decontamination; air monitoring; data reduction, validation, and reporting; control of documents, items, samples, and data; control of sampling and analysis processes; corrective action; and maintenance of quality assurance records.

**ENVIRONMENTAL MANAGEMENT
PROGRAM**
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area

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1.0 INTRODUCTION

This document presents the Work Plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit No. 13 (OU13) at the U.S. Department of Energy (DOE) Rocky Flats Plant (the RFP) in Jefferson County, Colorado. Volume I of this RFI/RI contains the text, Volumes I and II contain Appendices.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies (FSs), and remedial/corrective actions currently in progress at the RFP. These investigations are pursuant to an Interagency Agreement (IAG) between 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 program developed by DOE, EPA, and CDH addresses RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) issues. Although the IAG requires general compliance with both RCRA and CERCLA, RCRA regulations apply to RIs at OU13. In accordance with the IAG, the CERCLA terms "remedial investigation" and "feasibility study" as used in this document are considered equivalent to the RCRA terms "RCRA Facility Investigation" and "Corrective Measures Study" (CMS), respectively. Also in accordance with the IAG, the term "Individual Hazardous Substance Site" (IHSS) is equivalent to the term "Solid Waste Management Unit" (SWMU).

1.1 ENVIRONMENTAL RESTORATION PROGRAM

The 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 (RIs) include 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 (FSs) includes evaluation of remedial alternatives and development of remedial action plans to mitigate environmental problems identified in Phase 2. 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 of the Environmental Restoration Program has been completed at the RFP (DOE, 1986a), and Phase 2 is currently in progress.

1.2 WORK PLAN SCOPE

As required by the IAG, this Work Plan addresses characterization of sources and environmental media at each IHSS in OU13. It also addresses the nature and extent of contamination at each IHSS, migration pathways, and receptor exposure.

In this Work Plan, the existing information is summarized to characterize OU13, data gaps are identified, Data Quality Objectives (DQOs) are established, and a Field Sampling and Analysis Plan (FSAP) is presented to characterize site physical features, define contaminant sources, and assess the extent of contamination.

The Work Plan is for Phase I RFI/RI. It will be conducted in accordance with the Interim Final RCRA Facility Investigation (RFI) Guidance (EPA, 1989a) and Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988a). Existing data and that generated by the Phase I 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 sources within OU13.

This Work Plan is organized as follows:

- Section 1.0 of this Work Plan provides introductory information and a general characterization of the RFP regional and plant-site background information. This includes a description of the Work Plan Scope and Overview.

- Section 2.0 presents a comprehensive review and detailed analysis of all available historical information, previous site investigations, recently published reports, available data, and past and present activities pertinent to OU13. 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, groundwater, surface water, and sediments. Additionally, Section 2.0 presents conceptual models of sites where hazardous substances may have been released based on the physical characteristics of the sites and available information regarding the nature and extent of contamination.
- Section 3.0 presents a preliminary identification of Applicable or Relevant and Appropriate Requirements (ARARs) and their application to OU13.
- Section 4.0 outlines Phase I RFI/RI tasks to be performed.
- Section 5.0 establishes data needs and DQOs considering the site characteristics and conceptual model provided in Section 2.0.
- Section 6.0 presents the FSAP for the Phase I RFI/RI to satisfy the data needs and DQOs outlined in Section 5.0
- Section 7.0 presents a preliminary schedule for implementation of the Phase I RFI/RI.
- Sections 8.0 and 9.0 provide the Human Health Risk Assessment Plan and the Environmental Evaluation Work Plan components of the Phase I Baseline Risk Assessment Plan, respectively.
- Section 10.0 describes the Quality Assurance Addendum.
- Section 11.0 provides a list of references.

Additionally, the appendices contain all available supporting data used to characterize the physical setting and contamination at OU13.

1.3 REGIONAL AND PLANT-SITE BACKGROUND INFORMATION

1.3.1 Facility Background

the RFP is a government-owned, contractor-operated facility that is part of the nationwide Nuclear Weapons Complex. It 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 RFP 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 RFP from 1951 until June 30, 1975. Rockwell International was the prime contractor responsible for operating the RFP from July 1, 1975 until December 31, 1989. EG&G Rocky Flats, Inc. became the prime contractor at the RFP on January 1, 1990.

1.3.2 Plant Operations

Operations at the RFP consisted 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, the 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.

1.3.3 Previous Investigations

Various studies have been conducted at the 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 are summarized in Rockwell International (Rockwell, 1986a), and include:

- Detailed descriptions 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).
- Several drilling programs that began in 1960 and resulted in the construction of approximately 60 monitor wells by 1982.
- An investigation of surface and groundwater-flow systems by the U.S. Geological Survey (Hurr, 1976).

- Environmental, ecological, and public health studies, which culminated in an environmental impact statement (DOE, 1980).
- A summary report on ground-water hydrology using data from 1960 to 1985 (Hydro-Search, 1985).
- A preliminary electromagnetic survey of the RFP perimeter (Hydro-Search, 1986).
- A soil gas survey of the RFP perimeter and buffer zone (Tracer Research, Inc., 1986).
- Routine environmental monitoring programs addressing air, surface water, ground water, and soils. These programs are summarized in the annual environmental monitoring reports (Rockwell, 1975 through 1983, 1984, 1985, and 1986b).

Additional information on routine environmental programs is also presented in post-1986 annual environmental monitoring reports (Rockwell, 1987a; 1989a, and EG&G, 1990a).

In 1986, two major investigations were completed at the RFP. The first was the ER Program 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. A number of sites were identified that could potentially have adverse impacts on the environment. These sites were designated SWMUs by Rockwell International (Rockwell, 1987b) and were divided into three categories:

- 1) Hazardous waste management units that will continue to operate and need a RCRA operating permit;
- 2) Hazardous waste management units that will be closed under RCRA interim status; and
- 3) Inactive waste management units that will be investigated and cleaned up under Section 3004(u) of RCRA or CERCLA (Sec. 107).

The IAG redefines the SWMUs within the second and third categories as IHSSs. IHSS is used hereinafter; however, no RCRA or CERCLA regulatory distinction in the use of the terms "site," "unit," or "IHSS" is intended in this document.

Recent investigations have included a background geochemical investigation (EG&G, 1990d), geologic characterization (EG&G, 1991c), and surface geologic mapping (1992f).

1.3.4 Physical Setting

1.3.4.1 Location

the RFP is located in Sections 1 through 4, and 9 through 15, of Township 2 South, Range 70 West of the 6th Principal Meridian, in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). Nearby cities include Boulder, Westminster, and Arvada, which are located less than 10 miles to the northwest, east and southeast, respectively. The cities of Golden and Lakewood are located approximately 15 miles directly south of the RFP. The RFP property consists of approximately 6,550 acres of federally-owned land, 400 acres of which are located within the RFP security area where most major buildings are located. The security area is surrounded by a buffer zone of approximately 6,150 acres (Figure 1-2). The northern boundary of the property sits on the county line between Jefferson County and Boulder County. The property is bordered on the north by Colorado Highway 128, on the east by Jefferson County Highway 17 (Indiana Street), on the south by agricultural and industrial properties and Highway 72, and on the west by State Highway 93. Access to the property is via Colorado Highway 93 or Indiana Street.

OU13 is located on approximately 67.56 acres in the center of the RFP. A finger-like section of OU13 extends from the main section of the OU13 to the east and northeast and reaches the eastern edge of the RFP. This finger-like portion represents the drainage pathway of a caustic spill which occurred in December of 1978.

1.3.4.2 Topography

the RFP is located along the eastern edge of the southern Rocky Mountain region immediately east of the Colorado Front Range. the RFP is at an average elevation of approximately 5,950 feet above mean sea level. The site is located on a broad, eastward-sloping alluvial surface. The surface of the alluvium is nearly flat but slopes gently eastward at 95 feet per mile (EG&G, 1991a). At the RFP, the alluvial 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 are cut 50 to 200 feet below the level of the older alluvial surface in the vicinity of the RFP.

1.3.4.3 Meteorology and Climate

Atmospheric contaminant transport is controlled by the following parameters: climate, local meteorology, local topography and large structures or buildings onsite, and contaminant source, concentration, and physical/chemical characteristics (e.g., phase, volatility, solubility, and density).

Climate

The climate at the RFP is strongly influenced by the Front Range of the Rocky Mountains. Dry, cool winters with some snow cover and warm, moderately-moist summers characterize the Rocky Flats climate. The temperatures average a maximum of 24.4 C (76 F) and a minimum of -5.56 C (22 F), with an average annual mean temperature of 9.78 C (49.6 F). The temperature extremes recorded at the RFP range from 38.89 C (102 F) in July to -32.22 C (-26 F) in January (Schleicher, 1982). Infrequent cloud cover over the region allows intense solar heating of the ground surface during the day, and the low absolute humidity allows significant radiation cooling at night. The average relative humidity averaged 46 percent for the period between 1954-1976 (Rockwell, 1989b).

The regional topography and upper-level wind patterns over North America create a semi-arid climate along the foothills of the Front Range. Average annual precipitation is 15.16 inches. The maximum annual precipitation, recorded in 1969, was 24.87 inches. More than 80 percent of the precipitation occurs as rain between April and September, with the remainder of the precipitation occurring as snowfall in the winter months (Rockwell, 1989b). Snowfall at the RFP occurs during the months of November through May, although occasional snowstorms occur in April, May, and October.

Local Meteorology

Local meteorology is influenced by local topography, mountain ranges, and large-scale weather systems. The orientation of the bordering mountain range, as well as the general orientation of the Front Range of the Rocky Mountains, play an important role in determining the wind regime. The RFP is in the belt of prevailing northwesterly winds which are normally channeled across the geological bench called Rocky Flats.

Local mountain and valley features exert a strong influence on the wind flow under other meteorological conditions. When winds above the gradient level are strong and from a direction slightly north of west, channeling in the eastern Rocky Flats bench usually continues to produce northwesterly winds over most of the RFP.

Drainage winds also contribute to the overall area wind flow over the RFP. On clear or partly cloudy nights, the valley experiences rapid surface radiational cooling. This results in simultaneous cooling of the air near the surface, which causes the air to become stable and less turbulent. However, air along the slopes of the Front Range cools at a faster rate than air at the same elevation located over the valleys. Consequently, it becomes more dense and flows or sinks toward the valley, forming a down-slope wind. When this wind reaches the valley, it still flows toward lower elevations and becomes a down-valley wind.

Meteorology of the the RFP is strongly influenced by the diurnal cycle of mountain and valley breezes. The Front Range, located west of the the RFP, is broken by several canyons that generally run east-west. These canyons also serve to channel airflow, especially when there is strong atmospheric stability. Two dominant flow patterns exist, one during daytime conditions and one at night. During daytime hours as the earth heats, the mountains receive more direct sunlight than the plains and valleys, causing air to heat and rise. The result is a general trend for the airflow to travel toward the higher elevations (upslope condition). The general airflow pattern during upslope conditions for the Denver area is typically north to south with the flow moving up the South Platte River Valley and entering the canyons into the Front Range. After sunset, air against mountainsides cools and begins to flow toward the lower elevations (downslope conditions). The airflow pattern for the Denver area during downslope conditions is down the canyons of the Front Range onto the plains. This flow converges with the South Platte River Valley flow moving toward the north-northeast.

Strong convective activity and thunderstorms are common in the area during summer. This activity can produce severe anomalies on the normal airflow patterns because of strong inflow regions or outflow microbursts caused by the accompanying rain shafts. During late winter and spring, the meteorology can be influenced by chinook windstorms. The chinook phenomenon is characterized by strong winds moving from the west to the east over the continental divide. These winds often reach 70-80 mph (31.2-35.7 m/s) and have been recorded in excess of 120 mph (53.65 m/s) at the RFP (Rockwell, 1989).

The mean wind speed for 1990 was 4.0 m/s (9.0 mph) with the highest wind speed reported at 39.6 m/s (88.6 mph) (EG&G, 1991). Figure 1-3 gives the wind rose for the RFP, with compass point designations indicating the true bearing when facing against the wind (EG&G 1990). The predominance of northeasterly winds and low frequency of winds greater than 7 m/s (15.6 mph) with easterly components is typical at the RFP (EG&G 1990).

1.3.4.4 Surface Water Hydrology

Three streams -- Rock Creek, Walnut Creek, and Woman Creek -- drain the the RFP area and flow generally from west to east. Figure 1-4 provides an overview of the surface-water features in the vicinity of the the RFP. Rock Creek drains an area of the the RFP buffer zone generally to the northwest of the the RFP Controlled Area, flowing into Coal Creek offsite to the north. Walnut Creek is formed by the combined flows from North Walnut Creek and South Walnut Creek, which drain the central and northern areas of the RFP, respectively, along with an unnamed tributary draining a northern part of the the RFP area. These three tributaries join in the buffer zone, and Walnut Creek flows towards the Great Western Reservoir to the east. However, Walnut Creek flows generally are diverted around Great Western Reservoir into Big Dry Creek through the Broomfield Diversion Ditch.

Rock Creek, North Walnut Creek, South Walnut Creek, and the unnamed tributary are all intermittent streams; that is, flows occur in these streams primarily as a result of spring-season snowmelt and after precipitation events. Woman Creek, a perennial stream, originates to the west of the RFP, drains the southern buffer zone area, and flows eastward (Figure 1-4). A perennial stream has flow being contributed to the streambed by groundwater and therefore, the base flow is not dependent on the occurrence of precipitation events. The South Interceptor Ditch is located between the RFP Controlled Area and Woman Creek; it collects runoff from the southern part of the RFP, and diverts this to Pond C-2. Waters from Pond C-2 are pumped, treated, and discharged into Walnut Creek downstream of the eastern RFP boundary. Most of the remaining surface-water runoff in the Woman Creek drainage outside of the South Interception Ditch drainage flows offsite to the east and in part into Mower Reservoir and primarily into Standley Lake.

The Rock Creek drainage is located in the north part of the RFP. Coal Creek flows west and north of the RFP and is joined by Rock Creek northeast of the RFP. Coal Creek flows into Boulder Creek, then St. Vrain Creek, and eventually the South Platte River.

Eight ditches convey water throughout the general the RFP area: South Boulder Diversion Canal, Last Chance Ditch, Upper Church Ditch, McKay Ditch Bypass, Smart Ditch, Smart 2 Ditch, Mower Ditch, and Kinnear Ditch. Figure 1-5 provides a schematic diagram of surface-water drainage system in the vicinity of the Rocky Flats Plant. The Upper Church Ditch, McKay Ditch Bypass, Kinnear Ditch, and Last Chance Ditch all divert water from Coal Creek to the east; the Smart Ditch diverts water from Rocky Flats Lake to the east; and the Smart 2 Ditch diverts water from the Smart Ditch to a Woman Creek tributary (Figure 1-5). The Mower Ditch diverts water from Woman Creek into Mower Reservoir. The South Boulder Diversion Canal is located west of the RFP and is unlined in the vicinity of the the RFP, except for a cement-lined 100-meter aqueduct that crosses the Woman Creek drainage. All other irrigation ditches within the the RFP referenced above are unlined and tend to lose water through seepage into the underlying subsurface materials.

In addition to the ditches described above, other surface-water management controls also are in operation at the the RFP. The West Interceptor Canal (Figure 1-5) diverts runoff from the headwaters of North Walnut Creek via the McKay Ditch Bypass to Walnut Creek west of Indiana Street. The South Interceptor Canal collects runoff from the southern parts of the the RFP before it reaches Woman Creek and diverts the collected water into Pond C-2. In addition to ditches and canals, a series of detention ponds have been constructed to control the release of the RFP discharges and to collect surface runoff. See Section 2.1.6, Surface Water Hydrology for more details regarding the detention ponds of the east side of the plant.

1.3.4.5 Precipitation

Precipitation in the the RFP area primarily occurs as snowfall or short-duration thunderstorms. These localized thunderstorms are generally one hour or less in duration, and their areal extent is usually limited to approximately one square mile (ASI, 1991a). The precipitation data are collected and recorded in the West Buffer Zone Meteorological Station (MetSta). Over the long-term, the average annual precipitation at the RFP has averaged nearly 15.2 inches (ASI, 1991c). Annual evaporation at the the RFP site is estimated to be between 31 and 38 inches. This is based upon long-term records at Cherry Creek Dam

and the City of Fort Collins, respectively (ASI, 1991c). The Cherry Creek Dam is located in the Denver metropolitan area approximately 25 miles southeast of the RFP, and Fort Collins is located approximately 45 miles north of the RFP. These two sites are meteorologically similar and therefore the evaporation rates are considered representative of the the RFP evaporation rates.

1.3.4.6 Ecology

A variety of plant life is found within the RFP. The dominant vegetation found on the western portion of the site is disturbed mixed prairie, a mixture of both short and mid grasses. The eastern portion of the RFP is generally highly disturbed through overgrazing, and short grasses are dominant. Sedges (*Carex nebraskensis*) and rushes (*Juncus arcticus*) are found in stream flood-plains and wet valley-bottoms. Cottonwoods (*Populus sargentii*) and cattails (*Typha latifolia*) line many riparian areas (Clark, 1977).

Vegetative recovery has occurred in the buffer zone area, as evidenced by the presence of disturbance-sensitive species such as big bluestem (*Andropogon gerardii*) and side oats grama (*Bouteloua curtipendula*). None of the vegetative species at the RFP are reported to be on the endangered species list (EG&G, 1991b). No vegetative stresses attributable to hazardous waste contamination have been identified (DOE, 1980).

Animal populations within the RFP are representative of western prairie regions. The presence of a chain-link fence surrounding the production area effectively limits the occurrence of the most common large mammal, the mule deer (*Odocoileus hemionus*), to the buffer zone. The permanent population of *Odocoileus hemionus* is estimated to be 100 to 125. There are a number of small carnivores, such as the coyote (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), and the long-tailed weasel (*Mustela frenata*). Small herbivores are common throughout the plant complex and buffer zone, including the pocket gopher (*Thomomys sp.*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow vole (*Microtus pennsylvanicus*)(DOE, 1980).

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

and yellow warblers (*Dendroica magnolia*). Mallards (*Anas platyrhynchos*) and other ducks (*Anas sp.*) often nest and rear young on several of the ponds. Killdeer (*Chradrius vociferus*) and red-winged black birds (*Agelaius phoeniceus*) are found in areas adjacent to the ponds. Birds of prey commonly seen in the area include marsh hawks (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), and great horned owls (*Bubo virginianus*) (DOE, 1980).

Rattlesnakes (*Crotalus sp.*) and bull snakes (*Pituophis melanoleucus*) are the most frequently appearing 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 seen. 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).

Two procedures which concern the identification and management of threatened and endangered species at the RFP are currently under preparation by the EG&G National Environmental Policy Act (NEPA) Group. These are the draft Identification and Reporting of Threatened and Endangered and Special Concern Species, administrative procedure NEPA.12, Rev. 0, and the draft Protection of Threatened and Endangered and Special Concern Species, OP FO.21, Rev.0.

1.3.4.7 Surrounding Land Use and Population Density

The population, economics, and land use of areas surrounding the RFP are described in a 1989 Rocky Flats vicinity demographics report prepared by DOE (DOE, 1991b). This report divides general use of areas within 0 to 10 miles of the RFP into residential, commercial, industrial, parks and open spaces, agricultural and vacant, and institutional classifications and considers current and future land use near the RFP.

The majority of residential use within 5 miles (8 km) of the RFP is located northwest, west, southwest, and south of the RFP. Figure 1-6 shows the 1989 population distribution within a 5-mile radius from the center of the RFP. Commercial development is concentrated near the residential developments around Standley Lake, primarily north and southwest, and around the Jefferson County Airport (Jeffco) which is located approximately 3 miles (4.8 km) northeast of the RFP. Active industrial land use within 5 miles

(8 km) of the plant is limited to quarrying and mining operations located on lands directly west and southwest of the RFP. There are several pockets of industrially-zoned property located all around the RFP, both directly adjacent and nearby. This property is not likely to be developed in the near future due to a lack of water for fire protection. These properties must be accepted into a fire protection district in order to be developed for commercial or industrial use and no fire protection district is willing to accept the properties at this time. Open space lands are located northeast of the RFP, near the City of Broomfield, and in small parcels adjoining major drainages and small neighborhood parks in the cities of Westminster and Arvada. Standley Lake is surrounded by Standley Lake Park. Irrigated and nonirrigated croplands, producing primarily wheat and barley, are located northeast of the RFP near the cities of Broomfield, Lafayette, and Louisville; north of the RFP near Louisville and Boulder; and in scattered parcels adjacent to the eastern boundary of the RFP. Several horse operations and small hay fields are located south of the RFP.

1.3.4.8 Future Population and Land Use Projections

Future land use in the vicinity of the RFP will most likely involve continued suburban expansion, increasing the density of residential, commercial, and industrial land use in the surrounding areas. The expected trend in population growth in the vicinity of the RFP is addressed in the DOE demographics study (DOE, 1991b). This 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 the RFP can thus be examined. The DOE projections are based primarily upon long-term population projections developed by the Denver Regional Council of Governments (DRCOG). Expected population density and distribution around the RFP for the years 2000 and 2010 are shown in Figures 1-7 and 1-8, respectively.

1.3.4.9 Regional Geology and Hydrogeology

The RFP is located on gravelly alluvium that covers an eastward-sloping pediment surface. Bedrock is exposed locally along streams that have dissected the pediment. The surficial geology, general geologic setting for the RFP, and vicinity are shown in Figure 1-9.

The groundwater is recharged by infiltration of rainfall, snowmelt, stream seepage, and irrigation water into the surficial materials and bedrock. Flow of groundwater is in the general direction of the slope of the ground surface, primarily eastward. Discharge from the surficial materials is via springs and seeps along valley walls near the bedrock contact. Discharge from shallow bedrock is to the eastward flowing streams that dissect the alluvium covered pediment.

Surficial Deposits

The surficial deposits covering the pediment surface in the immediate vicinity of the RFP comprise the Rocky Flats Alluvium. This alluvium is Quaternary in age and was deposited as an alluvial fan with its apex at the mouth of Coal Creek Canyon transported as outwash located five miles to the west at higher elevations in the Front Range (Baker, 1973). It is composed of poorly-to moderately-sorted, poorly-stratified clay, silt, sand, gravel, and cobbles. The coarse clastic materials were derived primarily from Front Range provenance areas which are composed of Precambrian crystalline metaquartzites, metabasalts, pelitic shists, and younger granitoids of the Boulder Creek and Silver Plume Granites.

The Rocky Flats Alluvium is the surficial material beneath nearly all structures at the RFP, where the alluvium thickness ranges up to 100 feet. The alluvium is absent where it has been removed by downcutting of the streams (Walnut Creek and Woman Creek) in the vicinity. The depositional surface declines approximately 300 feet from the western edge of the the RFP peripheral buffer zone to the eastern edge of the buffer zone. This distance is 3.4 miles, and the slope is 88 feet per mile.

Local colluvial deposits are present on steeper slopes flanking drainages at the RFP. These deposits are derived from Rocky Flats Alluvium located upslope. Most bedrock is concealed beneath the colluvial material.

The bottoms of the stream valleys contain Quaternary alluvium deposited by the streams. Minor linear wetlands are present on these alluvial materials (EG&G, 1990).

The dominant soil developed on the Rocky Flats Alluvium is the Flatiron Series. These soils are very cobbly sandy loams with a slow infiltration rate where slopes are 0 to 3 percent. Nederland Series soils are also present and consist of very cobbly sandy loams. They are preferentially developed adjacent to

the Flatiron Series along the periphery of the Rocky Flats Alluvium where slopes are 15 to 50 percent and have a moderate infiltration rate. A third soil is the Denver-Kutch-Midway Series. These soils are clay loams developed on Arapahoe Formation claystones with slopes of 9 to 25 percent. Soils in the vicinity of the RFP are shown in Figure 1-10. The preceding information regarding soils at and adjacent to the the RFP is derived from Soil Conservation Service, 1980. Presently these natural soils are partly obscured by fill, gravel, and buildings at the the RFP.

Bedrock Geology

Figure 1-11 is a generalized stratigraphic section showing bedrock units exposed near the east edge of the Front Range in the Golden-Morrison area, a few miles south of the RFP. Figure 1-12 is a detailed stratigraphic section of the youngest units at the the RFP. These units dip generally eastward, as shown in Figure 1-13 and are present in the subsurface beneath the RFP.

The upper Cretaceous Arapahoe Formation unconformably underlies the surficial material the RFP. This formation was weathered and eroded during pedimentation and eventually covered by the Rocky Flats Alluvium. According to the Geologic Characterization Report for the RFP (EG&G, 1991), the Arapahoe Formation is 150 feet thick beneath the central portion of the the RFP. However, the position of the Arapahoe/Laramie contact is being evaluated. Results from a recent surface mapping project (EG&G, 1992), suggest that the Arapahoe Formation is generally less than 50 feet thick. The lithologic composition is mainly claystone and silty claystone with sandstone bodies present. Most of the sandstone is very fine to medium fine grained, poorly to moderately but occasionally well-sorted, subangular to subrounded, silty and clayey. Some coarse-grained to conglomeratic sandstone is present. The sandstone bodies are thought to be lenticular and laterally discontinuous. The Arapahoe Formation at the RFP has been interpreted as channel, point bar, and overbank deposits of a fluvial system (EG&G, 1991).

The Laramie Formation conformably underlies the Arapahoe (Weimer, 1973), and it is approximately 800 feet thick at the the RFP. The formation is divided into two intervals: a lower unit of sandstone, siltstone, and claystone with coal layers; and an upper claystone unit (EG&G, 1991a). The sandstones are fine to coarse grained, poorly sorted, subangular, and silty. The upper interval is about 500 feet thick at the RFP,

consisting of light to medium gray kaolinitic claystones with some dark grey to black carbonaceous claystones (EG&G, 1991). The Laramie Formation originated in a delta plain depositional environment.

The regional structural setting of the RFP is on the western flank of the Denver Basin, approximately four miles east of the steeply dipping strata on the eastern flank of the Front Range uplift. The generalized west to east structure beneath the the RFP is shown in Figure 1-13. The most prominent feature is a monoclinial fold which strikes roughly north-south. The bedrock dips steeply eastward in the west portion of the RFP, as shown by the 50 degree dip of the Fox Hills and Laramie Formations. These then flatten to a dip of no more than 1 to 2 degrees.

Hydrogeology

the RFP is situated in a regional groundwater recharge area. The groundwater system is dynamic with rapid changes in the level of the water table in response to short-term stresses to the groundwater system. Generally, water levels are highest in early summer (June) and lowest during the winter months. Hydrostratigraphic units that exist in the strata beneath the RFP in the surficial materials and the underlying Cretaceous bedrock are shown in Figure 1-13.

Hydrostratigraphic Units

Water Table (Unconfined) Aquifer

The water table (unconfined) aquifer at the RFP is primarily the unconsolidated alluvial material. It includes the Rocky Flats Alluvium, which is present on broad topographic highs, colluvium along valley slopes, and the Valley Fill Alluvium present in modern stream drainages (Figure 1-9). In the western part of the RFP, where the alluvial material is thickest, the depth to the water table is 50 to 70 feet below the surface. Although the water table depth is variable, it becomes shallower from west to east as the alluvial material thins. In the stream drainages, seeps are common at the base of the Rocky Flats Alluvium (EG&G, 1991a) and where individual Arapahoe Formation sandstones crop out.

Generally, the groundwater flows along the contact of the unconsolidated material and the Arapahoe Formation claystones in a downgradient direction to the east. The claystones have a low hydraulic

conductivity, on the order of 1×10^{-7} cm/s (EG&G, 1991c), effectively constraining much of the flow within the water table aquifer to the alluvial material above the alluvium/bedrock unconformity. Locally, however, a hydraulic connection exists between the uppermost Arapahoe Formation sandstone unit and the surficial materials, allowing them to function as a single water table aquifer in a limited area. The lower sandstones of the Arapahoe Formation also subcrop beneath alluvium and colluvium along valley slopes, therefore also existing as part of the water table aquifer in limited areas.

Confined Aquifers

Groundwater in the sandstone units of the Arapahoe Formation occurs under confined conditions over most of the RFP. The confining layers for the sandstones are claystones and silty claystones.

The Laramie/Fox Hills aquifer crops out at the west end of the RFP and dips at 45 to 50 degrees to the east. Gradually the dip decreases to less than two degrees beneath the central part of the the RFP where the Laramie/Fox Hills is separated from the the RFP activities by several hundred feet of claystone (Hurr, 1976; EG&G, 1991c). The claystone is an aquitard which separates the the RFP activities from the Laramie/Fox Hills aquifer (Figure 1-13).

Recharge and Discharge

Groundwater recharge occurs as infiltration of precipitation to confined aquifers where bedrock crops out in the western portion of the RFP along the west limb of the monoclinal fold and to the unconfined aquifer through unconsolidated material and subcropping permeable bedrock throughout the area. Recharge also occurs as a result of infiltration of surface water from streams, ditches, and ponds. At the local level, there are areas of discharge as well as recharge. Baseflow of some of the perennial streams is sustained by groundwater discharge. Additionally, groundwater within the surficial materials and underlying permeable bedrock (Arapahoe sandstones) discharges at seeps along slopes in the valleys and becomes surface water or evaporates.

Hydraulic Conductivities

The Arapahoe and the alluvial hydrostratigraphic units at the RFP have relatively low hydraulic conductivities and therefore, are not generally believed to be capable of producing amounts of water of economic significance (ASI, 1991; EG&G, 1991b). Hydraulic conductivity values are based on packer tests performed in 1986 and 1989. No data on hydraulic conductivity of the Arapahoe outside the RFP was discovered.

No conclusive data are available for the recent alluvial and colluvial deposits. An aquifer test conducted near Woman Creek in OU1 indicates a relatively high hydraulic conductivity of 1.8×10^{-2} cm/s for the Valley Fill Alluvium (Doty & Associates, 1992). The Rocky Flats Alluvium of the uppermost hydrostratigraphic unit has a hydraulic conductivity of roughly 6×10^{-5} cm/sec in Well 1-89. This value is comparable to the hydraulic conductivity of 8×10^{-5} cm/sec for the highly-weathered and unconsolidated subcropping Arapahoe sandstone which also forms a part of the uppermost hydrostratigraphic unit in Well 3-86. Both of these values are much greater than the hydraulic conductivities of the Arapahoe claystones which are approximately 1×10^{-7} to 1×10^{-8} cm/sec for both weathered and unweathered claystone (EG&G, 1991b).

In the subsurface, confined hydrostratigraphic units in the lower Arapahoe Formation have hydraulic conductivities of approximately 1×10^{-6} cm/sec. This value is intermediate to that of the hydrostratigraphic units in the Rocky Flats Alluvium and weathered subcropping Arapahoe sandstones (1×10^{-5} cm/sec) and the Arapahoe claystones (1×10^{-7} to 1×10^{-8} cm/sec) (EG&G, 1991c).

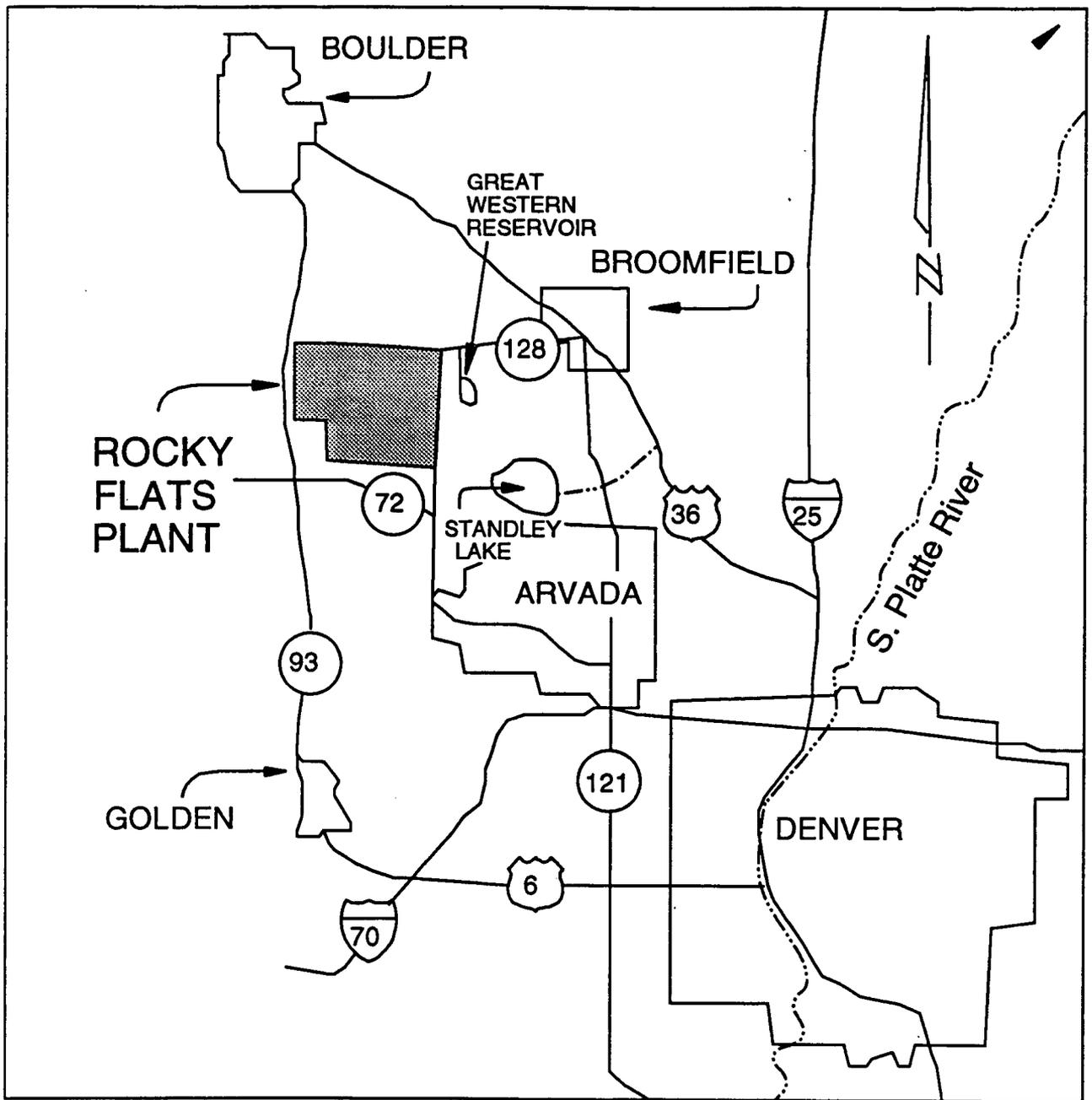
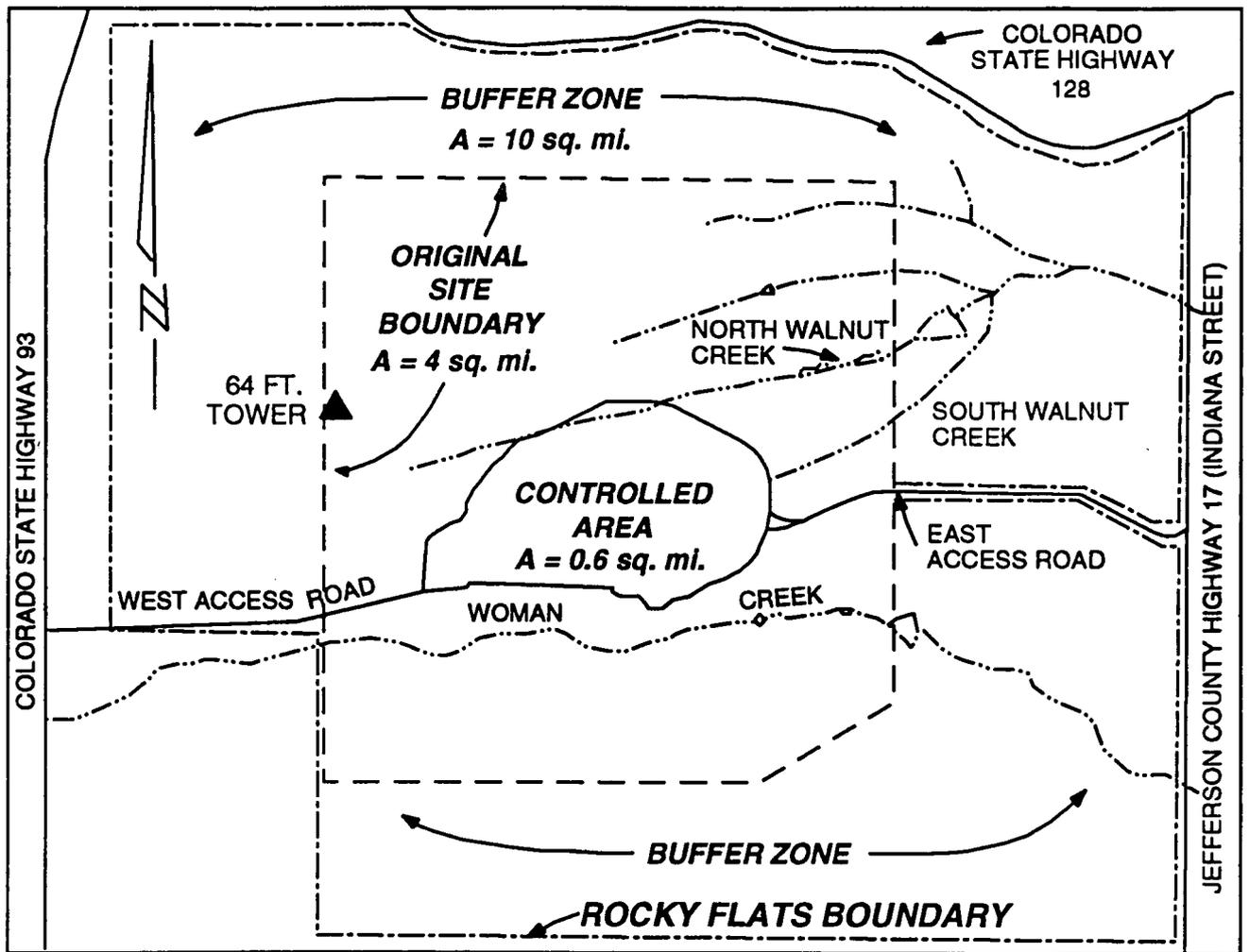


FIGURE 1-1
 SITE LOCATION MAP - ROCKY FLATS PLANT

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



Approx. scale 1" = 3,300'

FIGURE 1-2
ROCKY FLATS PLANT

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

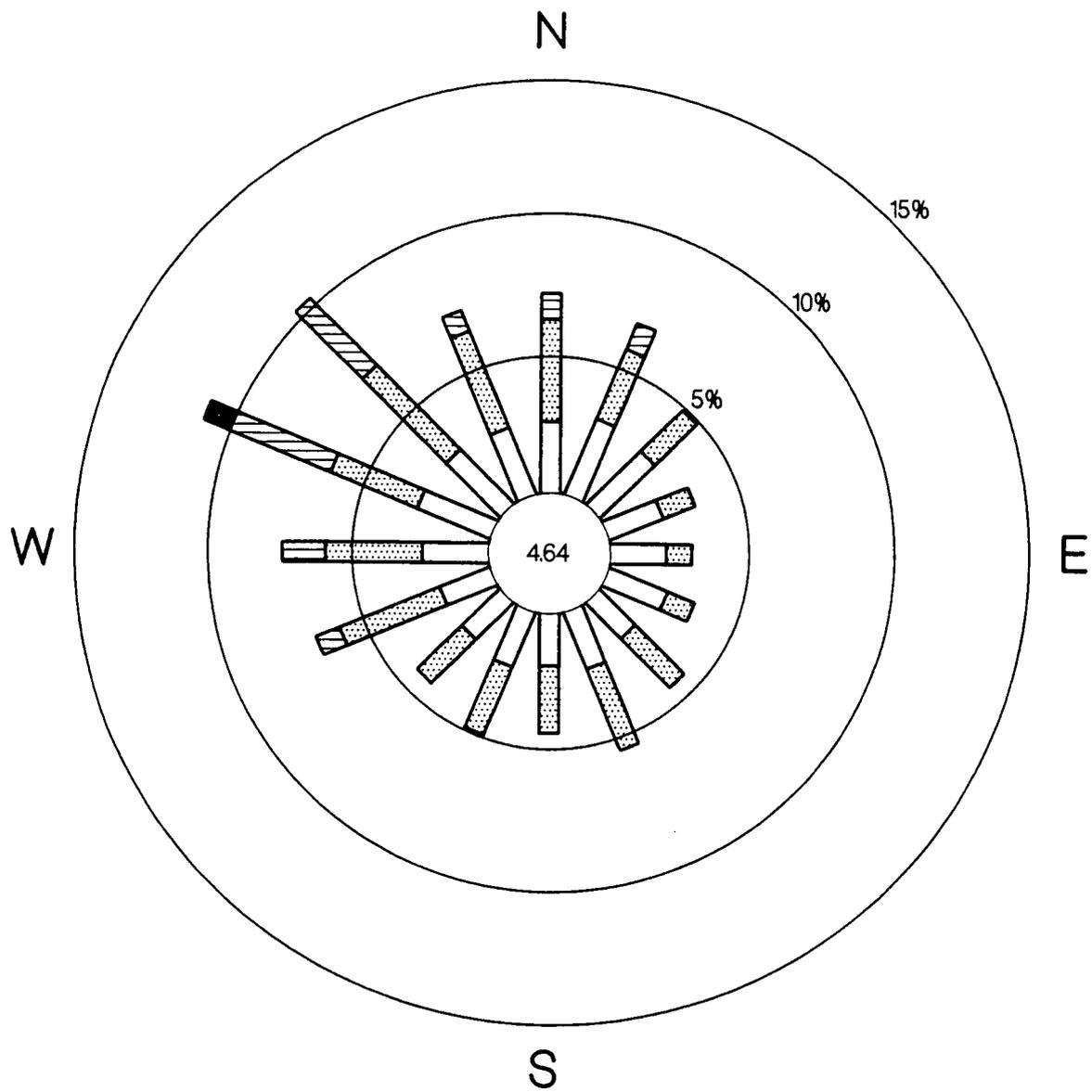
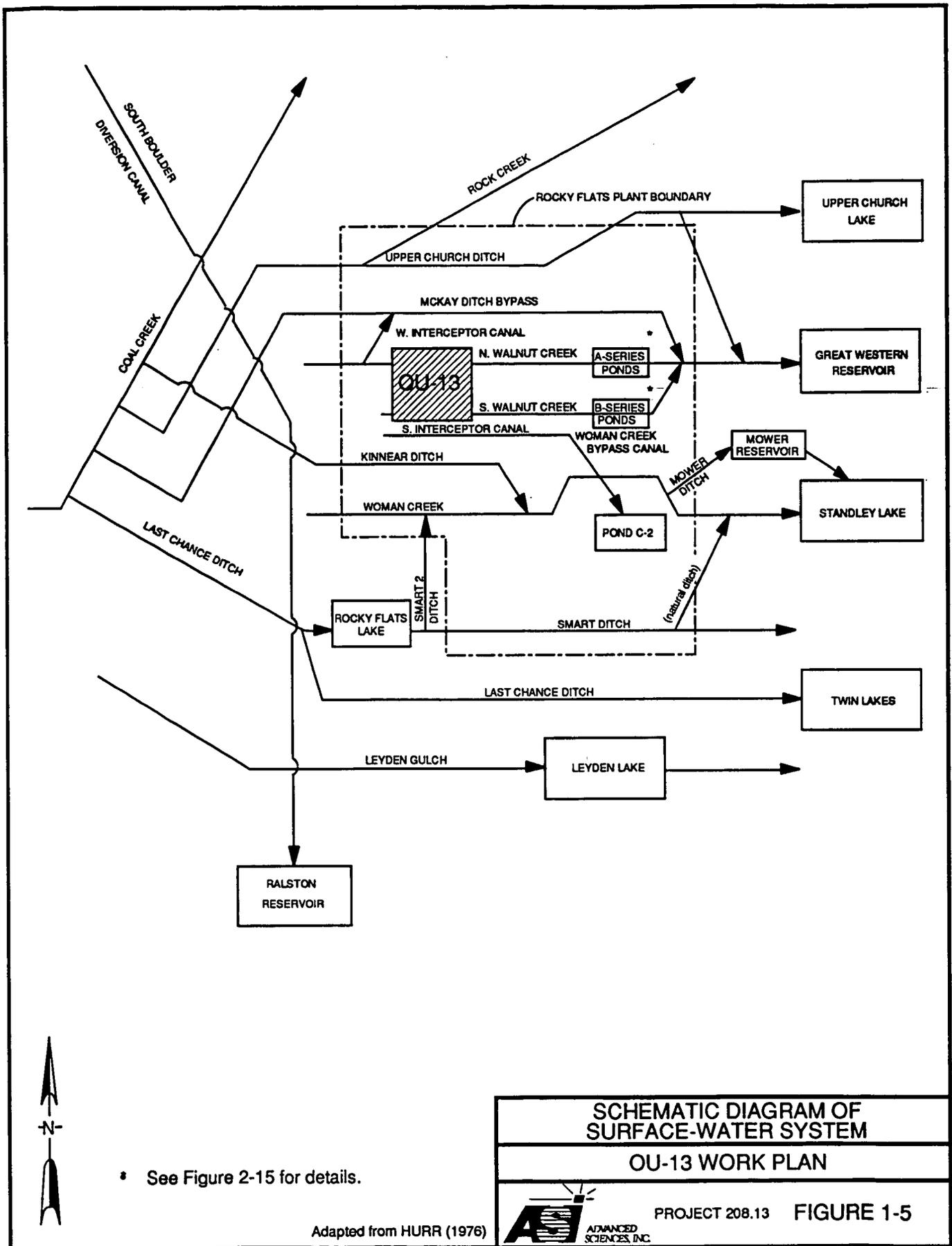


FIGURE 1-3
WIND ROSE FOR THE
ROCKY FLATS PLANT, 1990

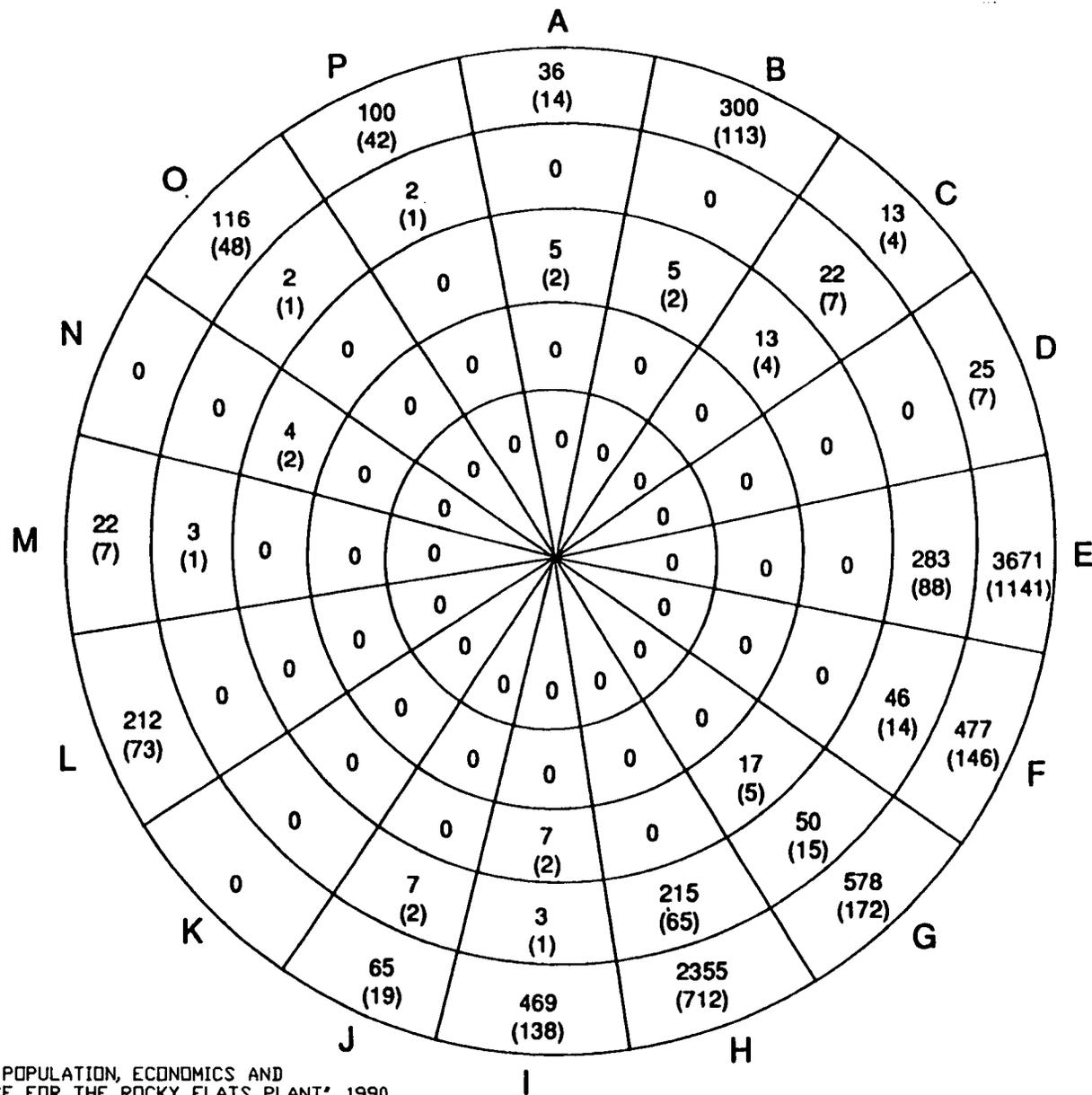
OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado



* See Figure 2-15 for details.

SCHEMATIC DIAGRAM OF SURFACE-WATER SYSTEM	
OU-13 WORK PLAN	
 ADVANCED SCIENCES, INC.	PROJECT 208.13 FIGURE 1-5

Adapted from HURR (1976)



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

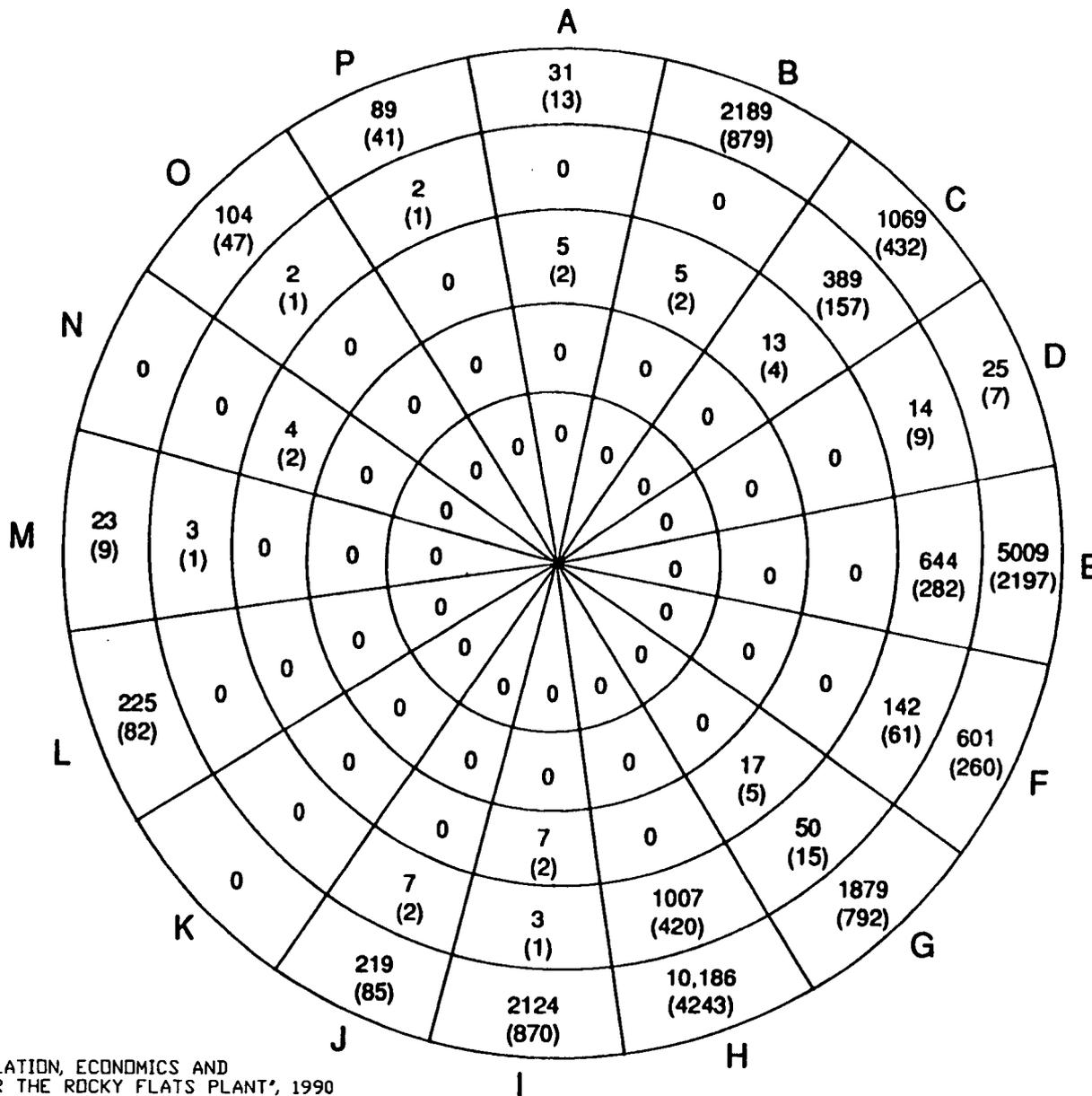


NOT TO SCALE

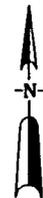
SOURCE: DOE, '1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT', 1990

FIGURE 1-6
1989 POPULATION DISTRIBUTION, WITHIN 5 MILES
OF THE ROCKY FLATS PLANT SITE

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



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

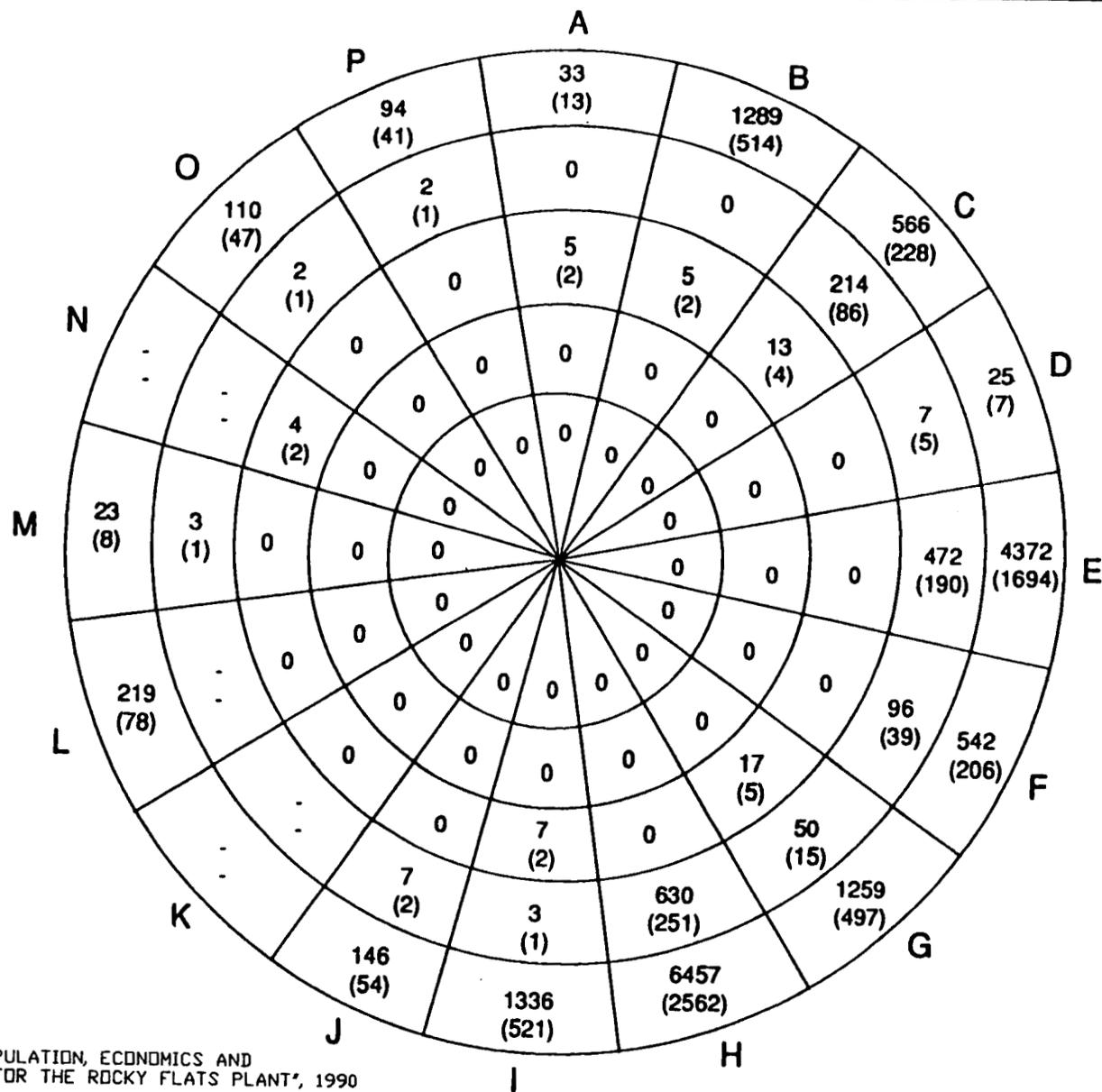


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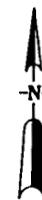
SOURCE: DOE, '1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT', 1990

FIGURE 1-8
EXPECTED POPULATION AND DENSITY DISTRIBUTION AROUND
THE ROCKY FLATS PLANT IN THE YEAR 2010

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



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



NOT TO SCALE

SOURCE: DOE, '1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT', 1990

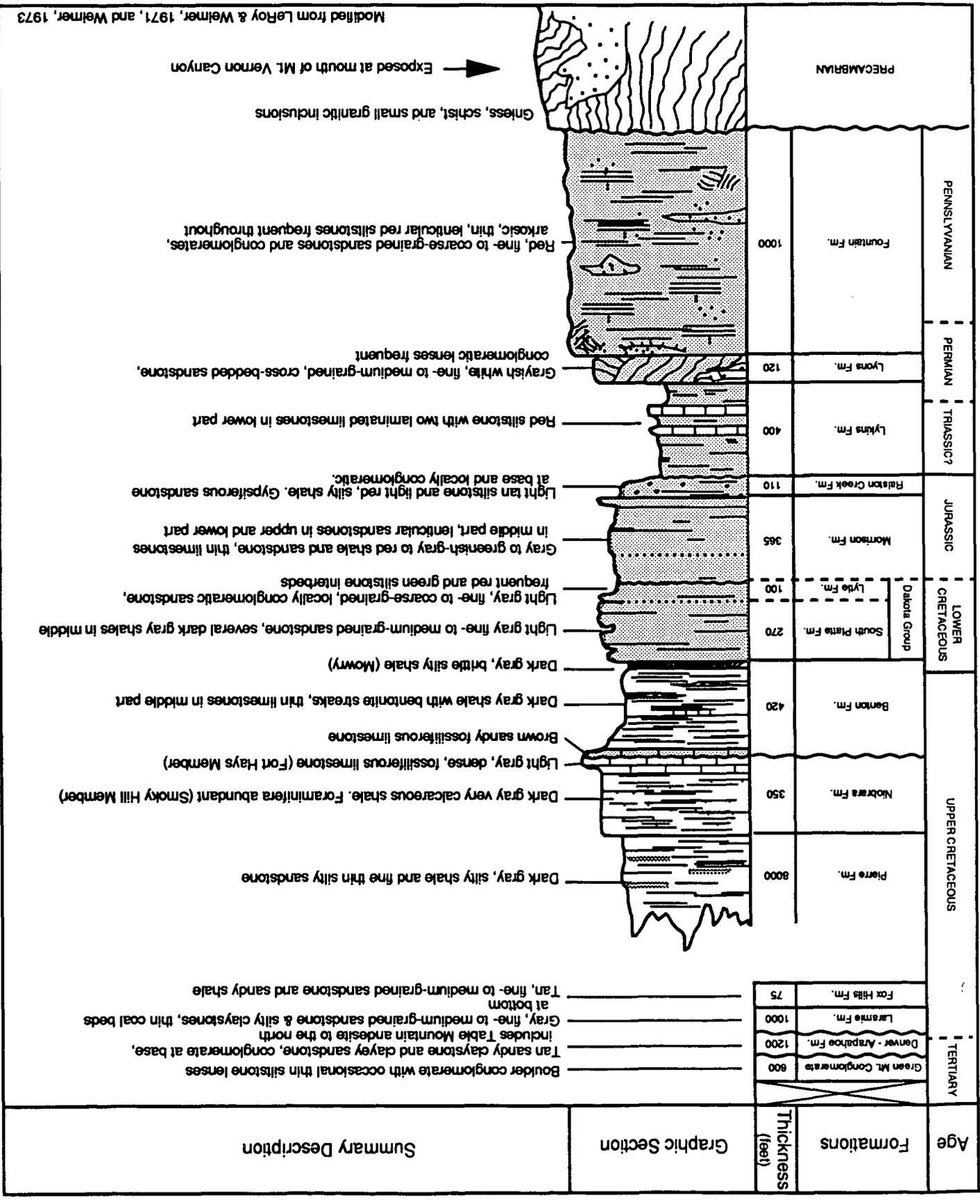
FIGURE 1-7
 EXPECTED POPULATION AND DENSITY DISTRIBUTION AROUND
 THE ROCKY FLATS PLANT IN THE YEAR 2000

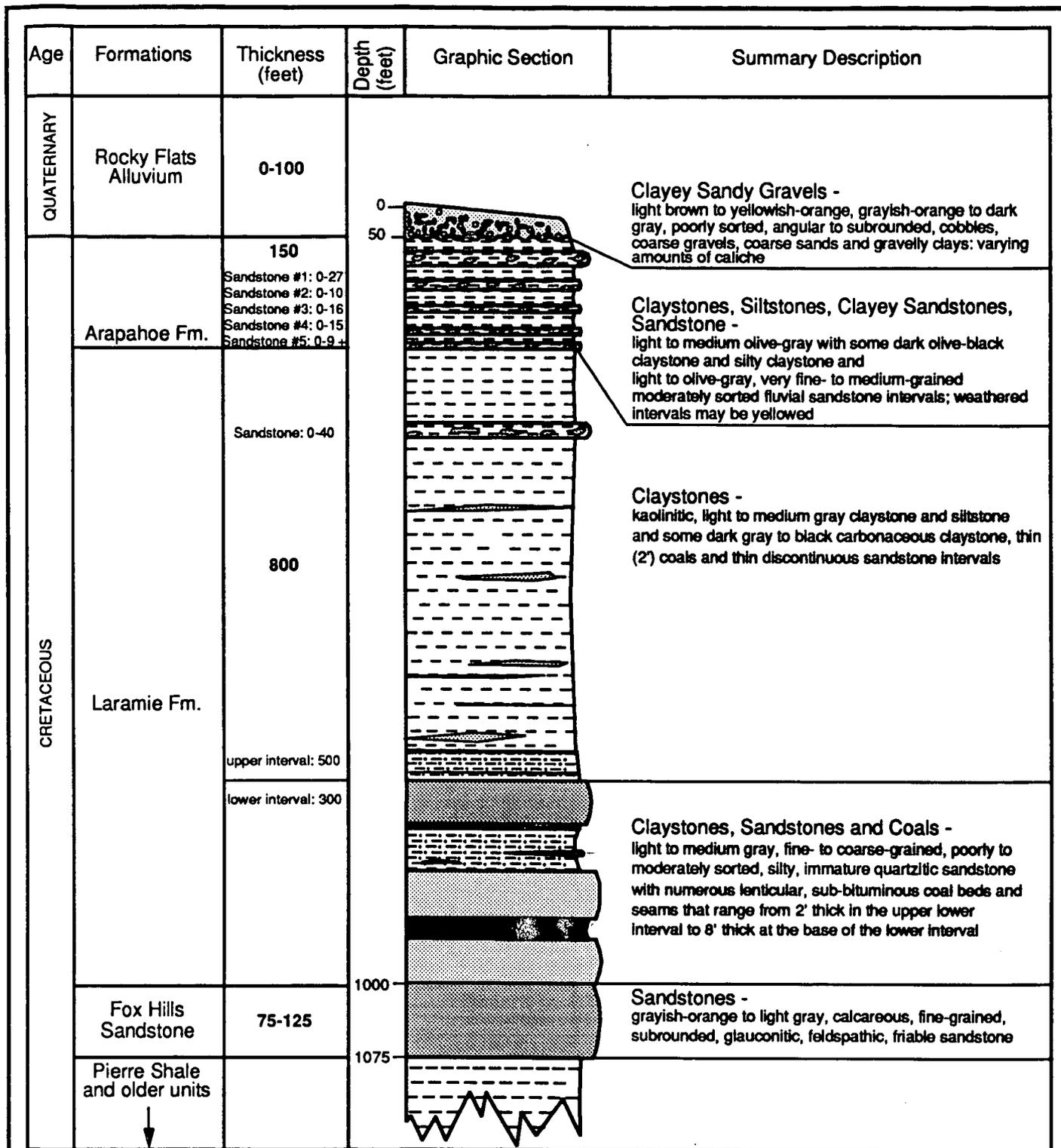
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 Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 13
 PHASE I RFI/R1 WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 FIGURE 1-11
 Rocky Flats Plant, Golden, Colorado

GOLDEN-MORRISON AREA GENERALIZED STRATIGRAPHIC SECTION

Modified from LeRoy & Welmer, 1971, and Welmer, 1973





LEGEND

-  Alluvium
-  Fine-grained sandstone
-  Siltstone and claystone
-  Fine-grained and coarser sandstone
-  Silty sandstone
-  Coal

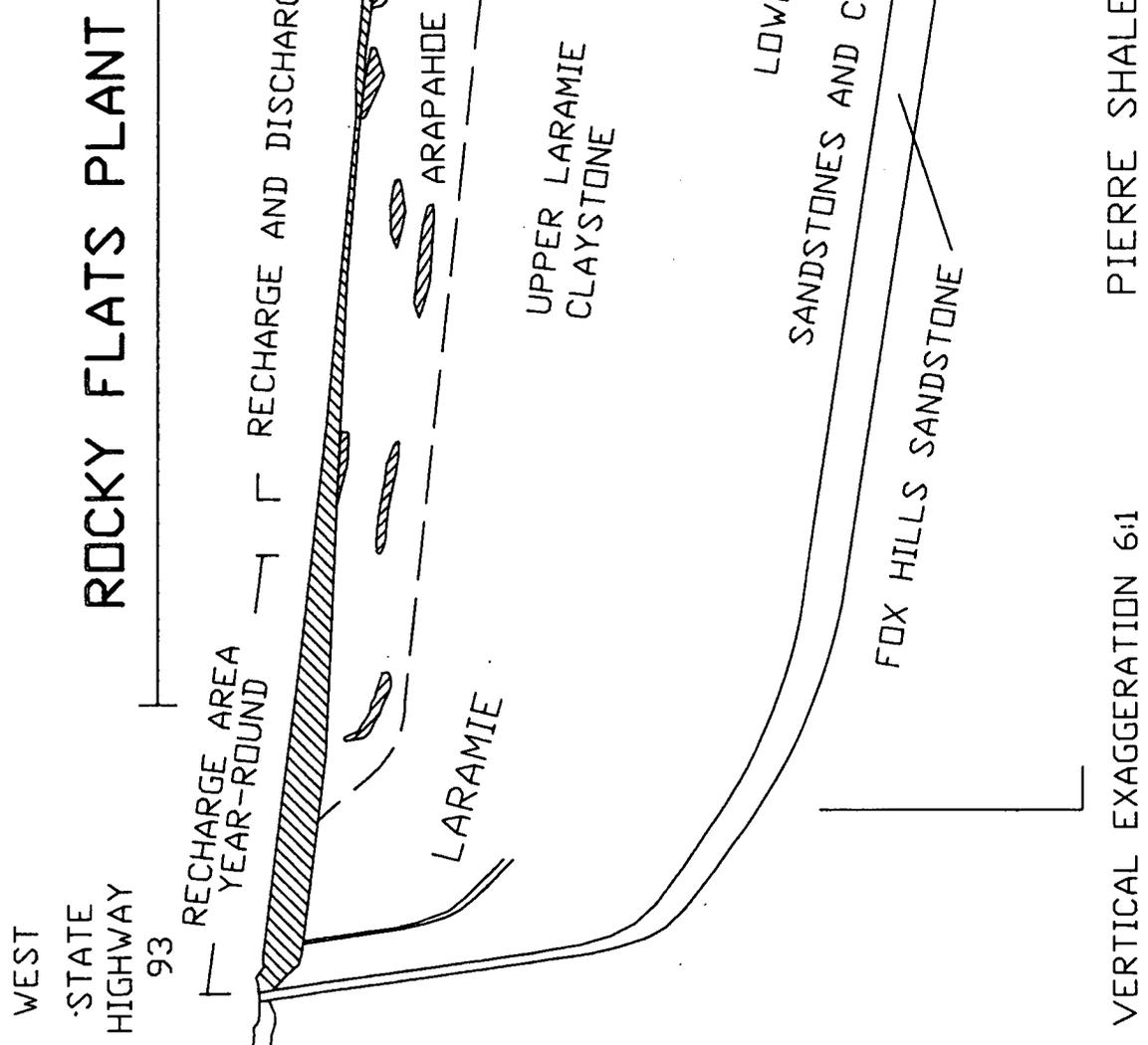
**GENERALIZED STRATIGRAPHIC SECTION,
ROCKY FLATS PLANT**

**OPERABLE UNIT 13
PHASE I RFI/RI WORK PLAN**

FIGURE 1-12

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

LOCSTRAY.DWG



EAST

ROCKY FLATS PLANT

WEST
STATE
HIGHWAY
93

RECHARGE AREA
YEAR-ROUND

RECHARGE AND DISCHARGE

UPPERMOST HYDROSTRATIGRAPHIC
UNIT INCLUDES SURFICIAL MATERIALS
AND UPPERMOST ARAPAHOE SANDSTONE

SURFICIAL MATERIALS

INDIANA ST.

ARAPAHOE FORMATION

LARAMIE

UPPER LARAMIE
CLAYSTONE

SANDSTONE
UNITS

LOWER LARAMIE

SANDSTONES AND COALS

FOX HILLS SANDSTONE

PIERRE SHALE

VERTICAL EXAGGERATION 6:1

FIGURE 1-13

SCHEMATIC WEST TO EAST STRUCTURAL CROSS SECTION

OPERABLE UNIT NO. 13
PHASE I R/F/R/I WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

**ENVIRONMENTAL MANAGEMENT
PROGRAM
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area**

Manual 21100-WP-OU13.1
Section No.: 2.0, REV. 2
Page: 1 of 96
Effective Date: May 11, 1992
Organization: Environmental Management

**TITLE:
Phase I RFI/RI Work Plan for
Operable Unit 13**

Approved By:

2.0 SITE CHARACTERIZATION

2.1 BACKGROUND AND PHYSICAL SETTING OF OU13

OU13 is defined as IHSS 117.1, the North Chemical Storage Site; IHSS 117.2, the Middle Chemical Storage Site; IHSS 117.3, the South Chemical Storage Site; IHSS 128, the Oil Burn Pit No. 1 Waste Leak; IHSS 134, the Lithium Metal Destruction Site; IHSS 148, the Waste Spills; IHSS 152, the Fuel Oil Tank; IHSS 157.1, the North Area Radioactive Site; IHSS 158, the Building 551 Radioactive Site; IHSS 169, the Waste Peroxide Drum Burial; IHSS 171, the Solvent Burning Ground; IHSS 186, the Valve Vault 12; IHSS 190, the Caustic Leak; and IHSS 191, the Hydrogen Peroxide Spill. The location of these IHSSs are shown on Figure 2-1. Although a boundary enclosing an area that contains the OU13 IHSSs is shown on many figures in this report to help orient the reader, IHSSs that are not included in OU13 are also located within this boundary. The boundary does not define the operable unit. It only shows the general location of the IHSSs of the operable unit.

This section of the report describes the IHSSs in the operable unit first to show the location and nature of the sites. Then the natural physical features of the area containing the IHSSs are described to show the nature of the media involved in *potential contamination*. Then the contamination is described to the extent possible with existing information and data gaps are identified. Finally, conceptual models indicating pathways from the IHSSs to potential receptors are presented.

2.1.1 Locations and Operational Histories of IHSSs

Information in the following discussion of IHSSs is based on interviews with RFP personnel, review of historical photographs and documents, site visits, engineering design drawings, and facilities drawings. Much additional information on each IHSS is presented in Appendix A, which contains detailed descriptions. Locations of IHSSs with respect to plant buildings are shown on Figure 2-1. Photographs of the IHSSs are presented in Photographs 2-1 through 2-12.

2.1.1.1 North Chemical Storage Site (IHSS 117.1)

IHSS 117.1 is located east and northeast of Building 552, west of Building 559, and north of the intersection of Sage Avenue and Seventh Streets. Presently, the area includes a portion of the Protected Area (PA), a storage area that contains a small amount of scrap metal, a contractor trailer parking area, a transformer, a valve vault, and two small buildings (223 and 549). The southern part of the area is now paved. However, during storage activities, the area was not paved.

No documentation was found indicating when the area was first used for storage. However, an RFP photo from the 1950s shows indications of property use at this location. Past use of the site is reported to include non-radioactive waste and scrap metal disposal, as well as storage for building construction debris. Scrap metal was collected in the area until it was sold. Materials stored in the area were moved to the current PU&D Storage Yard in 1974. Reports indicate no chemical storage at this site, although automotive batteries may have been stored there.

A non-radioactive waste site and a scrap metal disposal site were reported to have been uncovered during the excavation for the construction of the Protected Area in the early 1980s. It is estimated that the waste burial took place in the 1960s.

2.1.1.2 Middle Chemical Storage Site (IHSS 117.2)

IHSS 117.2 is located east of Building 551, south of Sage Street, and west of Seventh Street. Presently, the area includes a large storage tent and outside storage. The area is paved.

Based on review of RFP photographs, the area was first used as storage some time prior to July 1955. The area was used as a multi-purpose storage facility until the early to mid-1970s, and was divided in the following manner: the northern 1/3 of the facility was used as warehouse storage; the middle 1/3 was used as a nonradioactive chemical storage facility; and the southern 1/3 was used as storage for pallets, cargo containers, and new drums. The area is still used for storage purposes today. The area was paved during the 1970s, probably in 1975. The present storage tent was built in 1990. Minor leaks and spills have occurred at the storage area. Uranium chips and turnings were found in an aluminum scrap pile near the warehouse in 1963 and in 1964.

2.1.1.3 South Chemical Storage Site (IHSS 117.3)

IHSS 117.3 is at the southwest corner of Central Avenue and Seventh Street. It was used for storage of various unidentified material from at least 1964 until 1970. It is believed that a wooden waste box containing a glovebox was transferred from Building 776 to the storage area on May 4, 1965. Residual radioactively contaminated oil in the glovebox leaked out of the waste box. This was discovered after it arrived at the storage area. Highly contaminated oil had dripped onto the Central Avenue within 400 feet of the storage area and on the ground in the storage area where the box was placed.

The ground in the storage area that was contaminated during the glovebox incident, was removed on May 5, 6 and 7, 1965. The glovebox was returned to Building 776 for investigation, decontamination, and repackaging. After an investigation, it was concluded that approximately

4 gallons of contaminated oil had gone undetected in the glovebox when it was originally placed in the waste box.

2.1.1.4 Oil Burn Pit No. 1 Waste Leak (IHSS 128)

IHSS 128 is located north of Building 335 and beneath Sage Avenue, east of the Fourth Street intersection.

Approval was given by the Waste Disposal Co-Ordination Group and the Health Physics Department for experimental oil burning in July, 1956. Oil was burned in a pit that was north of the present location of Building 331 in an area that is now covered almost entirely by Sage Avenue. A report issued on September 7, 1956, by the Health Physics and Medical Section Director summarized the experiment and concluded that the remainder of contaminated waste oil could be disposed of in a similar manner. Fourteen high-volume air samplers were placed in the area around the oil burn pit. Background air samples were taken. Approximately 200 gallons of contaminated oil were dumped into a shallow pit and ignited. The pit was backfilled after the fire was extinguished. No dimensions were given for the pit.

The oil was probably from Building 444 or Building 881. The reported contaminant was depleted uranium (uranium-238).

2.1.1.5 Lithium Metal Destruction Site (IHSS 134)

The L-shaped Building 331 was built in 1952 and houses the fire station on the east side and the vehicle maintenance garage on the west side. About 1967 or 1968, the fire station was extended to the east and the area east of the building and the courtyard of the building were paved.

Lithium was introduced to the RFP in 1963 when lithium processing began in Building 444. Some forming and machining of lithium was also done in Buildings 777 and 881. The lithium

was used in alkaline batteries, desiccants, ceramics, glazes, greases, soaps, and metallurgical applications. It was unlikely that the lithium was radioactively contaminated.

Buildings 444 and 881 personnel were able to dispose of their waste lithium, which was mixed with machining oils, by offering it to the fire station personnel for use in hand-held extinguisher training. The destruction of lithium near the fire station was done routinely from approximately 1963 until approximately 1966. Lithium coated with machining oils was brought to the fire station in shallow metal pans or one-gallon cans. The lithium was placed in a 55-gallon drum on the ground and the oil was burned off by lighting the mass on fire. The lithium was oxidized in the process. Lithium and oil would be burned in the same drum until that drum was full of ash and non-combustible residue. The disposition of the drum is uncertain but it was likely to have been sent to the landfill (Original Landfill - IHSS 115).

For fire-fighting training, the fire was extinguished by various methods. These methods may have caused some residue to be expelled from the drum onto the ground. This activity was in the area around the fire station, often close to the building on the east and south sides. During the period of lithium destruction around Building 331, lithium was destroyed perhaps once every two to three months in quantities of less than the contents of a one-gallon can. Two explosions that sprayed lithium around the area have been reported. The building was extended to the east in approximately 1967 or 1968. The area used for the lithium destruction was covered by the building addition or by an asphalt parking lot that was constructed east of the addition.

Some lithium destruction occurred near the present location of Building 335. Considerable magnesium was destroyed here. It was spread on the ground and ignited.

2.1.1.6 Waste Spills (IHSS 148)

Several small spills of nitrate-bearing wastes have been reported to have occurred around the outside of Building 123. These wastes may have contained radionuclides. Nitrate bearing

wastes may also have been released from a process waste pipeline buried beneath Building 123. This pipeline was a part of the original process waste lines (PWLs), and was in use from the start of operations in Building 123 until the original process waste lines were replaced by the new process waste lines. The abandonment of the original process waste lines beneath Building 123 occurred no later than February 1975. The original process waste lines were typically abandoned in-place.

The original process waste line drain was not double contained, and varied in depth beneath the floor of Building 123 from approximately one-half foot to three feet beneath the bottom of the concrete floor. The line came out from beneath the south end of the east wing of the building, with an invert elevation of approximately 6032.5 feet. It has been stated by recent interviewees that this line, being constructed of iron, probably leaked considerable amounts of waste without personnel being aware of the leak. The types of waste carried by the pipe consisted of laboratory wastes from analysis of urine, fecal, and other bioassay samples. Nitrates and low levels of radionuclides were associated with the wastes carried in the original line. The process waste lines that replaced the original lines were either double-contained or overhead lines. Leakage from the new process waste lines is easily detected. The process waste line piping in the west wing, being newer, has never included the use of an iron pipe directly in contact with soils.

2.1.1.7 Fuel Oil Tank (IHSS 152)

Tank 221 is an 800,000-gallon fuel oil storage tank located east of Building 452. The tank was probably installed sometime in late 1955 or early 1956. It was originally constructed with a 10-foot high 140-foot by 140-foot earthen berm surrounding it. The tank contains fuel oil for use in RFP's central steam plant when natural gas is not available. This tank and the neighboring Tank 224, which is used for the same purpose, were noted as having spills on several occasions. Tank 224 holds approximately 1,800,000 gallons and was constructed sometime between July 1973 (when the last design drawings for the tank were completed) and December 1973 (when the as-built drawings for the tank were completed).

On January 29, 1971, No. 6 fuel oil leaked from the open end of the hose used to transfer the oil from a transport truck to Tank 221. Approximately 700 gallons of fuel oil leaked to the ditch, which runs just outside the tank berm on the west and north sides of the tank. On April 4, 1975, a fuel oil leak of unspecified volume occurred. This leak probably occurred at Tank 221. During the week ending February 16, 1979, approximately 400 gallons of No. 6 fuel oil were spilled during the transfer of oil to the Central Avenue tanks (specific tank not mentioned).

2.1.1.8 North Area Radioactive Site (IHSS 157.1)

Building 442 was constructed in 1952 and served as a laundry facility until approximately 1972 when it was converted to a filter test laboratory. The building is located at the southeast corner of Fifth Street and Central Avenue. Building 442 was expanded to its current size in the mid 1980s. As a laundry facility, the building received contaminated clothing from Buildings 444 and 883 and non-contaminated clothing from other areas of the plantsite. Building 444 handled depleted uranium and later beryllium. Beryllium was introduced to the RFP in the early 1960s.

Historical accounts reference the laundry building as being potentially affected by radionuclides and chemical materials. The notable constituents were depleted uranium and beryllium with at least one incident involving enriched uranium. The soil around the building was affected by radioactive releases. Contamination around Building 442 has been identified as resulting from the laundry operations and not from the activities that have occurred since approximately 1972. At that time, filter testing replaced laundry operations as the function of the building. No documentation was found which indicate that the activities of the filter testing laboratory contributed to contamination to the environment.

2.1.1.9 Building 551 Radioactive Site (IHSS 158)

Historical accounts reference the area north of Building 551 as potentially being contaminated from leakage of waste boxes loaded into railroad container cars. Building 551 was among the

initial RFP structures. The building has served as the RFP warehouse since 1952. The original building only occupied the southern portion of the current building, having been more than doubled in size during two expansion periods. The area has been disturbed and regraded several times since during subsequent construction activities.

Building 551 was and is used as a centralized location for the receipt and distribution of various supplies from vendors. Supplies include all types of products that are used at RFP from paper and office equipment to motor oil and other chemicals. On occasion, small quantities of waste materials contaminated with low levels of uranium from Building 444 were brought to the warehouse and stored in a cage while manifests were prepared for offsite shipment. These materials were reportedly transported in small containers or drums.

It has been reported that leakage of waste boxes from the fire (unstated whether it was the 1957 or 1969 fire) occurred while the boxes were loaded onto a train. Residual radioactive contamination may have occurred. Building 554 was the train loading facility. Storage of radioactive materials occurred in and around this building.

The area considered potentially contaminated from the Building 551 warehouse activities that occurred prior to 1965 is now located beneath the north wing. The north wing of Building 551 has been used by construction contractor J.A. Jones for the fabrication of sheet metal products since about 1990.

2.1.1.10 Waste Peroxide Drum Burial (IHSS 169)

Reference to this IHSS, found in RCRA 3004(u) (November 28, 1986), discusses the burial of a 55-gallon hydrogen peroxide drum in the chemical storage area east of Building 551. No documentation other than this reference was found regarding this incident. It is probable that a drum burial incident never occurred, but that details from IHSS 191, the hydrogen peroxide spill

at the intersection of Fifth Street and Sage Street, were confused at some point in time, and that this confusion led to the belief that another incident took place.

IHSS 169 will not be considered further in this work plan. Reasons for eliminating IHSS 169 are given in Appendix A.

2.1.1.11 Solvent Burning Ground (IHSS 171)

Building 335 has been used in the past and is still used to some degree for training of fire department personnel. The yard to the east of the building was used to practice extinguishing fires with various hand-held extinguishers.

Outdoor firefighting training occurred in the area to the east of the building from approximately 1969 through 1990. Outdoor types of training included the use of a large cross-shaped pan or a smaller square pan in which diesel fuel was burned and then extinguished. Most of the fuel was burned during the process although some was allowed to remain in the pan and would then mix with rainwater. The pans of fuel and rainwater were dumped on the ground. An inspection was conducted on December 11, 1990, by RFP Clean Water Act Division (CWAD) personnel. The large cross-shaped pan was found to have holes in it and oil contaminated soil was present around the pans.

An open sump is located in the area and consists of an approximately 2-foot section of corrugated pipe over a square concrete sump of unknown depth. Both the pipe and the concrete have grates over them. There has been standing water visible in the sump during site visits in November 1991, December 1991, and March 1992, and the water has had a sheen on the surface at every visit. The water surface is approximately 2 feet below the top of the sump. The contamination in the sump may have come from the gasoline tank on the north side of Building 331 since the sump is part of the french drain for the tank. The tank and sump were installed in 1979. The sump is located in the center of the fire training area but has no connection with

the training activities. The only materials used in fire training were diesel fuel, gasoline, and propane. Small amounts of magnesium may have been used to ignite the diesel fires.

2.1.1.12 Valve Vault (IHSS 186)

Valve Vault 12 is part of the existing process waste system. It is located west of Building 552 (a gas cylinder storage facility), east of a paved parking lot, south of the Protected Area, and north of the intersection of Sixth and Sage Streets. Valve Vault 12 extends approximately 20 feet below the ground surface and has plan-view dimensions of 15.5 feet by 12.3 feet. It is constructed with 9-inch-thick concrete walls. It contains pumps, transformers, breakers, switches, and a sump pump. The location of Valve Vault 12 can be identified by an above-ground structure.

Valve Vault 13 is west of Valve Vault 12 and Building 231. Valve Vault 11 is located east of Valve Vault 12. It contains pumps and valves for two adjacent tanks.

A pipe leak was discovered on October 24, 1986, in the excavation for the pump house located just southwest of the process waste tanks (personal communication, Norm Frybeck, RFP employee, March 30, 1992). The soil was excavated back to a failure in the pipeline between Valve Vault 12 and Valve Vault 13. Uranium nitrate (identified by process knowledge) had apparently seeped out along the bedding material of the pipeline and into the excavation. In response to the release, the area was excavated. All of the soil surrounding Valve Vault 12 was excavated, and the excavation extended approximately 18 feet west of the valve vault. Soil under the pipeline was removed and an underground concrete structure which supported a roadway going over a ditch at that time was excavated. The release occurred at an elevation approximately 7 to 8 feet below the ditches which dissect the area.

By November 21, 1986, the line between Valve Vaults 12 and 13 was replaced. Radiation surveys of the area at that time indicated low-level residues. Clean-up was deemed complete on December 8, 1986 with radiation in the area only slightly above background.

Process waste may contain a large range of constituents. Soil and water sampling done at the time of the incident indicate the presence of alpha and beta radiation, uranium, and americium. Reportedly, analysis of soils from the contaminated area indicated no detectable amounts of hazardous wastes. Chloride and sulfate were detected. The exact quantity of released process waste is unknown; however, one reference states that the soil was saturated with a yellow liquid.

Another incident, which occurred on October 21, 1989, may also have impacted the vicinity of Valve Vault 12. According to the Critique Report of the Unplanned Event Preliminary Investigation on the incident, Valve Vaults 11, 12, and 13 were flooded with approximately 10,000 gallons of solar pond water. The cause of the incident was the separation of a pipe joint outside of Valve Vault 12 during a routine transfer of solar pond water. At the time of the incident, the sensor alarms were not operating because of construction activities. The problem was identified during a scheduled visual surveillance, at which time a large amount of liquid was found in the valve vaults. All other transfers were curtailed, and the liquid was pumped from the valve vaults and put in Tank 231B.

2.1.1.13 Caustic Leak (IHSS 190)

A caustic storage tank is located near the southeast corner of Building 443, the steam generation plant. The tank is an above-ground, steel, 3,000-gallon tank which is used for concentrated sodium hydroxide storage. The secondary containment of the tank is a 3,000-gallon holding basin. The 50 percent sodium hydroxide solution is raw product, as opposed to waste product, and is used for cleaning purposes in Building 443. Two documented releases occurred, as described below.

immediately adjacent to OU13. The thickness extremes range from 0 to 38.3 feet with thicker intervals on the western side of OU13. Earthmoving for facilities construction at the RFP has locally removed all alluvial materials to bedrock (see well P115589, Table 2.1) and restored to design surface elevation with artificial fill.

2.1.3.2 Colluvium

These geologic materials are sediments derived directly from the Rocky Flats Alluvium and generally deposited along the slopes surrounding the dissected, alluvium-covered pediment. These materials are limited at OU13 but exist on the steep slopes in the extreme north central area as shown in Figure 2-2. Colluvium has not been identified in the core intercept data furnished in Table 2.1.

2.1.3.3 Soils

The soils at OU13 consist of the Flatiron Series, located on Rocky Flats Alluvium; Nederland Series, commonly located on the upper slopes flanking Rocky Flats Alluvium; and Denver-Kutch-Midway Series, located on slopes flanking the previous soils. The area of OU13 was nearly completely covered by the Flatiron Series soils prior to construction of the RFP. No soils are distinguished in the core intercepts given in Table 2.1.

2.1.3.4 Artificial Fill

Geologic materials native to the site (Rocky Flats Alluvium) and imported materials have been used as fill at the RFP for road grade and berm construction, recontouring peripheral to structures, and surface impoundments. Artificial fill thickness have been described in drill intercepts and are tabulated in Table 2.1. Crushed rock has been used for landscaping and levelling at the site. Pavement and gravel, in addition to buildings and disturbed ground, covers OU13.

2.1.2 Topography

Topographic relief on the east-northeast sloping Rocky Flats alluvial surface within OU13 is approximately 47 feet. Elevation extremes of 6,037 feet above Mean Sea Level (MSL) occur adjacent to Building 202 and 5,990 feet above MSL to the west of Building 419 located in the southwestern and central northwestern areas of OU13. The topography in the vicinity of the RFP is shown on Figure 1-4.

2.1.3 Geology

At the RFP, core drilling and geologic logging have been essential to characterization of the subsurface geologic materials due to lack of onsite or adjacent outcrop exposures. Through numerous investigations, the variety and thickness of underlying materials have been disclosed to consist of surficial clastic sediments and deeper, underlying, indurated sedimentary units at the RFP. Data for selected wells and boreholes within and immediately adjacent to OU13 are given in Table 2.1. Geologic data presented for these 23 wells includes location, type and thickness of surficial materials, elevation to the top of Arapahoe Formation bedrock, and type of bedrock intersected. Well completion, hydrologic, and geologic information for these boreholes are contained in Appendices A and B. Figure 2-2 depicts the surficial geology in the CA of the RFP. This map indicates that nearly all natural materials (soils atop Rocky Flats Alluvium) have been disturbed, filled, or covered by pavement and structures.

2.1.3.1 Rocky Flats Alluvium

Based upon mapping by Hurr (Hurr, 1976) and EG&G (1992a), nearly all of the CA at the RFP is underlain by Rocky Flats Alluvium. These sediments are covered by thin soils, colluvium, artificial fill materials, and the RFP structures. The Rocky Flats Alluvium generally ranges from slightly more than 50 feet to less than 10 feet in thickness at the CA as determined by drill core analysis. Table 2.1 lists the thickness of Rocky Flats Alluvium as intersected in core within and

On December 3, 1978, approximately 1,500 gallons of caustic leaked at an approximate rate of 0.5 gallons per minute from the lower flange area of the tank into the holding basin. An operator drained the holding basin through a ball valve, thinking that the liquid was snowmelt and condensate. The next day, it was realized by personnel that the liquid released was actually sodium hydroxide and not condensate and snowmelt. The holding basin again contained approximately 1,500 gallons of liquid (the remaining contents of the tank), with a pH of 14. An investigation was conducted on the drainage ditches. Repairs were made on the tank. The caustic which had been contained in the holding basin was pumped into Building 443 and handled as process waste.

It was determined that sodium hydroxide was present in the Central Avenue Drainage Ditch. Flow from this ditch was routed to Pond B-1 for containment. Additional surface water which would typically flow to the Central Avenue Ditch or Pond B-1 was diverted away from the ditch and to Pond B-3.

To neutralize the water in the ditch, 5,000 pounds of alum were spread along the Central Avenue Ditch between 5th and 10th Streets during the week of December 15, 1978 (Alum reacts with water to become sulfuric acid, thereby reducing the pH). By March 16, 1979, the water in Central Avenue Ditch was at an acceptable pH.

2.1.1.14 Hydrogen Peroxide Spill (IHSS 191)

During the week ending April 24, 1981, warehouse personnel were transporting three 55-gallon drums of hydrogen peroxide (H_2O_2) when two of the drums fell off of a pallet. One of the drums burst open, and the hydrogen peroxide drained into a culvert at the corner of Fifth Street and Central Avenue. A hole was dug east of Fifth Street by labor personnel and the fire department hosed down the area, allowing the diluted hydrogen peroxide to drain into the hole. The hole was refilled on April 23, 1981. The hydrogen peroxide was a 35 percent solution. The hydrogen peroxide was a pure raw material for use at RFP.

2.1.3.5 Buried Bedrock Surface

Based upon drill hole data and interpretation, the thickness of surficial materials are contoured in Figure 2-3, which also shows topographic contours. The isopach contours show the surficial materials are thickest in the western section of the CA and thinnest in the northern and southeastern areas. Within the area enclosed by OU13, the surficial materials generally thin eastward; thicknesses range from 30 to less than 10 feet.

These surficial sediments had been deposited on an older erosional surface. The depositional event occurred between early to middle Pleistocene time (Naesser et. al., 1973). The oldest erosional surface below the Rocky Flats Alluvium is that developed upon the Arapahoe Formation by pedimentation processes. This surface or pediment represents a pause in the sedimentation process located in the High Plains area. The surface is preserved as the top-of-bedrock now recognized by drill core evaluation.

This paleotopographic surface is preserved from subsequent and present-day erosion in the RFP vicinity only where covered by Rocky Flats Alluvium. Some parts of the Rocky Flats Alluvium within the CA have been removed by headward (westward) erosion of North and South Walnut Creeks and Woman Creek. As a consequence, the preserved pre-Rocky Flats Alluvium pediment surface now can be found beneath approximately 90 percent of the CA. This area is shown on Figure 2-4. This map depicts present-day surface topography and shows contours of the subsurface paleotopography at the time of deposition of the Rocky Flats Alluvium.

Three paleoridges and two prominent paleodrainages in the vicinity of OU13 are interpreted on Figure 2-4. This paleodrainage pattern could influence groundwater flow in the lower part of hydrostratigraphic unit 1. This is a consequence of the configuration and relatively lower permeability of the claystone bedrock found in the Arapahoe Formation in contrast to the relatively higher permeability of the Rocky Flats Alluvium. The direction of groundwater flow

may be influenced by the permeability contrast, with the water tending to flow through the more permeable alluvium.

Arapahoe Formation

The geological description of OU13 was derived from the Geological Characterization Report (EG&G, 1991c), and much of the site-specific information was obtained from the 1986, 1987, and 1989 borehole drilling and well installation programs. The borehole logs and completion data are presented in EG&G (1991c), and ASI (1991c, 1991d). Additional tabulated geologic data is presented in Appendix B.

There were ten wells completed in OU13 during previous drilling and well installation programs. Of these ten wells, none penetrate more than 10 feet into the bedrock. Directly below the Quaternary/Cretaceous unconformity, six wells (P114789, P115489, P115589, P115689, P313489, and P414189) encountered claystone; three wells (44-86, 61-86, and P214689) encountered silty claystone; and one (P114889) encountered sandy claystone. In general, these claystones are moderately to highly weathered with iron staining. They also usually contain a small percentage of a coarser grained constituents, ranging from silt to coarse grained sand.

In the immediately surrounding area, there are two deeper wells: P416289 is 43 feet deep, and P416989 is 220 feet deep. Both of these wells are southwest of OU13. The upper bedrock lithologies of these wells show fining upward sequences. Table 2.2 reveals that the sequences range from 2.3 feet thick (38.0 to 40.3 in well P416289) to 11 feet thick (27.0 to 33.0 in well P416289). The deeper lithologies of well P416989 consist predominately of claystone with some silty claystone and siltstones. There is also an interval of interbedded sandstone and silty claystone at 96.3 to 98.6 feet in depth.

Another significant well is P113589 located southwest of OU13. The suballuvial lithology is two feet of silty clayey sandstone. This interval is very fine to fine grained, has interbedded

claystone units, and is highly weathered. Underlying is 4.8 feet of silty sandstone. The sandstone is very fine to fine grained, interbedded with sandy claystone, and has iron staining present.

The Arapahoe Formation contains several sandstone intervals. The upper most sandstone unit is referred to in the Geological Characterization Report as the No. 1 Sandstone. The following geologic model is taken directly from that report. Figures 2-5 and 2-6 are isopach maps which present two interpretations for the No. 1 Sandstone in the OU13 area. These maps are highly interpretive since subsurface control is sparse. The first interpretation shows a continuous single channel system. Channel and point bar deposits are both recognized, however, channel fill deposits dominate. The second interpretation depicts a multiple channel system containing migrated channel and point bar deposits. Both interpretations imply lenticular geometries of individual sandstones and that the sandstones may not be in hydraulic connection (EG&G, 1991c).

Both interpretations recognize that the No. 1 Sandstone consists of more than one fining upward sequence. The Geological Characterization Report states that a minimum of three fining upward sequences are recognized where penetration of the No. 1 Sandstone is complete. Information from drilling is presented in Table 2.2 for wells within and surrounding OU13. Note that the wells actually in OU13 do not definitively penetrate the No. 1 Sandstone, and that the interpretations given are extrapolated beneath OU13 from other distant well locations.

Interpretation 1 (Figure 2-5) shows north-south trending No. 1 Sandstone channel crossing beneath OU13. The two wells which intersect the channel in OU13, P114789 and P115589 are only completed into the bedrock 5.0 and 4.6 feet, respectively. The sub-alluvial lithology in these wells was logged as claystone, which may or may not be interpreted as the upper portion of a fining upward sequence. Cross-sections A-A', B-B', C-C', D-D', E-E', and F-F' (Figures 2-7 to 2-11) show an idealized conceptual model for this interpretive channel. These cross-

sections were directly extrapolated from the isopach maps presented in the Geological Characterization Report.

Interpretation 2 (Figure 2-6) shows the distribution of the No. 1 Sandstone in the southern portion of the unit. It indicates that the No. 1 Sandstone may have a lateral extent of approximately 450 feet within OU13. Three wells within OU13 also exist within the boundary of the channel system. Well 44-86 penetrates 8 feet of bedrock into a uniform silty claystone. Wells P218289 and P313489 penetrate 10 and 5.4 feet of bedrock, respectively, into claystone with a trace of silt. This claystone may or may not be interpreted as the upper portion of a fining upward sequence. Cross-sections A-A', B-B', C-C', and D-D' show an idealized conceptual model for this interpretive channel. These cross-sections were directly extrapolated from the isopach maps presented in the Geological Characterization Report.

The top of bedrock surface shows the remnants of the Pre-Wisconsin pediment as well as the effects of recent stream incisement (EG&G, 1991c). The paleotopography in the vicinity of OU13 is shown in Figure 2-4. Immediately south of the OU13 area, the top of the bedrock forms a paleotopographic high trending east-west. Other minor paleoridges extend north-northeast beyond the northwest corner and northeast beneath the eastern portion of OU13. A paleotopographic low between the minor paleoridges trends east-northeast in the southwest portion, then trends northeast in the northwest portion. This low has a gradient ranging between 10-20 feet per 1,000 feet in the southwest, steepening to 40-50 feet per 1,000 feet in the northeast.

Additional wells are needed that penetrate the bedrock to a depth deep enough to evaluate the presence of the No. 1 Sandstone. First priority should be given to those areas in OU13 where the No. 1 Sandstone has been interpreted to be located, namely the east portion (Interpretation 1) and the southern half (Interpretation 2).

2.1.4 Hydrogeology

The characterization of the groundwater flow regime in OU13 is limited to water level measurements from ten alluvial piezometers and one alluvial monitoring well. There are no bedrock monitoring wells or piezometers within OU13. The groundwater system is dynamic with wide fluctuations in water level over a short period of time as a result of rapid responses to short-term weather conditions and over longer periods of time reflecting seasonal stresses.

2.1.4.1 Recharge and Discharge

OU13 is within a regional recharge area (EG&G, 1991c). Locally, there are areas of recharge and discharge. Recharge resulting from incident precipitation occurs over most of the unpaved or uncovered areas of OU13, approximately less than 20 percent of the total area. Two surface drainages are present. An unnamed tributary of North Walnut Creek (Figure 1-4) acts as a gaining stream (discharge area) with year-round baseflow contribution as evidenced by the presence of marshes along most of its extent within OU13. The manmade drainage ditch on the south side of Central Avenue (within the drainage basin of South Walnut Creek) is probably always a losing stream and therefore a source of recharge to the groundwater system during periods of precipitation. Groundwater also enters the RFP area by lateral flow from upgradient areas.

2.1.4.2 Piezometers and Monitoring Wells

With the exception of two wells, 44-86 and 61-86, all wells in OU13 were installed in 1989 as non-regulatory groundwater characterization piezometers during the 1989 geologic characterization project (EG&G, 1991d). All wells within the OU13 boundary are alluvial piezometers which extend a few feet into the Arapahoe claystone, silty claystone, or sandy claystone.

Water levels have been measured on a monthly basis since installation of the wells in 1989 and 1990 (Table 2.3). No groundwater sampling has been done on the 1989 wells within the OU13 area.

Well 44-86 is a non-regulatory groundwater characterization well installed in 1986. It is sampled quarterly for groundwater chemistry and measured monthly for water level elevations (Table 2.2). Hereinafter, piezometers and monitoring wells collectively will be called wells.

2.1.4.3 Hydrostratigraphic Units

The uppermost hydrostratigraphic unit consists solely of surficial materials, Rocky Flats Alluvium, artificial fill, and a limited amount of valley fill alluvium along the unnamed tributary of North Walnut Creek. Although the uppermost Arapahoe sandstone exists in hydraulic connection with the surficial materials in other areas at the RFP, notably to the southeast of OU13 in well P313589, limited borehole control indicates that the uppermost Arapahoe sandstone is not in direct contact with the surficial materials in the OU13 area. Unconfined groundwater flow occurs in the uppermost hydrostratigraphic unit. Generally, the groundwater flows along the contact of the surficial materials with the claystones and silty claystones of the Arapahoe Formation from west to east, with minor diversions along drainages. Although the saturated thickness may thin considerably during the winter months, wells are rarely dry in the OU13 area.

Although there are no bedrock monitoring wells in the OU13 area, borehole data provides limited evidence suggesting the presence of the uppermost Arapahoe sandstone beneath a confining layer of Arapahoe Formation claystones and silty claystones. If the uppermost Arapahoe sandstone and other stratigraphically lower sandstones are present and bounded by relatively impermeable Arapahoe claystones and silty claystones, then they would most likely exist as confined aquifers, as is the case elsewhere at the RFP.

2.1.4.4 Water Level Map

Monthly water levels measured in the wells within OU13 and the surrounding area indicate that overall saturated thicknesses were greatest in June of 1991 (Tables 2.1 and 2.3). A high water level map was generated from water levels measured June 7-20, 1991. This map is presented here as Figure 2-12. As the figure indicates, groundwater in the uppermost hydrostratigraphic unit flows almost due east.

Monthly water levels measured in the wells within OU13 and the surrounding area indicate that overall saturated thicknesses were the least in January 1991 (Tables 2.1 and 2.3). A low water level map is presented here as Figure 2-13. Comparison of high water table contours on Figure 2-12 with low water table contours on Figure 2-13 shows that the hydraulic gradient varies with water table elevation. This change may be related to the influence of the paleotopography on pediment surface. Significant influence of the paleotopography on hydraulic gradients (hence on flow direction) is also indicated by the geologic cross-sections (Figures 2-7 through 2-11), where the low water table is seen to approach the top of the Arapaho Formation in some areas.

No water level data are available for the lower hydrostratigraphic units believed to be present under OU13 as confined aquifers. Water levels measured in bedrock wells in other areas of the RFP consistently indicate a strong downward component in the hydraulic gradient (EG&G, 1991c). This is in keeping with the fact that the RFP site is on a topographic high and is within a regional recharge area.

2.1.4.5 Hydraulic Conductivities

No values of hydraulic conductivity are available for the OU13 area.

2.1.5 Surface Water Hydrology

The surface-water drainage areas from OU13 were analyzed using the information presented by Lee Wan and Associates (LWA)(Lee, 1987), Wright Water Engineers, Inc. (Wright, 1991) and EG&G (EG&G, 1991e; EG&G, 1991f; EG&G, 1991g). For the purposes of this analysis, the outer boundary of OU13 was superimposed over the drainage-basin map (Figure 1-4) to assess which drainage areas are located wholly or partly within OU13. From this analysis, flow paths of the runoff leaving OU13 were tracked through ditches, swales, culverts, storm sewer systems, and ponds to evaluate what areas located outside the OU13 boundary are receiving runoff originating from within the OU13 boundary.

The major drainage basins that receive runoff from OU13 are:

- 1) North Walnut Creek
- 2) South Walnut Creek
 - A. Upper South Walnut Creek
 - B. Lower South Walnut Creek

Figure 2-14 shows the OU13 boundary with the surface-water drainage basins outlined. Figure 1-5 provides an overall schematic diagram of the RFP site area surface-water drainage system with the boundary of OU13 indicated. This map indicates the layout of the different major drainageways and shows the location of the OU13 boundary in relation to these surface-water drainage systems. Figure 2-15 provides a schematic diagram of surface-water diversion structures at the A-series and B-series ponds.

2.1.5.1 North Walnut Creek

The North Walnut Creek basin collects drainage from the northern part of the RFP CA, including approximately 18.3 acres located within the OU13 boundary. Runoff in the upper part normally

bypasses Ponds A-1 and A-2 and is collected in Pond A-3 (see Figure 2-15). Water may be diverted to Ponds A-1 and A-2, which are used exclusively for spill control (EG&G, 1991g). Pond A-4 is the terminal pond on North Walnut Creek and receives water released from Pond A-3 (EG&G, 1991g). Water from Pond A-4 is discharged to North Walnut Creek in accordance with the National Pollutant Discharge Elimination System (NPDES) permit for the Sewage Treatment Plant, the Federal Facilities Compliance Agreement (FFCA), and the Agreement in Principle (AIP)(EG&G,1991g). North Walnut Creek is a perennial stream, whereas the tributary that carries the runoff from OU13 to North Walnut Creek is an intermittent stream, with flow occurring primarily after precipitation and snowmelt events.

The surface-water runoff leaving OU13 flows north through OU8 and OU10 before reaching North Walnut Creek. Upon reaching North Walnut Creek, the runoff enters OU6 which encompasses the A-series ponds. Other OUs having IHSSs also located within the OU13 boundary are OU6, OU8, OU9, OU10, OU12, OU14, OU15, and OU16. The OU13 IHSSs located within the North Walnut Creek drainage basin are numbers 117.1, 128, 134, 158, 171, and 186. Table 2.4 provides a listing of each operable unit whose boundary overlaps with the OU13 boundary (EG&G, 1991d). Also, each IHSS associated with these operable units are listed and the drainage basin is identified. The listed IHSS are either located within the OU13 boundary, or are located in an area that drains to one of the surface-water monitoring sites.

2.1.5.2 South Walnut Creek

South Walnut Creek begins on Rocky Flats property and receives the majority of stormwater runoff from the site within the OU13 boundary. This basin can be further divided into upper South Walnut Creek and lower South Walnut Creek drainage basins (LWA, 1987) (Figures 2-14 and 2-15). Lower South Walnut Creek is an intermittent stream and upper Walnut Creek is a perennial stream.

The upper South Walnut Creek drainage basin receives storm runoff from approximately 24.8 acres within OU13. This runoff flows primarily along a manmade ditch on the north side of Central Avenue and into a storm sewer system which discharges on the east side of the RFP Protected Area into the natural channel of South Walnut Creek. This channel then drains east to a culvert system under the Northeast Perimeter Road and into a diversion structure located just upstream from Pond B-1 (see Figure 2-15). This runoff is normally diverted around Ponds B-1, B-2, and B-3 through a bypass line to Ponds B-4, although it may be diverted into Pond B-1 (see Figure 2-15). Pond B-4 has limited storage capacity and generally passes water directly to Pond B-5 (EG&G, 1991g).

Ponds B-1 and B-2 are spill-control ponds (EG&G, 1991g) which receive water from the South Walnut Creek basin. Water levels in Pond B-1 and B-2 are kept low in order to maintain capacity for spill control. Pond B-3 collects effluent discharged via a pipeline from the sewage treatment plant. Excess water in Pond B-3 is discharged in accordance with provisions of the sewage treatment plant NPDES permit to Pond B-4 and thence to Pond B-5.

Pond B-5 is the terminal pond on South Walnut Creek. Water from Pond B-5 was historically treated and discharged to South Walnut Creek. Currently, excess water in Pond B-5 is transferred by a new pipeline to Pond A-4, where it is treated and discharged to Walnut Creek according to the NPDES permit, the FFCA, and the AIP (EG&G, 1991g).

The surface-water runoff leaving OU13 flows east into OU6, which encompasses the B-series ponds located along South Walnut Creek (Figures 1-4 and 1-5). The OU13 IHSSs which are located within the upper South Walnut Creek sub-basin are numbers 117.1, 117.2, 158, 190, and 191.

The lower South Walnut Creek drainage basin receives storm runoff from approximately 25.5 acres within OU13. The primary drainage structure of this drainage basin is the manmade drainage ditch along the south side of Central Avenue. Runoff from this basin is conveyed to

a diversion structure located on the west side of the Northeast Perimeter Road. This runoff can be diverted north to the Upper South Walnut Creek drainage subsystem or east to South Walnut Creek between Ponds B-4 and B-5 (see Figure 2-15).

2.1.6 Air

Meteorological Monitoring

The RFP air quality and meteorological monitoring programs are designed to collect data on the entire site and are not specific to OU13. Meteorological data is being collected at one location at the RFP. Telemetered wind measurements are collected at the RFP 61-Meter Meteorological Tower (Figure 1-2) (EG&G, 1990a).

2.2 NATURE AND EXTENT OF CONTAMINATION

The description of the nature and extent of contamination presented in this subsection is based on historical reports, review of historical photographs, site visits, interviews with former and present the RFP employees, and review of analytical data obtained from the Rocky Flats Environmental Database System (RFEDS). All available analytical data for air, surface water, sediments, borehole samples, and groundwater are presented in Appendices C, D, E, and F. Validated data are identified in the tables in these appendices and in the summary tables in this subsection by a V (validated and valid), an R (validated and rejected), or an A (validated and acceptable with qualifications). J indicates that data are present but below the detection limit, and B indicates that the constituent was also detected in laboratory blanks.

Analytical data available from RFEDS for the area in and around OU13 are limited, and much of the available analytical data have not been validated. The quality of the unvalidated data is unknown and is included here for planning purposes only. Without this data, the amount of information available would not be sufficient for making initial decisions regarding the nature

and extent of contamination and for determining the number and locations of sampling points for the RFI/RI.

The available analytical data presented in this subsection are compared to background data to characterize the nature and extent of contamination. The background data discussed in this subsection are those provided in the Background Geochemical Characterization Report (EG&G, 1990c) which was submitted to, and approved by, EPA and CDH. The Final Background Geochemical Characterization Report is to be delivered to EPA and CDH in September 1992. The Background Geochemical Characterization Report identifies separate environmental media, and through statistical analyses provides background concentrations for each media, or group of media. In that report, where sufficient data were available tolerance intervals were calculated for each parameter. When there was an insufficient number of samples or an insufficient number of detectable concentrations for a given constituent for the calculation of tolerance intervals, the Background Geochemical Characterization Report provides maximum and minimum detected values. The analytical data obtained for OU13 were compared to the upper tolerance limit (or both upper and lower tolerance limits for pH) or the maximum detected concentration for each parameter to determine if the concentration exceeded background. In addition, when the upper tolerance limit was exceeded, the concentrations were compared to the maximum concentration detected in background samples as an additional indicator of whether the concentration detected may be evidence of a release to the environment. When the pH of a sample was greater than the upper tolerance limit or less than the lower tolerance limit, it was also compared to the range of background values.

Background data for media relevant to the discussion of the nature and extent of contamination associated with OU13 are summarized in Tables 2.5, 2.6 and 2.7. For the purposes of this Work Plan, analytical data for surficial materials identified as artificial fill on borehole logs were compared to background data for North Rocky Flats Alluvium. Regardless of whether borehole logs identified bedrock as being weathered or not, all bedrock data were compared to the background data for colluvial, weathered claystone, and weathered sandstone.

Subsections 2.2.1 through 2.2.13 discuss the nature and extent of contamination associated with each IHSS within OU13. These discussions are based primarily on the documented events related to each release within an IHSS and the available analytical data for borehole and groundwater samples. Data on air monitoring and surface-water and sediment monitoring are generally not discussed on an IHSS-specific basis due to the fact that the monitoring locations for these media are such that contamination attributable to individual IHSSs cannot be defined. Summaries of the data available for these media and data requirements are provided in Subsections 2.2.15 and 2.2.16, respectively.

The analytical data for wells that were completed as piezometers are limited to borehole samples taken when the wells were drilled. The majority of the wells within the OU13 boundary were completed as piezometers. Figure 2-16 is a map of the wells in the vicinity of OU13 showing those for which analytical data were requested from RFEDS and the types of data available for each well. The data available for each well are included in Appendices C and D and are summarized in tables discussed in the following subsections.

2.2.1 North Chemical Storage Site (IHSS 117.1)

There have been no documented incidents that would be likely to result in environmental impact at IHSS 117.1 (Appendix A). Excavation of a portion of the site during the construction of the Protected Area in the early 1980s uncovered machine turnings, rings, shapes, overlays, and other metal parts. The material uncovered was believed to be non-radioactive and was not oily.

It is improbable that the storage of scrap metal, construction debris, or limited chemical storage (if this occurred) had an impact on the air. No documentation regarding air monitoring in the area was found.

Well P214689 is located within this IHSS immediately north of the intersection of Seventh Street and Sage Avenue. Analytical data from this well are limited to analyses of volatile organic

compounds (VOCs), metals, inorganic constituents, and radionuclides in surficial material and bedrock samples taken during the drilling of this well in September 1989. Sampling and analysis of groundwater have not been performed at this well. A summary of the analytical data for borehole samples from this well is presented in Table 2.8. Several VOCs were detected in borehole samples from various depths in this well (Figure 2-17). Toluene, benzene, and carbon disulfide were detected in both alluvium and bedrock samples. The concentrations of these constituents do not display a clear trend of distribution with depth although the highest concentrations of toluene were detected in samples collected from 16 to 20 feet deep. Ethylbenzene was also detected in samples of alluvium taken at depths of 16 to 20 feet. Contamination of laboratory blanks with acetone and methylene chloride, two common laboratory contaminants, was indicated in a number of samples from this well. One sample taken from 20 to 22 feet contained 17 g/g acetone. Laboratory blank contamination was not indicated for this sample.

Metals detected in concentrations above background in samples of alluvium include barium, cadmium, copper, iron, manganese, potassium, sodium, vanadium, and zinc. Although the concentrations detected in these samples exceeded the upper tolerance limit for background alluvium (except for cadmium and sodium for which an upper tolerance limit has not been calculated), most do not exceed the maximum background concentrations for each constituent. Cadmium, copper, and sodium concentrations in a sample taken within 3 feet of the ground surface exceeded the maximum background concentrations. Copper concentrations in samples taken from several other depths also exceeded the maximum background concentration. The copper concentrations detected, however, are comparable to those detected in borehole samples from other wells throughout OU13. Copper was also detected at a concentration exceeding the upper tolerance limit but less than the maximum background concentration in the one sample of bedrock taken from this well. The only inorganic constituent that exceeded background was nitrate/nitrite in a sample taken from depths of 0 to 3 feet.

Radionuclides detected at levels exceeding background in samples of alluvium were plutonium-239,240, radium-226, radium-228, strontium-89,90, tritium, uranium-233,234, uranium-235, and uranium-238. Only plutonium-239,240 and radium-226 were detected at levels greater than the maximum concentration detected in background samples. No radionuclides were detected at levels exceeding background in bedrock samples.

Based upon the information currently available, it is not possible to relate the contaminants detected in Well P214689 to IHSS 117.1. Since there is no documented evidence of the storage or disposal of radioactively- or chemically-contaminated materials at IHSS 117.1, it is possible that the contaminants detected in alluvium and bedrock from Well P214689 may be related to a source upgradient of this IHSS. The nearest upgradient wells for which analytical data are available are Well P114789, located approximately 450 feet west of Well P214689, and Well P115589, located approximately 600 feet to the southwest near Building 551. Analytical data are available for borehole samples taken during the drilling of these wells (Tables 2.9 and 2.10). Groundwater samples have not been collected from these wells. Several VOCs were detected in samples of alluvium from both of these wells at concentrations less than the analytical detection limit. Several of the compounds detected in Well P114789 are the same as those detected in Well P214689. Due to the distance between Wells P114789 and P115589 and Well P214689 and to the presence of other IHSSs and potential sources of contamination between these wells and Well P214689, it is not possible to identify the source of the contaminants detected in Well P214689.

More information is needed on the nature of the contamination expected to be associated with IHSS 117.1 and on other potential sources of contamination in the vicinity. Additional data on possible contamination of soils upgradient and downgradient of IHSS 117.1 are needed to determine the nature, extent and source of contamination in the area. In addition, data on upgradient and downgradient groundwater quality are lacking. As indicated on Figure 2-17, most of the zones where VOCs were detected in alluvium and bedrock at the time of drilling are below the water table in Well P214689. No data exist regarding possible contamination of groundwater

in this area. The nearest downgradient well is P218089, which is located approximately 1,050 feet east of Well P214689.

Alluvium and bedrock samples were collected during the drilling of Well P218089. Groundwater samples for analyses of VOCs were collected once during 1990 and once during 1991 and for analysis of radionuclides twice during 1990 and twice during 1991 (Tables 2.11 and 2.12). Inorganic constituents were also analyzed in several of these samples. Acetone was detected in concentrations less than the detection limit in several borehole samples from this well. Contamination of laboratory blanks was not indicated for these samples. Methylene chloride was also detected in several samples, but laboratory blank contamination was indicated for these samples. Metals detected in concentrations greater than background in surficial materials were barium, calcium, chromium, copper, lead, magnesium, vanadium, and zinc. The concentrations of these metals did not exceed the maximum background concentration for alluvium. Barium, calcium, magnesium, and strontium were detected in concentrations greater than background in bedrock samples with only barium and strontium being detected in concentrations exceeding the maximum background concentration for bedrock. No inorganic constituents were detected in concentrations exceeding background in any sample. Borehole samples were not analyzed for radionuclides.

The only VOC detected in groundwater from Well P218089 was methylene chloride in the sample taken May 31, 1990. No laboratory blank contamination with methylene chloride was indicated for this sample. Methylene chloride was also detected in several other samples, but contamination of laboratory blanks was indicated for those samples. Bicarbonate, chloride, nitrate/nitrite, and sulfate concentrations have exceeded background concentrations on at least one occasion. Radionuclides detected at levels exceeding background levels in groundwater from this well were U-233,234, U-235, and U-238 in samples taken during 1990. Analysis of uranium isotopes was not performed on samples collected during 1991. Groundwater samples taken from this well have not been analyzed for metals.

It is improbable that the storage of scrap metal, construction debris, or limited chemical storage (if this occurred) had an impact on the surface water. There are no ditches dissecting the area. The surface-water runoff from the North Chemical Storage Site (IHSS 117.1) flows northwest to the unnamed tributary to North Walnut Creek or southeast to the upper South Walnut Creek drainage ditch. The surface-water runoff flowing to the north is sampled by monitoring sites SW018 and SW093. However, these sites are located downstream 1,300 feet and 4,300 feet, respectively. Therefore, the water-quality data cannot be used to accurately interpret the impacts from this IHSS.

The drainage flowing southeast into the upper South Walnut Creek drainage ditch is sampled by monitoring site SW023, which is located approximately 4,100 feet downstream. This water-quality data cannot be used to accurately interpret the impacts from this IHSS.

2.2.2 Middle Chemical Storage Site (IHSS 117.2)

No documentation was found regarding the nature and extent of contamination that may be associated with IHSS 117.2. As described in Appendix A, several incidents occurred within this IHSS when radiologically or chemically contaminated materials were stored within the IHSS or when leaks or spills occurred which may have released contaminants to the environment. No documentation of sampling activities or corrective action in response to these incidents was found.

It is improbable that the past spills and leaks in the area have any present impact on the air. No documentation regarding air monitoring in the area was found.

It is possible that past incidents have resulted in residual soil contamination. No documentation was found indicating soil sampling or removal in the area, except that soil analyses done at the time of the beryllium storage in 1971 concluded no significant contamination of beryllium (Lindsay and Robinson, 1971).

Analytical data for surficial materials, bedrock, and groundwater are lacking for the area in and around IHSS 117.2. Well P115689 is located near the eastern edge of the IHSS. No samples of surficial materials or bedrock were taken when this well was being drilled, and no samples of groundwater have been taken. The nearest sampling points that may provide an indication of possible contamination associated with IHSS 117.2 are Wells P115589, P213689, and P214089. Well P115589 is located approximately 250 feet upgradient of the IHSS on the west side of Building 551. Wells P213689 and P214089 are located approximately 750 feet east-southeast of the IHSS. The only analytical data available for these wells are for samples of surficial materials and bedrock taken when they were being drilled in 1989. A summary of this data is provided in Tables 2.13 and 2.14. Well P215789 is located approximately 450 feet east-southeast of the IHSS, but no sampling has occurred at this location.

No samples of bedrock were taken from Well P115589. Acetone; 1,1,1-trichloroethane (1,1,1-TCA); 1,1,2,2-tetrachloroethene; 1,1-dichloroethane (1,1-DCA); 1,1-dichloroethene (1,1-DCE); 1,2-dichloroethene (1,2-DCE); tetrachloroethene (PCE); and trichloroethene (TCE) were detected at concentrations less than detection limits in samples of surficial materials from this well. Acetone and methylene chloride were detected in several samples, but contamination of laboratory blanks was indicated for those samples. Metals detected in concentrations above background in samples of alluvium were arsenic, copper, manganese, potassium, vanadium, and zinc. With the exception of copper, the concentrations of these metals detected did not exceed the maximum concentrations detected in background alluvium. Copper concentrations in samples taken from depths of 16 to 28 feet exceed the maximum background concentration but are comparable to those detected in alluvium from other wells in and around OU13. The pH of a sample taken from 3 to 6 feet was less than the lower tolerance limit but within the range of background levels. All other inorganic constituents were detected in background concentrations.

Radionuclides detected at levels exceeding background in samples of alluvium from Well P115589 include plutonium-239,240; radium-226; radium-228; strontium-89,90; uranium-233,234; uranium-235; and uranium-238. The concentrations of plutonium-239,240 detected in these

samples exceeded the maximum background concentration at all depths. Radium-226; strontium-89,90; and uranium-235 concentrations exceeded the maximum background concentration in several samples but these concentrations occurred sporadically with no clear trend of concentration with depth. The levels of the other radionuclides were generally within the range of concentrations detected in background samples.

Acetone was the predominant VOC detected in alluvium from the two wells downgradient of IHSS 117.2, P213689 and P214089. Acetone concentrations detected in Well P213689 ranged from 44 µg/kg to 200 µg/kg. 2-butanone (methyl ethyl ketone, MEK) was also detected in two samples at concentrations of 21 µg/kg and 43 µg/kg. Total xylenes and toluene were detected at levels less than detection limits in several samples. One sample from Well P214089 contained 140 µg/kg of acetone. Acetone and methylene chloride were detected in several other samples, but contamination of laboratory blanks was indicated for those samples. No other VOCs were detected in samples from this well. VOCs were not detected in samples of bedrock from either well.

Metal concentrations in several samples of alluvium from Well P213689 exceeded background for arsenic, copper, chromium, lead, magnesium, strontium, and zinc. Copper, strontium, and zinc concentrations in several of these samples also exceeded the maximum background concentrations for these elements. In addition, the analysis of a sample taken from 7 to 12 feet deep indicated that the concentration of mercury and lead in that sample exceeded maximum background concentrations. Analysis of a duplicate of that sample, however, resulted in the detection of concentrations of these elements that are less than maximum background concentrations. The analysis of the duplicates of that same sample detected cadmium concentrations of 27.4 µg/kg and 10.4 µg/kg. Both concentrations exceed the maximum background concentration for cadmium in alluvium. One sample of bedrock from this well was also analyzed. Concentrations of copper, lead, strontium, and zinc exceeded background, but only strontium exceeded the maximum concentration detected in background. All inorganic constituents were detected in concentrations comparable to background concentrations.

Samples of alluvium from Well P214089 contained concentrations of aluminum, antimony, arsenic, barium, calcium, copper, iron, lead, magnesium, manganese, nickel, potassium, strontium, vanadium, and zinc that exceeded background concentrations. As with samples of alluvium from other wells in the vicinity of OU13, copper concentrations in this well exceeded the maximum background concentration for most samples. Strontium and zinc concentrations also exceeded maximum background concentrations for several samples, and antimony and iron concentrations exceeded maximum background concentrations in a sample taken from 3 to 7 feet. Metal concentrations in the two bedrock samples taken from this well exceeded background for arsenic, barium, calcium, lead, magnesium, strontium, and zinc. Strontium was the only element for which the concentration detected exceeded the maximum background concentration. All inorganic constituents were detected in concentrations comparable to background concentrations.

Radionuclides detected at levels exceeding background in alluvium from Well P213689 include cesium-137; plutonium-239,240; radium-226; radium-228; tritium; uranium-233,234; uranium-235; and uranium-238. The concentrations of most of these radionuclides did not exceed the maximum background concentration with the exception of cesium-137; plutonium-239,240; and tritium. Cesium-137 was detected in only one sample at a concentration of 0.83 pCi/g. Plutonium-239,240 was detected at activities ranging from 1.756 pCi/g in the 0 to 3 foot sample to 0.066 pCi/g in the 3 to 6.5 foot sample. Tritium activities ranged from 3,260 pCi/l in the 0 to 3 foot sample to 1,000 pCi/l in the 3 to 6.5 foot sample. Plutonium-239,240 was also detected at a concentration exceeding the maximum background concentration in a sample of alluvium collected from 7 to 12 feet, but tritium was not detected at that depth. Radium-226, radium-228, and tritium were detected in concentrations exceeding background in the one sample of bedrock from this well. The tritium concentration detected in this sample, 420 pCi/l, is three orders of magnitude greater than the background concentration for bedrock. Radionuclide analyses were not performed on samples taken from Well P214089.

Based upon the information currently available, it is not possible to attribute the potential contamination of surficial materials or bedrock from these wells to IHSS 117.2. The wells were

not installed for the purpose of determining impacts from this or any other IHSS. The locations of the wells are such that soils in the vicinity of them could have been impacted by several possible sources of contaminants. The quantity and quality of the data currently available are not sufficient for determining impacts from IHSS 117.2. The concentrations of several constituents in samples from the two wells downgradient of IHSS 117.2 were higher than those detected in the upgradient well. Acetone and methyl ethyl ketone (MEK) were detected in relatively high concentrations in the downgradient wells, particularly Well P213689. There have been no documented releases of these two chemicals from IHSS 117.2. Although no contamination of laboratory blanks was indicated for these samples, detection of acetone in several other samples from these wells was attributed to laboratory contamination. It is also important to note that these data have not been validated, and validation may or may not confirm the reported results.

Concentrations of aluminum, barium, iron, lead, magnesium, and zinc were higher in samples from the downgradient wells than in the upgradient well. Although the concentrations of these elements were higher in downgradient wells and exceeded the background upper tolerance limits, the concentrations did not exceed the maximum concentration detected in background samples. Thus, it is difficult to attribute any increase in the concentration of these metals to possible releases from IHSS 117.2. Concentrations of cadmium in Well P213689 and strontium in both P213689 and P214089 are higher than those detected in P115589 and are greater than the maximum concentrations detected in background samples. The reason for these increased concentrations is not clear. There were also a few increased concentrations of antimony, chromium, mercury, and nickel reported for samples from the downgradient wells.

Similarly, the concentrations of plutonium-239,240 and tritium were higher in samples from Well P213689 than in P115589. These radionuclides were detected in concentrations greater than the maximum background concentration in samples of surficial materials taken within 6 feet of the surface from P213689. The one sample of bedrock from this well contained concentrations

of radium-226, radium-228, and tritium greater than background. The concentrations of these radionuclides in the remaining samples from this well were similar to those detected in P115589.

It is possible that there is no residual effect on the surface water due to the leaks and spills in the storage yard. However, it is possible that the unidentified leaking substance in 1971, and the aluminum nitrate in 1986 affected the surface water at the time of the incidents.

The surface-water runoff from this site flows east to the roadside ditch on the west side of Seventh Street and then north to a low point just south of Sage Avenue. A culvert carries this runoff east to the upper South Walnut Creek drainage ditch where it flows south then east, eventually discharging into Pond B1. This surface-water runoff is sampled by monitoring site SW023, which is located approximately 4,100 feet downstream. This water-quality data cannot be used to accurately interpret the impacts from this IHSS.

2.2.3 South Chemical Storage Site (IHSS 117.3)

As described in Appendix A, there was one documented incident of a release of material within this IHSS. On May 4, 1965, radioactively contaminated oil leaked from a glovebox contained in a wooden waste box that was being transported to the storage area from Building 776. Approximately 900 square feet of soil within the IHSS were contaminated during this incident. The composition of the oil was not determined, but based upon the fact that the glovebox originated from Building 776, it is presumed that the radioactive constituent of the oil was probably plutonium. It was documented that the contaminated soil around the waste box, except for the area underneath the waste box, was removed. The soil under the waste box was to be removed after the box was removed, but no documentation was found to confirm that this ever occurred. The storage area was subsequently modified during the construction of Tank 224 in 1974. Drainage ditches in the area were filled in, the area regraded, and a 10-foot-high berm was constructed around the tank.

The asphalt along Central Avenue was removed after the glovebox incident occurred in 1965. The path the truck took at the time of the glovebox incident from Central Avenue to the spot where the waste crate was placed is unknown. Therefore the area of greatest potential for contamination in the soil would be the area at the corner of the storage area outside the berm that may not have been disturbed during the construction of the tank. The area along the south Central Avenue ditch was regraded in 1969, which was after the glovebox incident occurred.

No soil sampling or groundwater monitoring with the purpose of determining potential impacts from releases from IHSS 117.3 has been performed. Wells P414189 and P313489 were constructed in 1989 in the vicinity of this IHSS. Well P414189 is located southeast of Tank 224 near the intersection of Seventh Street and Cottonwood Avenue. No samples of surficial materials or bedrock were taken for chemical analyses at the time this well was being drilled, and groundwater has never been sampled at this location. Well P313489 is located approximately 250 feet southeast of IHSS 117.3. Samples of surficial materials and bedrock were taken during the drilling of this well. No groundwater samples have been taken. Based on the current understanding of the boundary of IHSS 117.3, Well P313489 is not downgradient of the IHSS. Analytical data for this well are provided here in an attempt to further define the extent of IHSS 117.3. A summary of the data available for Well P313489 is provided in Table 2.15.

Well P418289 is located upgradient of the IHSS near the northeast corner of Building 444. Surficial materials and bedrock were sampled during the drilling of this well and groundwater samples have been collected on a quarterly basis since March 1990. Monitoring Well 6186 is located downgradient of IHSS 117.3, approximately 750 to the east. Groundwater samples were collected from this well in July 1989 and quarterly since March 1990. No samples of surficial materials or bedrock were collected from this well during drilling. Tables 2.16, 2.17, and 2.18 provides a summary of the analytical data available for these wells.

Based on the information currently available for Well P418289, groundwater upgradient of IHSS 117.3 has been impacted by operations unrelated to this IHSS or other IHSSs within OU13.

Several VOCs have been detected in this well since it was first monitored (Figure 2-18). In addition, 1,1-DCA has been detected in concentrations less than the detection limit in several groundwater samples from this well. Methylene chloride, acetone, and 4-methyl-2-pentanone were also detected in groundwater samples, but contamination of laboratory blanks was indicated for these samples. Mercury, uranium-233,234, and uranium-238 have been detected in groundwater from this well in concentrations exceeding background (Figures 2-19 and 2-20). Other metals detected in groundwater in concentrations greater than background were barium, calcium, chromium, magnesium, sodium, and strontium. Bicarbonate, chloride, nitrate/nitrite, and sulfate concentrations in groundwater from this well have routinely exceeded background levels. Bicarbonate and nitrate/nitrite concentrations have generally been less than maximum background concentrations.

Analysis of samples of surficial materials and bedrock from this well did not contain detectable concentrations of any VOCs. Methylene chloride and acetone were detected in several samples, but contamination of laboratory blanks was indicated for these samples. Mercury was not detected in these borehole samples and the concentrations of uranium-233,234 and uranium-238 exceeded the upper tolerance limit for background alluvium but were less than the maximum background concentrations. Cesium-137, plutonium-239,240, radium-226, and radium-228 were also detected in concentrations exceeding background in alluvium from this well. Metals present in concentrations above background in alluvium from this well include calcium, copper, lead, magnesium, manganese, potassium, and vanadium. The concentrations of all of these elements, however, were within the range of background concentrations. The concentration of nitrate/nitrite in one sample of surficial materials in this well exceeded background.

The only VOCs detected in groundwater from Well 6186 were acetone and tetrachloroethene (PCE). With the exception of acetone in one sample, these compounds were always present in concentrations less than the analytical detection limits. Methylene chloride and acetone were detected in several samples, but contamination of laboratory blanks was indicated for these samples. Metals routinely detected in concentrations exceeding background include calcium,

magnesium, and sodium. Chromium and lead were also detected in concentrations exceeding background in one sample. Bicarbonate, chloride, nitrate/nitrite, and sulfate concentrations generally exceeded background levels in all samples, but the concentrations of bicarbonate and chloride were less than the maximum background concentration. Radionuclides detected in concentrations above background include cesium-137; strontium-89,90; uranium-233,234; and uranium-238. These radionuclides were present in levels exceeding background in only one or two samples taken from this well.

Samples of surficial materials from depths of 0 to 9 feet from Well P313489 contained 1,1,1-TCA (Figure 2-21). No other VOCs were detected in borehole samples from this well. Metals detected in concentrations exceeding background concentrations in surficial materials were arsenic, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, and zinc. Only lead and magnesium in the 0 to 3 foot sample (noted as artificial fill on the borehole log) exceeded the maximum background concentration for alluvium. Metals detected in concentrations exceeding background in the one sample of bedrock taken at this location were barium, copper, lead, manganese, and zinc with only barium being detected in a concentration greater than the maximum background concentration for bedrock. All inorganic constituents were detected in concentrations comparable to background concentrations.

Radionuclides present in surficial materials in concentrations greater than background were plutonium-239,240, radium-226, radium-228, strontium-89,90, uranium-233,234, uranium-235, and uranium-238. Most of these radionuclides were detected in concentrations less than the maximum background concentration. A significant exception is plutonium-239,240 which was detected at a concentration of 15.86 pCi/g in the 0 to 3 foot sample. Radionuclides detected above background in bedrock were radium-226, radium-228, strontium-89,90, uranium-233,234, and uranium-238. The concentrations of radium-226, radium-228, and strontium-89,90 were greater than the maximum concentration detected in background samples.

Due to the limited quantity and quality of the currently available data, it is not possible to associate the presence of any of the constituents discussed in the previous paragraphs in surficial materials, bedrock, or groundwater to releases from IHSS 117.3. The only data from an upgradient location are those from Well P418289. Groundwater data from this well indicate that it has been impacted by activities unrelated to any OU13 IHSS. Analyses of samples of surficial materials and bedrock taken from this well when it was drilled on November 7, 1989, do not indicate contamination which may reflect a release that occurred between the time the well was drilled and when groundwater was first sampled at this location on March 22, 1990. This apparent discrepancy may also indicate a plume of contaminated groundwater that had not reached this location at the time the well was drilled.

The analytical data for groundwater samples from Well 6186, the nearest downgradient monitoring well, do not clearly indicate any impact to groundwater that may be attributed to IHSS 117.3. Likewise, it is not possible to link contamination detected in borehole samples from Well P313489 to known incidents that occurred within IHSS 117.3.

Surface water in the area at the time was controlled by drainage ditches that traversed the area. Drainage on the north part of the area was into the Central Avenue ditch. The diagonal drainage ditches directed flow to the northeast then through a culvert beneath Seventh Street. Beyond Seventh Street, the flow appears to have been directed to the Central Avenue ditch. The surface water ditches were changed when Tank 224 was constructed.

At the present time, the surface-water runoff from this site flows northeast to the corner of Seventh Street and Central Avenue. A culvert under Seventh Street conveys the runoff eastward where it flows in the Central Avenue past monitoring site SW020, located approximately 1,250 feet downstream, and monitoring site SW022, located approximately 3,500 feet downstream. No analytical data for sediments was obtained downstream of this site.

The water-quality data obtained from SW020 and SW022 cannot be reliably used to interpret the impacts from this IHSS because the surface runoff from other IHSSs also drains to these monitoring sites.

2.2.4 Oil Burn Pit No. 1 (IHSS 128)

Monitoring of potential environmental impacts from the burning of waste oils in this pit was limited to air monitoring conducted at the time of the experimental burn in July 1956 described in Subsection 2.1.1.4. Documented results of sampling and analysis of surficial materials, bedrock, or surface and groundwater in the vicinity of the pit was not found.

The incident of oil burning in the area now covered by Sage Avenue and the drainage ditch left residual ash and residue on the ground surface. The composition of the material resulting from the oil burn has not been documented, although reference was made to soil samples being taken at the time of the experiment. It is unknown whether the ground surface was scarified or in another way disturbed prior to the placement of the fill and roadbase for Sage Avenue. Based on visual observations made by long-time employees and a review of photographs, the road is perhaps 10 or up to 18 feet above the original ground surface.

Two wells were installed in 1989 (P114889 and P114989) in the general proximity of this IHSS north of Sage Avenue. The borehole log from P114989 indicated approximately 9.5 feet of artificial fill while the log for P114889 indicated approximately 4 feet of fill. The fill material, however, almost certainly came from the RFP either from one of the borrow pits or from excavation during another construction activity. The borehole logs do not indicate what evidence was used to distinguish between fill and alluvium. Therefore the distinction made in the borehole logs between fill material and alluvium may or may not be accurate.

Samples of surficial materials and bedrock were taken during the drilling of Well P114889. A summary of the analytical data for these samples is presented in Table 2.19. No borehole

samples were taken from P114989. No groundwater samples have been taken at either location. P114889 is located 150 feet east of the site of the oil burn pit. Acetone was present in a sample of alluvium taken from 9 to 11 feet. Carbon disulfide was present in a sample taken at 12 to 13.9 feet near the alluvium-bedrock contact. These two VOCs were also detected at concentrations less than the analytical detection limits in alluvium and bedrock samples at other depths. Acetone and methylene chloride were detected in a number of samples, but contamination of laboratory blanks was indicated for these samples. Several metals were detected in concentrations exceeding the upper tolerance limit for their respective background concentrations in alluvium. The concentrations of these metals did not exceed maximum background concentrations. Many of the same metals were detected in concentrations exceeding background upper tolerance limits for bedrock, but only vanadium was detected in a concentration that exceeded the maximum background concentration for bedrock. All inorganic constituents were detected in concentrations comparable to background concentrations.

Radionuclides detected in concentrations exceeding background in samples of surficial materials were plutonium-239,240; radium-226; radium-228; uranium-233,234; and uranium-238. Only radium-226 and radium-228 were present in concentrations exceeding the maximum background concentration for each radionuclide in alluvium. The highest concentrations of radionuclides detected were in the sample collected from 0 to 3 feet. The only radionuclide present in bedrock in a concentration greater than background was radium-226, and its concentration did not exceed the maximum background concentration for bedrock.

Based upon the available analytical data for borehole samples from Well P114889, it is difficult to make any conclusions regarding the nature and extent of contamination associated with IHSS 128. Organic constituents expected to be associated with a wide variety of waste oils were not detected in borehole samples taken from this location. Assuming that the ground surface at the location of this well is the same as it was when the oil burning pit was being used, it is possible that the elevated concentrations of radionuclides detected in near-surface borehole samples could

be attributable to air emissions from the burning or transport of radionuclides by surface water to this location.

The surface drainages have changed significantly over time. Prior to 1969 and the construction of Sage Avenue, the major surface water feature was the tributary to North Walnut Creek. Pond A-1 has been located on North Walnut Creek since January 1954. After Sage Avenue was constructed, surface drainage in the area is most likely toward the drainage ditch along Sage Avenue, that may overlap with the oil burn pit area. Organic components of the oil may have migrated into the ditch, but organic components from other sources might also have migrated into the ditch. Two notable sources are the solvent burning area on the south side of the ditch (IHSS 171) and the underground 18,000-gallon gasoline tank near Building 331.

The oil burning was done on the ground surface and then backfilled. Residual material from the oil burning was subsequently disturbed as it was buried beneath the fill for Sage Avenue.

A Hazard Ranking Score (HRS) was applied to this IHSS as part of the 1986 CEARP Interim Report for the RFP. Although the description of the site and incidents were similar to the current understanding of the incident, there were significant discrepancies with the description provided above. One major discrepancy was that the CEARP indicated that Building 335 was constructed directly over the site, whereas subsequent investigation locates the site north of Building 335. The conclusion of the report was that petroleum oil sludge residues and uranium contamination are still in place. The evaluation of the HRS resulted in a Total Migration Mode score of 4.7, which reflected a non-zero score for the groundwater route (EG&G, 1992b).

The surface-water runoff from this site is collected in a sump located on the south side of Sage Avenue. A culvert carries the flow north under Sage Avenue, where an open ditch carries the flow east to the natural drainageway which flows northeast through the Protected Area and into North Walnut Creek.

The closest surface-water monitoring site is SW018, which is located approximately 1,800 feet downstream along the unnamed tributary to North Walnut Creek. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was received. The water-quality data obtained from SW018 cannot be reliably used to interpret the impacts from this IHSS because the surface runoff from other IHSSs also drains to this monitoring site.

2.2.5 Lithium Metal Destruction Site (IHSS 134)

As discussed in Appendix A, IHSS 134 consists of an area used primarily for destruction of lithium, located north and east of Building 331, and an area used primarily for the destruction of magnesium, located north of Building 335 in the same area as the No. 1 oil burn pit (IHSS 128). No documentation exists regarding the nature and extent of contamination that may be associated with this IHSS. No monitoring was conducted at the time the burning occurred and no sampling has been performed to determine the nature and extent of contamination that may have resulted from this burning.

The incidents of magnesium and lithium burning by the fire department were routine but not regularly scheduled. These events were typically monthly although they may have varied seasonally. No specific air sampling was done at the time of the events to monitor any releases to the atmosphere. The only atmospheric consideration noted was that the burning of magnesium caused a very bright fire that was often noted by uninvolved plant personnel and airplane pilots (Dienst and Miller, 1992). Because no records were maintained regarding the schedule or duration of the events, it is speculated that no additional information can be derived from the atmospheric consideration of the events of this IHSS.

The incidents of magnesium burning in the area of the ponds now covered by Sage Avenue and the drainage ditch north of Building 335 left residual ash and residue on the ground surface. The composition of the material resulting from the reaction with magnesium and water has not been documented. If the composition of magnesium was magnesium metal, logically magnesium

hydroxide resulted. If the initial magnesium was in another form, another compound may also have resulted. In addition to magnesium metal, the fire extinguishing agents may be remnant in the soil. Different agents in addition to water were used on the magnesium. It is unknown whether the ground surface was scarified or in another way disturbed prior to the placement of the fill and roadbase for Sage Avenue. As discussed in Subsection 2.2.5 for IHSS 128, the borehole logs for the two wells in this area do not provide conclusive evidence of the thickness of artificial fill in the area.

Analytical data for borehole samples from Well P114889 are presented in Subsection 2.2.5 for IHSS 128. These data do not indicate contamination of surficial materials or bedrock that appears to be attributable to the destruction of magnesium. Although concentrations of magnesium exceeded the upper tolerance limits for both alluvium and bedrock, the concentrations did not exceed the maximum background concentrations for magnesium in either alluvium or bedrock. The magnesium concentrations detected in borehole samples at this location are comparable to those detected in samples from wells throughout OU13.

The incidents of lithium burning in the area around Building 331 took place in containers on the ground. The overspray from extinguishing the burning material came into contact with the ground. The area directly behind the building was relatively active since the early 1960s, and the ground was disturbed many times. In addition to lithium hydroxide resulting from the reaction of lithium with water, other compounds would include residues from the solvents in the machining oils that coated the lithium and residues from the extinguishing agents which were used during training. The burning of lithium occurred in the general area of Building 331 in more than one spot. To the recollection of several the RFP employees involved with the lithium and magnesium destruction, lithium was not burned in the same area as the magnesium. The specific locations in the area cannot be identified through any written record. Other activity in the area has probably impacted the soil. Prior to its being paved, tanker trucks and other heavy equipment were stored in the area.

Well P115489 was installed east of Building 331 in 1989. Analytical data are available for borehole samples taken during the drilling of this well. A summary of these data are presented in Table 2.20. Acetone and toluene were reported at concentrations less than the analytical detection limits in samples of surficial materials taken from Well P115489. No VOCs were reported as being detected in the one sample of bedrock taken at this location. Acetone and methylene chloride were also detected in several samples of both surficial material and bedrock, but contamination of laboratory blanks was indicated for these samples. Several metals were detected in concentrations exceeding background in samples of surficial materials, but only copper and zinc were detected in concentrations greater than their respective maximum background concentrations. The copper concentrations detected are comparable to those detected in surficial materials from other wells within OU13. Arsenic and lead were present in concentrations greater than background in the sample of bedrock, but the concentrations of both elements did not exceed the maximum background concentrations for bedrock. All results for lithium were less than the analytical detection limit. Nitrate/nitrite concentrations in two samples taken within 6 feet of the ground's surface exceeded background levels.

Several radionuclides were detected in concentrations exceeding background in samples of surficial materials. With the exceptions of plutonium-239,240; radium-226; strontium-89,90; and uranium-235, all concentrations of radionuclides were less than the maximum background concentration for alluvium. The concentrations of uranium-233,234 and uranium-238 in the sample of bedrock from this location exceeded the upper tolerance limits for these radionuclides, but did not exceed the maximum background concentrations for bedrock.

Based on the available data for borehole samples from Wells P114889 and P115489, the contaminants expected to have resulted from the burning of magnesium and lithium have not been detected in surficial materials or bedrock from these locations in concentrations that would indicate impact from this IHSS. It is possible that the low concentrations of acetone and toluene in samples from Well P115489 could be attributable to the solvents that reportedly coated the lithium burned in this area. These compounds, however, are used in a variety of analytical

laboratory process and could be an artifact of laboratory contamination. It should also be recognized that these wells were not installed for the purpose of monitoring possible releases from this IHSS and are not ideally located for such a purpose.

The surface drainages have changed significantly over time. Prior to 1969 and the construction of Sage Avenue, the major surface water feature was the tributary to North Walnut Creek. Pond A-1 has been located on North Walnut Creek since January 1954. Since 1961, emission spectrographic analyses have been made on monthly composite water samples from Ponds A-1, B-4, and C-1 for the monitoring of lithium. The results of the composite sample were all less than 5 ppm lithium with most concentrations less than the minimum detection limit (Unknown, 1973). Magnesium concentrations in the surface water have not been obtained, and it is not known if such information exists. Other than small quantities of magnesium being associated with the solvent burning events, there are no other known sources of magnesium or lithium in this area of the RFP that would have impacted surface water.

This IHSS is located in the North Walnut Creek drainage basin. The surface-water runoff from this site is collected in a sump located on the south side of Sage Avenue. A culvert conveys the runoff north under Sage Avenue, where a man made ditch carries the runoff east to the natural drainageway. This natural drainageway, which is the unnamed tributary to North Walnut Creek, flows north through the Protected Area.

The closest surface-water monitoring site along this drainage path is SW018, which is located approximately 1,800 feet downstream. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was obtained from the RFEDS request. The water-quality data obtained from SW018 cannot be used to reliably interpret the impacts from this IHSS. The surface-water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

2.2.6 Waste Spills (IHSS 148)

As discussed in Appendix A, no documentation was found to support the occurrence of releases associated with this IHSS. Little or no information is currently available that would assist in defining the nature and extent of contamination associated with this IHSS. No evidence has been obtained that would indicate that air, soil, surface water, or groundwater sampling has been conducted in this area.

The types of materials that may have come to be located in soils under Building 123 include nitrates and other laboratory materials the exact nature of which is not currently known. The possibility of the presence of low levels of radioactive materials also exists. Information on the anticipated types and concentrations of any materials that may have been released to the soil was not found. It is possible that releases from the original PWLs under Building 123 affected groundwater. No historical groundwater monitoring wells were installed to investigate any potential releases associated with this building.

Monitoring Well 4486 is located approximately 600 feet northeast of Building 123. This well is downgradient of this IHSS, and groundwater monitoring data from this well could be used to indicate possible impact to groundwater due to releases within the IHSS. However, due to the distance between the IHSS and Well 4486, the presence of several other IHSSs or other potential sources of contamination between the tanks and the well, and the lack of data on upgradient groundwater quality, any conclusions made on the basis of this information would be tenuous. Analytical data for groundwater samples from Well 4486 are discussed in Subsection 2.2.8 for IHSS 157.1.

Drainage in the area of Building 123 is not believed to have changed significantly since the building was constructed. Drainage north of the building is toward the east, and a ditch behind the building (to the south) also drains eastward. Although unlikely, it is possible that the releases

from the OPWLs could have impacted the surface water ditches. No historical surface water sampling results related to these releases has been found.

This IHSS is located in the lower South Walnut Creek drainage basin. The surface-water runoff draining from this site flows north to the Central Avenue ditch, then east to Pond B-1. The closest surface-water monitoring site is SW019, which is located approximately 800 feet downstream along the Central Avenue ditch. The water-quality data obtained for SW019 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

2.2.7 Fuel Oil Tank (IHSS 152)

Several releases of fuel oil from Tank 221 have occurred in the past and are described in Appendix A. No documentation was found of any monitoring or sampling with the purpose of determining the nature and extent of contamination that may be associated with these releases.

Documentation exists that contaminated soil from one of the spills was excavated and disposed of in the onsite landfill. However, documentation that the other spills had been cleaned up was not found. It is possible that some soil contaminated with hydrocarbons remains in the area, especially within the berm around Tank 221.

Geotechnical soil borings were done at the location of Tank 224 prior to construction. Most of the soils underlying Tank 224 consist of clayey sand that may provide an effective barrier to the movement of No. 6 fuel oil through the soil column (Dow, 1973). The same soil profile is probably present under Tank 221 given the close proximity of the tanks.

Well P414189 was installed approximately 60 feet southeast of Tank 224 in 1989. No samples of surficial materials or bedrock were taken at the time this well was being drilled, and groundwater samples have not been collected from the well. The nearest downgradient sampling

point from this IHSS would be Well 6186, located approximately 900 feet to the east. The analytical data for groundwater samples from this well are described in Subsection 2.2.3 for IHSS 117.3. The analytical results for groundwater samples from this well do not indicate contamination with compounds indicative of fuel oil. It should be noted, however, that the organic analyses performed on groundwater samples from this well would not detect many of the constituents of fuel oil.

Based upon the descriptions of the spills provided in Appendix A, surface-water contamination was not a problem during any of the events involving the tank. The existence of a berm around the tank also should have helped to prevent surface-water contamination. Runoff from the general area of these tanks enters the Central Avenue ditch, then flows northeast to Pond B-1. This IHSS is located in the lower South Walnut Creek drainage basin.

The closest surface-water monitoring site is SW020, which is located approximately 1,400 feet downstream along the Central Avenue ditch. The water-quality data obtained for SW020 cannot be used to reliably interpret the impacts from this IHSS. The surface-water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

2.2.8 North Area Radioactive Site (IHSS 157.1)

Subsection 2.1.1.8 describes releases that have occurred within IHSS 157.1. These releases involve incidents when laundry effluent contaminated primarily with beryllium, and depleted uranium was discharged from Building 442. One documented release from Building 442 also involved enriched uranium. Historical information regarding the nature and extent of contamination associated with these releases is limited. On October 14, 1953, 15 soil samples were taken from drainage ditches to the west and north of Building 442. These samples were analyzed for radioactivity and the results ranged from 1.8×10^4 to 5.2×10^5 disintegrations per minute per kilogram of soil (dpm/kg). The isotopic content of the soils was not determined. No

documentation of efforts to remediate the contaminated soils was found. On March 11, 1954, standing water in a culvert 30 feet west of the building was sampled. The water was suspected to have come from snowmelt which had drained from contaminated soil near Building 442 (Chinn, 1954). No documentation was found which details the results of the sample analysis.

The Site Survey Annual Report for 1954 stated that soil sampling throughout that year had disclosed contamination ten times the background level in the ditches near Building 442. This report states that Buildings 441 and 442 showed consistent areas of significant contamination (Kittinger, 1955). The method of soil sampling and analysis was not identified.

The soil around Building 442 has most likely been altered considerably since the time any soil contamination might have occurred in the early years of operation of the RFP. Depleted uranium which may still be present in the soil may become airborne if disturbed. Atmospheric considerations should be considered if remedial actions could result in disturbance of the soil.

The incidents of depleted uranium contamination in the soil around Building 442 may have left residual uranium on the ground surface. The area around Building 442 has been altered since the various events that may have contributed to soil contamination. There is no longer a ditch where the west ditch described in the 1953 Site Survey Report was identified; however, there is a culvert parallel to the road which empties into the Central Avenue ditch. The Central Avenue ditch was modified and expanded in 1969. During this construction process, uranium may have come into contact with the ground surface. Uranium may have entered the groundwater as a result. However, it is thought that the soil beneath Building 442 is also contaminated from the activities that occurred inside the building. The soil beneath the building has not become contaminated in the same manner as the soil outside the building. Therefore, contamination affecting the groundwater of the area may not be a direct result of this IHSS. Concentrations of contaminants in the groundwater may be greater than the source could have produced if the source is considered only to be the contaminated soil around the building.

Well 4486 is located approximately 20 feet west of Building 442. This well is located between the west drainage ditch described in the 1953 Site Survey Report and the building. Groundwater samples from this well have been collected and analyzed since March 1989. A summary of the results of groundwater monitoring at this location is presented in Table 2.21. Of particular interest to the characterization of the nature and extent of contamination associated with this IHSS are the above-background concentrations of uranium-233,234 and uranium-238 detected in samples from this well. The concentrations of these isotopes have exceeded the maximum background concentrations for alluvial groundwater in all samples analyzed from 1989 to 1991 (Figure 2-22). Uranium-235 was not detected in a quantifiable concentration in any of the samples.

In addition to the presence of above-background concentrations of uranium isotopes, several VOCs and several metals have been detected in groundwater from this well in concentrations exceeding background. Concentrations of PCE have ranged from 37 µg/l in the March 20, 1989 sample to 10 µg/l in the November 8, 1991 sample. The concentration of PCE has fluctuated somewhat over time but has generally decreased (Figure 2-23). Acetone; chloroform; and 1,1,1-TCA have also been detected in groundwater from this well in one sample each. VOCs detected at levels less than the analytical detection limits include 1,1-DCA, 1,1,1-TCA, and TCE. Methylene chloride, toluene, and acetone were detected in several samples, but contamination of laboratory blanks was indicated for those samples.

Several metals have been detected in groundwater samples from Well 4486 in concentrations exceeding background. The only metals that have routinely exceeded their respective maximum background concentrations in this area are calcium, magnesium, and sodium. Chromium exceeded background in the June 20, 1991 sample and mercury exceeded background in the November 8, 1991 sample. Aluminum, barium, chromium, iron, lead, and manganese exceeded background levels in unfiltered samples taken during August and November of 1991. All results for beryllium have been less than the detection limit. Bicarbonate, chloride, nitrate/nitrite, and

sulfate concentrations have routinely exceeded background, but concentrations of bicarbonate and sulfate were generally less than maximum background concentrations.

The analytical data for groundwater samples from Well 4486, particularly for radionuclides, indicate that groundwater in the vicinity of Building 442 may have been impacted by releases of contaminated effluent. This conclusion is preliminary, based on data of limited quantity and quality, and does not explicitly implicate this IHSS as the source of the contamination detected. Other potential sources of contamination exist in this area, and without additional information on groundwater quality upgradient and downgradient of this IHSS and information on the chemistry of surficial materials in the area, other sources of contamination cannot be eliminated.

From the 1953 account of soil sampling, contamination was detected in the soil along the drainage ditch in the direction of flow. Although the area is level and appears to have been since the construction of Building 442, the surface drainages have changed significantly. Ditches in the area carry runoff into the main Central Avenue ditch which drains into the B-Series Drainage.

This IHSS is located in the lower South Walnut Creek drainage basin. The closest surface-water monitoring site is SW019, which is located approximately 200 feet downstream along the Central Avenue ditch. The water-quality data obtained for SW019 included one sample in 1990 for gross alpha and gross beta. The average dissolved concentrations for gross alpha and gross beta was 1.40 pCi/L and 6.65 pCi/L, respectively. However, these results cannot be used to reliably interpret the impacts from this IHSS. The surface-water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

2.2.9 Building 551 Radioactive Site (IHSS 158)

As described in Appendix A, several incidents occurred in the area around Building 551 that may have resulted in releases to the environment. No documentation has been found describing monitoring or sampling activities that have occurred and that may provide information on the

nature and extent of contamination that may be associated with this IHSS. Documentation of remediation efforts in response to the incidents was not found.

Several wells were installed in the vicinity of Building 551 during 1989. Well P115589 is located near the west side of Building 551 and may provide information on conditions upgradient of the IHSS. Well P214689 is located downgradient of the IHSS, approximately 300 feet northeast of the current Building 551. Samples of surficial materials and bedrock were taken from both locations when these wells were being drilled. No samples of groundwater have been collected from either well. The available analytical data for Wells P214689 and P115589 are discussed in Subsections 2.2.1 and 2.2.2, respectively.

As discussed in Subsection 2.2.1, several VOCs were detected in surficial materials and bedrock from Well P214689. Several VOCs were also detected in concentrations less than detection limits in Well P115589. With the exception of acetone, the compounds detected in Well P214689 are different than those detected in Well P115589. Since there is no documentation of the release of organic compounds in IHSS 158, the compounds detected in borehole samples from Well P214689 may have come from another source. The concentrations of metals in borehole samples from both locations and, with the exceptions of strontium-89,90 and uranium-235, the concentrations of radionuclides detected in samples from both locations are comparable. The concentrations of strontium-89,90 and uranium-235 in samples from Well P115589 are higher than those detected in samples from Well P214689.

Based on the available analytical data and on what is currently known about the types of materials that may have been released in this IHSS, the contamination of surficial materials and bedrock in the vicinity of Well P214689 cannot be attributed to IHSS 158. Additional information on the types of releases that may have occurred within this IHSS and on other potential sources of contamination in the area are needed. Data are also needed for upgradient and downgradient soil and groundwater conditions in order to attempt to define the source(s) of the contamination detected.

The topography is essentially flat in the area around Building 551. The ground is paved to the south and east of the building. Between Buildings 551 and 554, the ground surface slopes toward the north and is not entirely paved. Runoff flows toward the north or northeast. Flow into a ditch parallel to Sixth Street enters a culvert beneath Sage Avenue to a drainage west of Building 552. A ditch parallel to Sage Avenue directs water to the east. The area to the north of Building 552 was an empty field cut with a drainage ditch until the fall of 1986 when construction of Tanks 231A and 231B began.

This IHSS is located in both the North Walnut Creek and the upper South Walnut Creek drainage basins. The surface water draining from the west side of Building 551 flows north across Sage Avenue into the North Walnut Creek basin. The runoff draining from the north and east parts of Building 551 drains into the upper South Walnut Creek drainage basin via a man made ditch flowing southeast and then east along the southern boundary of the Protected Area.

The nearest surface-water monitoring site within the North Walnut Creek basin is SW018, located approximately 1,300 feet downstream along the unnamed tributary within the Protected Area. The nearest site within the upper South Walnut Creek basin is SW023, which is located approximately 4,300 feet downstream from Building 551.

The water-quality data obtained from surface-water monitoring sites SW018 and SW023 cannot be used to reliably interpret the impacts from this IHSS. There are other IHSSs which also drain to these monitoring sites, making it difficult to isolate the source of any contaminant.

2.2.10 Solvent Burning Ground (IHSS 171)

The operations and potential releases from the solvent burning ground located near Building 335 are described in Subsection 2.1.1.11. This area is located adjacent to oil burn pit No. 1 (IHSS 128) and a portion of the lithium/magnesium destruction site (IHSS 134). No sampling, monitoring, or remediation activities have occurred at this site. Analytical data for borehole

samples from Well P114889 located approximately 100 feet north-northeast of this IHSS are presented in Subsection 2.2.5 for IHSS 128.

Atmospheric releases at this IHSS would be limited to the combustion products of diesel fuel, gasoline, propane, or solvents. These releases have occurred approximately once a month since 1969. It is unknown if volatiles from soil contamination are currently being released into the air. However, further remediation efforts should take into consideration the possibility of potential contamination becoming airborne if the soil is disturbed.

An area due east of Building 335, extending roughly 40 feet east of the building, 20 feet north and 50 feet south has been the site of extensive fire training which may have resulted in the release of contaminants to the soil. The lateral extent of possible surface contamination is likely constrained by the surface drainage ditch to the south and the roadway to the east. Building 335 marks the western edge of the suspect area, although a small area near the southeast corner of the building might also have been used for small fires. The southern extent of the area used for practice fires is not clearly defined and may be anywhere from 30 to 50 feet south of Building 335 and in the vicinity of the 5-foot rise in topography (Dienst, 1992). The vertical extent of possible contamination has yet to be determined and likely varies across the site. The fire practice area has at least 4 inches of gravel on the surface and has been built up over the years with other gravel layers. The depth of the porous gravel layers and the depth to groundwater are unknown and would be required for further remediation considerations.

The analytical data available for borehole samples from Well P114889 do not indicate contamination that could be attributed to this IHSS. Organic constituents expected to be associated with the wide variety of petroleum hydrocarbons and solvents reportedly burned at this site were not detected in borehole samples from this location.

Surface water from the site flows to the north into the storm drainage on the south side of Sage Avenue. A culvert conveys the runoff north under Sage Avenue, where a man made ditch carries

the runoff east to the natural drainageway. This natural drainageway, which is the unnamed tributary to North Walnut Creek, flows north through the Protected Area. The fire training involved great volumes of water, most of which flowed immediately into this drainage and likely carried uncombusted solvents away from the site. The area around Building 335 has been known to flood as it lies in a low spot near the culvert which runs under Sage Avenue (Dienst, 1992). It is unknown if any of the solvents are leaching from the soil to the surface water.

The closest surface-water monitoring site along this drainage path is SW018, which is located approximately 1,800 feet downstream. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was obtained from the RFEDS request. The water-quality data obtained from SW018 cannot be used to reliably interpret the impacts from this IHSS. The surface-water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

2.2.11 Valve Vault (IHSS 186)

Three documented leaks of process waste have occurred in Valve Vault 12. These incidents are described in Subsection 2.1.1.12. The first incident occurred in 1986 and resulted in a release of material to the environment. The second incident occurred in 1988, and it is believed that this leak was contained in the valve vault and, therefore, there was no release to the environment. No confirmed release of material to the environment occurred as a result of the third incident, which occurred in 1989.

At the time the 1986 leak was discovered, samples of soil and water from the area around the leak were sampled and analyzed for radioactivity. Analyses of water samples from the area of the leak detected gross alpha activities of 1.0×10^3 to 1.7×10^5 pCi/l, gross beta activities of 5.0×10^2 to 5.0×10^4 pCi/l, and uranium-238 activities of 1.0×10^4 to 9.0×10^4 pCi/l. Americium-241 was also detected in a water sample in activities of 3.3×10^2 and 2.4×10^2 pCi/l. Analyses of "mud" from the area detected a gross alpha activity of 2.0×10^3 pCi/l, a gross beta

activity of 5.0×10^2 pCi/l and a uranium-238 activity of 1.0×10^3 pCi/l. Plutonium was not detected in samples of either water or soil. It was also reported that the analysis of soil from the contaminated area indicated no detectable amounts of hazardous wastes. Documentation of such analyses was not found. Chloride and sulfate were detected (Illsley, 1986a).

In response to the 1986 incident, up to 24 boxes of uranium-contaminated sand and gravel were excavated from the area and shipped offsite. Soil samples were reportedly collected at the time to verify contamination removal; however, the results of the analysis of these samples was not found. Due to the large area that was initially impacted and uncertainty over the extent of the leak, it is possible that soil contamination still exists. The condition of the soil used to backfill the excavation is also unknown.

It is improbable that these three incidents had an impact on the air. No documentation regarding air monitoring at the time of either incident was found. It is possible that soil disturbance during investigative or remedial activities could cause radionuclide contaminated soil to become airborne.

Shortly after the 1986 incident, it was recommended by a member of Environmental Analysis and Control that three or four monitoring wells be installed (Illsley, 1986). Well P114789 was installed approximately 50 feet south-southwest of Valve Vault 12 in 1989. This well was installed as part of a geologic characterization program and was not installed for the purpose of monitoring releases from this or any other IHSS. Borehole samples of surficial materials and bedrock were obtained during drilling. No groundwater samples have been taken at this location. There are no soil or groundwater sampling points downgradient of this IHSS. It is also possible that the groundwater flow system in the area has been affected by the construction of Tanks 231A and 231B northeast of this IHSS. Disturbance to surficial materials during construction as well as the presence of the tanks and the containing wall surrounding them may locally affect groundwater flow.

The available analytical data for borehole samples from Well P114789 are described in Subsection 2.2.1 for IHSS 117.1. This well is located upgradient of Valve Vault 12. This may have prevented liquid from leaks at the valve vault from impacting the soils and groundwater in the vicinity of this well. Radionuclides that were detected in concentrations greater than background in samples of surficial materials from this well were plutonium-239,240; radium-226; strontium-89,90; uranium-233,234; uranium-235; and uranium-238. The concentrations of plutonium-239,240, radium-226, strontium-89,90, and uranium-235 were greater than the maximum background concentration for alluvium in a few samples. Uranium-235 was detected in a concentration greater than the upper tolerance limit but less than the maximum background concentration in the one sample of bedrock analyzed.

Several VOCs were detected at levels less than the analytical detection limits in several samples from this well, but none were detected at concentrations exceeding the detection limits. Several metals were also detected in concentrations exceeding background, but only the concentration of copper in one sample of bedrock was greater than the maximum background concentration.

The available analytical data for borehole samples from Well P114789 do not indicate that the releases from this IHSS have impacted surficial materials or bedrock at this location. If residual contamination is present in soils in the vicinity of this IHSS and if groundwater has been impacted by the releases, it is likely that such contamination would only be detected in wells and borings downgradient of the IHSS. At the present time, there are no wells located in the downgradient direction.

The two ditches dissecting the area may have been affected by the 1986 release. No documentation was found which elaborated on this issue. After the leak in 1986 was discovered, surface water and groundwater seeps in the area were collected in small coffer dams. The contained water was then transported to Solar Pond 207A by tank truck (Illsley, 1987). One RFP employee who was present at the time of this leak indicated that it was unlikely that the material released had impacted surface water (Frybeck, 1992).

This IHSS is located in the North Walnut Creek drainage basin. The surface-water runoff draining from the area around this site flows north through the Protected Area in the unnamed tributary to North Walnut Creek.

The closest surface-water monitoring site along this drainage path is SW018, which is located approximately 1,300 feet downstream within the Protected Area. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was obtained from the RFEDS request. The water-quality data obtained from SW018 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

2.2.12 Caustic Leak (IHSS 190)

Subsection 2.1.1.13 describes two leaks of sodium hydroxide from an aboveground, steel, 3,000-gallon storage tank near the southeast corner of Building 443. The first incident occurred in December 1978 and resulted in a release of sodium hydroxide to the environment. The other incident occurred on January 6, 1989. All of the sodium hydroxide from this leak was contained in the tank's secondary containment, and no release to the environment resulted.

In response to the release during the 1978 incident, alum was spread along the Central Avenue ditch to neutralize the sodium hydroxide in the ditch. In addition, alum was added to Pond B-1 to neutralize the sodium hydroxide that had reached that location. Other than monitoring the pH of water in drainage ditches, ponds, and monitoring wells east of the perimeter road, documentation of monitoring or sampling activities at the time of the leak was not found. No documentation was found of remedial actions taken in response to this leak, such as excavation of soils.

It is improbable that either documented incident resulted in an impact to air. It also does not seem likely that any residual impact to soil or groundwater in the area would be detected. The

sodium hydroxide that leaked during both incidents was a raw product and, therefore, would not have contained radionuclides, metals, or other dissolved constituents. Constituents expected to be present in soils or groundwater in excessive concentrations as result of the 1978 incident include sodium, aluminum, and sulfate. Sodium concentrations in groundwater samples from Well 4486, located approximately 150 feet northeast of the storage tank and near the drainage ditches, have routinely exceeded background. Aluminum and sulfate concentrations in groundwater from this well have generally been less than upper tolerance limits or less than maximum background concentrations. These are all naturally-occurring constituents and the presence of these constituents in soils or groundwater would not necessarily indicate impacts that resulted from this incident.

It is possible that the drastic change in pH of the water in the drainage ditches that occurred after this leak may have temporarily mobilized other constituents in the sediments and soils in those ditches, but the effects of this mobilization would have been short-lived. Groundwater in wells adjacent to the Central Avenue ditch east of the perimeter road was monitored after the 1978 leak. The results were considered to be normal, and the groundwater in the wells did not appear to be impacted by the event.

The liquid released in 1978 flowed down the Central Avenue ditch and into Drainage Pond B-1. There was no lateral dispersion of caustic from the ditch (Frazee, 1978). Surface runoff was diverted from Central Avenue ditch, and the remaining contaminated water in the ditch was contained. Impacted surface water held in Pond B-1 was neutralized and pumped to Solar Pond 207B-North. The water was then transferred to Ponds A-2 and B-2 and was subsequently sprayed on the hill adjacent to Pond B-1. Water from the spill that was being contained in Central Avenue ditch was neutralized, and, when found to be environmentally acceptable, released from the ditch. The released water probably entered Walnut Creek through the normal path through Pond B-3 and Pond B-4. Although the spills impacted the surface water at the time of the 1978 incident, it is improbable that effects of this spill are evident in the existing surface water.

The closest surface-water monitoring site along this drainage path is SW019, which is located approximately 400 feet downstream along the Central Avenue ditch. Additional sites along the flow path to Pond B-1 are SW020, SW022, and SW023, located downstream of the source of the spill approximately 1,200 feet, 4,500 feet, and 5,100 feet, respectively. The water-quality data obtained from these sites cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drain to these monitoring sites, making it difficult to isolate the source of any constituents found in the samples.

2.2.13 Hydrogen Peroxide Spill (IHSS 191)

An incident involving the release of hydrogen peroxide from a 55-gallon drum near the intersection of Fifth Street and Central Avenue occurring during April 1981, is described in Appendix A. The hydrogen peroxide that was spilled during the incident was raw product, not a waste product. No monitoring, sampling, or remediation activities occurred, aside from the hydrogen peroxide being hosed into a hole east of Fifth Street.

It is unlikely that any impact to the atmosphere resulted from this incident. Any impact to soil resulting from this incident would likely be confined to the area immediately surrounding the hole. The addition of large quantities of hydrogen peroxide to soils can result in the formation of a wide variety of water-soluble organic compounds (Dragun, 1988). However, based on the limited quantity of hydrogen peroxide spilled during this incident, it is improbable that such compounds would have been formed in detectable quantities. It is also unlikely, that any residual impact to groundwater, if groundwater was impacted, would be detectable. At the time of the incident, the hydrogen peroxide was confined to the hole, and no surface discharge beyond the hole was documented. It is unlikely that any impact to surface water resulted from this spill.

This IHSS is located in the lower South Walnut Creek drainage basin. The surface-water runoff draining from the intersection of Fifth Street and Central Avenue flows east along the Central Avenue ditch and discharges into Pond B-4.

The closest surface-water monitoring site is SW019, located approximately 300 feet downstream along the Central Avenue ditch. The water-quality data obtained from SW019 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drain to these monitoring sites, making it difficult to isolate the source of any constituents found in the samples.

2.2.14 Summary of Surficial Material, Bedrock, and Groundwater Impacts and Data

Requirements

This subsection summarizes the information provided in the previous subsections on possible impacts to surficial material, bedrock and groundwater resulting from each OU13 IHSS. In addition, this subsection summarizes the data required to determine the nature and extent of contamination of surficial materials, bedrock, and groundwater attributable to each IHSS.

The data provided in the previous subsections indicate that surficial materials, bedrock, and groundwater in and adjacent to OU13 have been impacted by the RFP operations. However, the data that are currently available are not of sufficient quantity or quality to allow a determination of the nature and extent of contamination attributable to these IHSSs. Conclusions cannot be formed based on the existing data because the nature of the materials that may have been released within each IHSS are not accurately known. With few exceptions, the contamination detected in borehole and groundwater samples from the nearest well(s) to each IHSS is not indicative of the types of materials believed to have been stored, disposed, leaked, or otherwise released within that IHSS. The determination of impacts that may be attributable to each OU13 IHSS is further complicated by the presence of IHSSs to be investigated under other OU investigations and other potential sources of contamination in close proximity to or upgradient from many of the OU13 IHSSs. Both of these items point to the need for further characterization of all possible sources of contamination.

2.2.15 Summary of Surface-Water and Sediment Contamination and Additional Data Requirements

2.2.15.1 Introduction

The purpose of this section is to summarize probable surface-water impacts and data requirements associated with the RFI/RI efforts. To the extent possible, reference is made to available relevant data and information sources (see Section 6.0).

2.2.15.2 Approaches

Available sediment-chemistry and water-quality data from RFEDS were retrieved for inclusion in this Work Plan for the following general categories of variables:

- Radionuclides;
- Trace metals (including major cations and silicon);
- Priority pollutants; and
- Pesticides, major anions, and miscellaneous chemical constituents.

The following sampling sites were included in the RFEDS data retrieval (EG&G, 1992b):

- SW018
- SW019
- SW020
- SW022
- SW023 (GS10)
- SW118
- SED118
- SW093

All surface-water monitoring sites used in this evaluation are indicated in Figure 2-24. Although available relevant data for sites SED010 and GS13 (SW092) were requested, no data were included in the RFEDS retrieval. When applicable, selective comparisons were made with geochemical-characterization results reported in EG&G documents (EG&G, 1990c; EG&G 1991h).

Because contaminants possibly have entered the groundwater underlying OU13, selective monitoring-well data also were evaluated to the extent data results were available in documents.

For purposes of this assessment, available data were compared, as appropriate, with EPA's drinking-water standards (ASI, 1991e; Appendix F), the Colorado Department of Health's (CDH's) Water Quality Control Commission (WQCC) stream standards (ASI, 1991e; Appendix F), or the proposed groundwater concentration limits (EG&G, 1991d; Table 3.2). Available historical water-quality data were taken into consideration when available (ASI, 1991e; EG&G, 1990d; EG&G 1991h; and Rockwell 1989c; Rockwell 1989d; for example); otherwise, the RFEDS retrieval results of recent data for a broader aerial coverage were used (EG&G, 1992c). In addition, the applicable federal and State of Colorado ARARs and the RFP surface-water background concentrations were used for comparison (EG&G, 1990c).

2.2.15.3 Results

Available surface-water, water-quality, and sediment-chemistry data judged applicable to characterizing OU13 conditions cannot be segregated completely from other OUs. Locations of surface-water monitoring sites are such that impacts of IHSSs associated with other OUs may affect noted characteristics as documented by water-quality and sediment-chemistry data at these sites.

Surface Water

Gross-alpha and gross-beta data were used in this assessment as indicators of radionuclides. Based upon EG&G (EG&G 1990k; Table 3.7), the reported ARARs and CDH-WQCC stream standards for total gross-alpha and total gross-beta concentrations are 7 pCi/L and 5 pCi/L, respectively. However, it was noted that these stream standards apply only to Woman Creek; the comparable stream standards for Walnut Creek are 11 pCi/L and 9 Pci/L for total gross-alpha and total gross-beta concentrations, respectively (ASI, 1991e). In comparison, the reported

background limits for these two indicator radionuclides in surface water are 177 and 163 (rounded) Pci/L for total gross-alpha and total gross-beta concentrations, respectively (EG&G, 1990d, Table 3.7). Data is also available for the following radioisotopes -- americium-241; cesium-137; plutonium-239/240; radium-226; radium-228; strontium-89/90; tritium; uranium-233/234; uranium-235; and uranium-238 -- at a reduced measurement frequency (EG&G, 1992c). No statistical analyses of the available specific radioisotopic data were included in this assessment.

For comparison, the observed indicator-radionuclide data (gross-alpha and gross-beta) for 9 of the 10 surface-water sites are summarized in Table 2.22. For the North Walnut Creek basin, site SW118 (and SED118, see below) is located on North Walnut Creek generally upstream from OU13-related effects as reflected by conditions monitored by site SW018, and site SW93 is located downstream from OU13 on North Walnut Creek as well as other areas potentially contributing to radionuclide sources. Gross-alpha and gross-beta concentrations at upstream site SW118 provide a characterization of pre-OU13 impacted flows: average dissolved concentrations of 2.66 and 4.75 pCi/L, respectively (for gross-alpha and gross-beta), and average total concentrations of 32.41 and 39.02 Pci/L, respectively. In contrast, the dissolved gross-alpha and gross-beta concentrations at downstream site SW093 are 4.70 and 5.07 Pci/L, reflecting the contributing intervening OU13-related flows characterized by site SW018 (4.81 and 8.95 Pci/L, respectively). The number of data values in the RFEDS retrieval (EG&G, 1992c) for dissolved concentrations was quite limited (two samples), and no samples at this site had reported values for total concentrations. At any rate, average total indicator-radionuclide concentrations at the downstream site SW093 were about 2/3 of those average values reported upstream (19.29 and 23.96 pCi/L) for gross-alpha and gross-beta, respectively.

For the lower South Walnut Creek basin (sites SW019, SW020, and SW022) and upper South Walnut Creek (site SW023), the available RFEDS data (EG&G, 1992b) provide ambient characterization of the central and eastern parts of OU13 (Figure 2-24). For the western part of this subarea, limited data at sites SW019 and SW020 (1 sample each) provide a preliminary

depiction of conditions (in terms of dissolved concentrations): 1.40 and 1.57 pCi/L for gross alpha, and 6.65 and 6.32 pCi/L for gross beta, respectively. At site SW022 downstream, average dissolved gross-alpha concentrations increase about seven-fold, and dissolved gross-beta concentrations double compared to conditions upstream sites SW019 and SW020 (with limited data), at 10.59 pCi/L and 14.42 pCi/L, respectively. Upstream data for the Central Avenue drainage ditch on total concentrations were not available (EG&G, 1992c); however, average total gross-alpha and gross-beta concentrations at site SW022 were 16.41 and 27.33 pCi/L, respectively, which is about the same levels that were noted for site SW092 on North Walnut Creek. Much of this average increase in indicator-radionuclide concentrations at site SW022 may be influenced in large part by runoff flows into the Central Avenue drainage ditch from the 903 and 904 Pad areas (Rockwell, 1989d). Flows at site SW023 are affected by flows from site SW022 at times when the Central Avenue drainage ditch is diverted northward into South Walnut Creek (Figure 2-24). Average concentrations at this site are as follows, based upon the RFEDS data (EG&G, 1992c): dissolved gross-alpha and gross-beta concentrations, 5.41 and 5.70 Pci/L, respectively; total gross-alpha and gross-beta concentrations, 8.86 and 18.80 Pci/L (Table 2.22).

Regarding trace metals (including major cations and silicon), analyses were made relatively frequently for up to 24 trace metals, the four major cations (calcium, magnesium, potassium, and sodium), and relatively infrequently for silicon. The resultant site-sample coverage is summarized in Table 2.23, based upon the RFEDS retrieval (EG&G, 1992c). Analyses for a total of 89 samples at nine surface-water sites were available for this assessment. The number of samples for a given site varied considerably, ranging from one sample each at sites SW019 and SW020 up to 22 and 23 samples at sites SW022 and SW093, respectively. For several samples, either only dissolved or total trace-metal concentrations were analyzed; however, for most of the samples, analyses were completed for both dissolved and total concentrations. The ARARs or associated CDH-WQCC stream standards for the trace metals were used for comparison (EG&G, 1990k; Table 3.7). Whenever appropriate, comparable EPA drinking-water standards were considered (ASI, 1991e). Results of these comparisons follow.

Regarding priority pollutants (semivolatile/volatile compounds), applicable ARARs and CDH-SWCC standards for only selected chemicals in this category of constituents are reported (EG&G, 1990k; Table 3.7). A total of 20 detectible concentrations were noted in the RFEDS retrieval (EG&G, 1992c), as indicated in Table 2.24. Fifteen of these 21 detectible concentrations involved methylene chloride, with surface-water concentrations ranging between 5 and 130 ug/L and found at six of the nine sites. The possibility of laboratory contamination exists since methylene chloride and acetone was also found in the laboratory blanks. Chemical constituents found in detectible concentrations to a lesser extent were carbon tetrachloride (one sample at site SW018), chloromethane (same sample), acetone (one sample each at sites SW023 and SW118), and tetrachloroethene (one sample at site SW093).

Regarding the category of pesticides, major anions, and other miscellaneous chemical constituents, a total of 17 surface-water samples at nine monitoring sites were each analyzed for a suite of 27 pesticide compounds. In all cases, no detectible concentrations were found (EG&G, 1992c). The associated ARARs and CDH-WQCC standards for some of these constituents are found in EG&G (EG&G, 1990k; Table 3.7), however, no background limits were specified. In the case of data on major anions or other miscellaneous constituents (such as percent moisture, pH, selected nutrient species, dissolved solids, and suspended solids associated with surface waters), no evaluation was made of values in the RFEDS retrievals because these constituents were not particularly useful in discerning sources or extent of contaminants relative to the other variables discussed above.

Sediments

Gross-alpha and gross-beta data were used as indicators of radionuclides in sediments, as was the case discussed above for surface-water characterizations. Based upon EG&G (EG&G, 1990k; Table 3.7), no ARARs or CDH-WQCC stream standards are applicable for gross-alpha or gross-beta concentrations analyzed on stream sediments. However, the reported background limits for these two indicator radionuclides in surface water are 57.75 and 51.76 (rounded) pCi/L for gross-

alpha concentrations and gross-beta concentrations, respectively (EG&G, 1990k; Table 3.7). For comparison, the observed indicator-radionuclide data for the one sediment-chemistry site SED118 are summarized in Table 2.24. Average (based upon three samples) concentrations for dissolved gross-alpha and gross-beta concentrations were 7.62 and 24.81 pCi/L, respectively. Data also are available at a quite limited measurement frequency for the following radioisotopes -- americium-241, cesium-137, plutonium-239,240, radium-226, radium-228, strontium-89,90, tritium, uranium-233,234, uranium-235, and uranium-238. These averages are considerably below the reported background limits indicated above.

Analyses were made relatively frequently for up to 24 trace metals (including major cations and silicon), the four major cations (calcium, magnesium, potassium, and sodium), and relatively infrequently for silicon at the single sampling site SED118. The resultant statistical summary is given in Table 2.25, based upon the RFEDS retrieval (EG&G, 1992c). Analyses for five samples were available for this assessment. Only total trace-metal concentrations were analyzed on these sediment samples. The ARARs or associated CDH-WQCC stream standards for the trace metals were used for comparison (EG&G, 1990k; Table 3.7). Whenever appropriate, comparable EPA drinking-water standards were considered (ASI, 1991e). Results of these comparisons follow.

Five detectible concentrations of priority pollutants (semi-volatile/volatile compounds) were noted in the RFEDS retrieval (EG&G, 1992c) for the single sediment-survey site (SED118) located on North Walnut Creek, as indicated in Table 2.23. For this set of constituents, ARARs and CDH-WQCC standards are not applicable in the case of sediment chemistry; however, no background limits for selected priority pollutants were given in EG&G (EG&G, 1991d; Table 3.7). Three of these five detectible concentrations found in the RFEDS retrieval (EG&G, 1992c) involved methylene chloride with surface-water concentrations ranging between 10 and 110 ug/kg. Chemical constituents found in detectible concentrations to a lesser extent were 2-butanone (one sample) and acetone (one sample).

Regarding the category of pesticides, major anions, and other miscellaneous chemical constituents, a total of five sediment-chemistry samples at single monitoring sites were each analyzed for a suite of 27 pesticide compounds. In all cases, no detectible concentrations were found (EG&G, 1992b). No ARARs and CDH-WQCC standards for constituents are applicable in the case of sediments (EG&G, 1990k; Table 3.7) and no background limits were specified. In the case of data on major anions or other miscellaneous constituents (such as percent moisture, pH, selected nutrient species, dissolved solids, and suspended solids associated with sediments), no evaluation was made of values in the RFEDS retrievals, because these constituents were not particularly useful in discerning sources or extent of contaminants relative to the other variables discussed above.

2.2.15.4 Conclusions

Selective aspects of continuing surface-water (and interactive ground-water; see Section 2.3.16) monitoring programs at the RFP will aid further in the characterization as well as assessment of identified areas of concern regarding existing or potential contamination in the OU13 area. Subsequent data analyses should be more detailed and focus on selected chemical-constituent and ancillary hydrologic data identified with past activities in this OU. Such causes and possible sources have been documented in large part by delineation and descriptions of the several IHSSs in this OU (Appendix A), with the qualification of possible impacts of IHSSs and conditions in other OUs that are unrelated to OU13 impacts.

2.2.16 Summary of Air Impacts and Data Requirements

Air pathway concerns associated with OU13 include volatile organic compounds, radioactive materials, and other inorganics in the form of vapors, aerosols, and contaminated particulate material. Lateral migration of these materials into surrounding soils and beneath the area of release may have resulted in additional areas of secondary contamination. Migration through soil, groundwater, and by windblown dust can serve as an effective conduit for dispersal of

contaminants and sustain long-term, area-wide volatile and particulate emission sources. Volatile emissions are likely from those IHSS sites containing organic solvents or petroleum wastes, particularly if they exist in a liquid phase. Fine-grained geologic materials especially those particles possessing an aerodynamic diameter of 40μ or less and are subject to mechanical disturbance or strong surface winds offer the strongest potential for furnishing contaminated airborne particulates.

All contaminated soils and liquids, whether at the point of initial contamination or after migration has occurred, represent a potential source of fugitive (non-point source) air emissions. This may occur by means of molecular diffusion into the air-soil matrix and subsequent expulsion to the atmosphere, by diffusion directly to the atmosphere, or by adherence onto mobile-geologic or aqueous material. The rate of contaminant transfer to the air is site-dependent, contingent upon the size, and concentration of the contaminant, the chemical and physical properties of the spilled material, the adhesion characteristics of non-mobile matrices, and existing meteorological conditions. Emissions may occur continuously or episodically over a broad area. Sometimes the emitting surface becomes depleted of contaminant and acts as an inhibitor to further emissions. Disturbance of such barrier surfaces may enhance the rate of contaminant transfer to the air.

Particles contaminated with sorbed organics and possibly radionuclides or metals are the OU13 contaminant fractions most likely to be measurably encountered in the air. However, because of the low level of contamination associated with individual OU13 IHSS sites the amount of contaminant-laden airborne particulates attributable to OU13 Work Plan implementation is anticipated to be very small. Organic vapors may be detected during performance of site invasive procedures such as soil gas surveys, drilling and installing boreholes, or in the headspace of site boreholes. Similarly, extracted samples of site soils and waters may contain various concentrations of contaminants potentially capable of being mobilized to air. However, the quantity of volatile materials expected to be emitted to air at OU13 IHSS sites during Work Plan implementation is expected to be relatively insignificant. No offsite impacts attributable to the air pathway are anticipated as a result of OU13 Work Plan implementation.

Nonradioactive ambient air monitoring at the RFP provides baseline information on particulate levels. The RFP monitors ambient air with both Total Suspended Particulates (TSP) and Particulate Matter 10 microns or less in diameter (PM-10) samplers. In 1988, CDH requested concurrent TSP sampling until State regulations are changed to reflect PM-10 changes in Federal regulations. The site where TSP and PM-10 are measured is located near the east entrance to the RFP. This location is unobscured by structures, near a traffic zone, and generally downwind from the RFP buildings. Samplers are operated on a schedule of one day per every sixth day.

Ambient radiological air samplers are located in the RFP site operations area, at the RFP perimeter [at distances of approximately 3 to 6 kilometers (2 to 4 miles) from the plant's center], and in surrounding communities. These RFP-designed air samplers operate continuously at a volumetric flow rate of approximately 12 l/s (25 ft³/min), collecting air particulates on 20-x 25-cm (8- x 10-in.) fiberglass media. Manufacturer's test specifications rate this filter media to be 99.97 percent efficient for the relevant particle sizes under conditions typically encountered in routine ambient air sampling (Schleicher and Schuell, 1982). Airborne particulates in ambient air have been sampled continuously at 25 locations within and adjacent to the RFP operations area (Figure 2-25). However, two samplers (5-12 and 5-15 are temporarily inactive.) The sample filters are collected biweekly from all RFP samplers.

2.2.16.1 Air Quality Data Analysis

Insufficient data is available to support a summary of air quality impacts specific to OU13. However, considerable data is available for the RFP.

Radiological Data

During 1988, four samples exceeded the TLL- α screening level and were analyzed for plutonium. The mean concentrations of plutonium in ambient air at the five onsite stations during 1988 ranged from 0.149×10^{-15} to 0.710×10^{-15} $\mu\text{Ci/ml}$ (5.51×10^6 to $2.63 \times 10^5 \text{Bq/m}^3$). These

concentrations are less than 4 percent of the offsite Derived Concentration Guide (DCG) for plutonium in air. Radioactive ambient air samplers monitor airborne dispersion of radioactive materials from the RFP into the surrounding environment. Samplers are designated in three categories by their proximity to the main facilities area. Twenty-five onsite samplers are located within the RFP, concentrated near the main facilities area. Fourteen perimeter samplers border the RFP along major highways on the north (Highway 128), east (Indiana Street), south (Highway 72), and west (Highway 93) (Figure 2-25). Fourteen community samplers are located in metropolitan areas adjacent to the RFP (Figure 2-26).

Filters were collected biweekly from all the RFP samplers and analyzed for plutonium. Each biweekly filter from the onsite samplers was analyzed separately each month except in December. Filters collected in December were composited by location into one onsite sample. Filters from perimeter and community samplers are collected biweekly, composited by location, and analyzed monthly for plutonium.

Overall mean plutonium concentration for onsite samplers was $0.072 \times 10^{-15} \mu\text{Ci/ml}$ ($2.7 \times 10^{-6} \text{ Bq/m}^3$), 0.36 percent of the offsite DCG for plutonium in air. Overall mean plutonium concentration for perimeter samplers was $0.003 \times 10^{-15} \mu\text{Ci/ml}$ ($1.1 \times 10^{-7} \text{ Bq/m}^3$). Overall mean plutonium concentration for community samplers was $0.001 \times 10^{-15} \mu\text{Ci/ml}$ ($3.7 \times 10^{-8} \text{ Bq/m}^3$). These values are 0.013 percent and 0.005 percent, respectively, of the offsite Derived Concentration Guide (EG&G 1991i).

None of the air samplers in or adjacent to OU13 have shown high TLL- α activities. However, one recently deactivated sampling station, S-15, did exhibit elevated plutonium levels for TLL- α levels in 1988. Station 15 was located to the west of the operable unit and showed an increase in 1988 activity of less than four percent of the offsite Derived Concentration Guide for plutonium in air. For 1990, Table 2.26 describes on-site ambient air plutonium concentrations.

Nonradiological Data

The highest TSP value recorded in 1990 (24-hour sample) was 134 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) (51 percent of the former TSP 24-hour primary standard), and the annual geometric mean value was $31.4 \mu\text{g}/\text{m}^3$ (12 percent of former TSP primary annual geometric mean standard). The observed 24-hour maximum for the PM-10 sampler was $26 \mu\text{g}/\text{m}^3$ (17 percent of the primary 24-hour standard) and the annual arithmetic mean was $9.8 \mu\text{g}/\text{m}^3$ (20 percent of the primary annual arithmetic mean standard).

2.2.16.2 Use of Existing Data

The air quality and meteorological monitoring programs at the RFP have routinely monitored for meteorological parameters, total suspended particulates, and ambient air concentrations of radionuclides on particulates. These data sets combine to provide a record of the radionuclide concentrations and trends, the mode of radionuclide transportation, and a measure of the containment of the source, although no central report has integrated the data from the past 10 years.

Characterization of ambient air quality at OU13 will require compiling relevant existing data and collecting additional data to fill the gaps identified in Section 3.1. The relevant existing data consists of meteorological data collected from the monitoring station at the RFP. Parameters of interest include wind speed, wind direction, sigma theta, temperature, relative humidity, and precipitation. Hourly averages of these data may be required for performance of refined air quality impact analysis. Daily summaries of the other parameters may be required and ; maintained in a form amenable for use in dispersion modeling codes. A continual review of existing data that pertains to the air quality assessment of OU13 should be conducted as part of the Work Plan. These data may include ambient air contaminant concentrations from previous modeling or monitoring programs.

2.2.16.3 Description of Additional Data Required

General

Monitoring ambient concentrations in air requires appropriate sampling and analysis methodologies for each contaminant. The sampling and analysis methods should be selected according to established EPA guidelines (EPA, 1988a). Each monitoring station should sample daily for all "Monitored Contaminants and Analysis" (see Section 3.3.3). A frequency should be defined in the Field Sampling and Analysis Plan (FSAP) to account for natural variability.

Soil gas surveys are planned for select IHSS sites believed to contain VOCs. This data can: (1) identify areas of higher than average soil gas contaminant content and their movements, (2) serve as model inputs (source terms) to estimate ambient air concentration under changing meteorological conditions, and (3) estimate uncontrolled emissions levels during invasive site operations. This information may be coupled with indirect monitoring data collected in accordance with the Site-Specific Health and Safety Plan to help understand the potential impacts attributable to individual IHSS sites.

Monitoring Stations

Construction and analysis of isopleth maps of ambient concentrations require a network of stations on and around the site. There are six ambient air monitoring stations of interest to this investigation. The monitors are located within the perimeter of OU13 (S-2 and S-17) and outside the perimeter (S-12, S-13, S-14, S-16). S-16 is located to the northwest, S-14 is located to the west, S-13 is due south, S-12 (which is currently inactive) is located to the southeast, S-17 is due east, and S-2 is located northeast of OU13. With the exception of S-12, which will remain inactive for two years, these six samplers encircle the OU and provide a representative airborne particulate sample both upwind and downwind (according to prevailing area wind patterns). These samplers also provide data from directions not normally associated with the prevailing wind pattern. This may require reactivation of the S-12 monitoring site. If a need is identified

for additional stations to characterize air quality impacts, the stations should be selected on the basis of the dominant wind patterns at the site, discussed in Section 1.0. Since the plumes from the site will be directed by the wind, locating monitors downwind will allow sampling of the plumes. The primary wind direction is northwesterly. Additional onsite stations should be distributed to take maximum advantage of these dominant wind directions. Two stations are positioned to monitor concentrations when the winds are not from the primary direction.

Monitored Contaminants and Analysis

The recommended air monitoring program should monitor all contaminants detected in the geologic and hydrologic surveys. High-volume samplers are proposed for this application because they provide a high particulate loading on the filters. Heavily-loaded filters provide greater contaminate concentrations per unit filter area and therefore, greater detectability than lightly-loaded filters. Filters in the low-volume total suspended particulate samplers are often so lightly loaded that collected radionuclides exists at concentrations which fall below detection limits. Since high-volume samplers sample almost twice as large a volume of air in 24 hours (2448 m³), they should collect commensurately more contaminant mass and better detectability than the low-volume filters. Additionally, EPA guidelines specify that total suspended particulates should be sampled with a high-volume sampler (EPA, 1985) for analysis of inorganic compounds.

Sampling Schedule

If additional air monitoring stations are required, they should operate over a one year period. A full year of data is necessary to ensure that the data are collected during all conditions that occur at the RFP. A full year of data will allow accurate estimation of the maximum and mean on-site concentrations that workers are exposed to and quantification of the flux of contaminants off the site.

2.2.17 Previous Investigations in the OU13 Area

Due to its location near the center of the RFP, OU13 is adjacent to, or overlaid by several other OUs, including OU2, OU6, OU8, OU9, OU10, OU12, OU14, OU15, and OU16. Three of these OUs are either currently undergoing studies or have had current studies completed that are likely to provide data supporting the determination of the nature and extent of contamination at OU13. These OUs are OU2 (903 Pad, Mound and East Trenches), OU8 (700 Area) and OU10 (Other Outside Closures). The RFI/RI Phase II Work Plan for OU2 was conditionally approved by the regulatory agencies.

In addition, several previous investigations and studies have been undertaken at OU13 in response to spills related to the IHSSs. These investigations and studies include the following:

- Environmental Release Report - Building 123 Process Waste Line Break; Sanchini, D.J., May 1989;
- Issue Statement: Update on Valve Vault No. 17 Flooding Incident Investigation; Twining, B.G., April 1989;
- Building 123 Contamination Investigation; Freehling, M.J., May 1989;
- RCRA Report - Acid Release, Goldber, E.S., June 1989;
- Valve Vault 17 Incident; Browdy, S.L., June 1989;
- Report of Investigation of Acid Leak, Building 443, September 11, 1970; Williams, A.K., E.M. Bellagamba, C.R. Rose, C.W. Ellis, C.R. Heiple, September 1970;
- No. 6 Diesel Oil Spill UE 89-152, Ortiz, J.M., February 1989;
- CEARP, Phase I Effluent Pipe, 700 Area, Unknown, April 1986; and
- Steam Plant Fuel Oil Tanks Background/Chronology/Action Plan, Setlock, G.H., March 1986.

2.3 SUMMARY OF IHSS CONCEPTUAL MODELS

Using the known site physical conditions and potential contamination sources described in the preceding sections, a conceptual model of exposure pathways is developed here for two IHSS groups in OU13. The conceptual models have been developed for use in the evaluation of potential risks of OU13 contamination to human health and the environment. The IHSSs were organized into the two logical groups to simplify the conceptual models. The IHSSs are categorized based source type and release mechanism.

The two groups are as follows:

- | | |
|----------|---|
| Group I | Releases Originating Above Ground and Affecting Surficial Materials |
| Group II | Releases Originating and Affecting Transport Media Below Ground Surface |

The primary purpose of a conceptual model is to aid in identifying exposure pathways by which human and biotic receptors may be exposed to contaminants. 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 Figure 2-27 an exposure pathway must include a contaminant source, a release mechanism, a transport medium, an exposure route, and a receptor. An exposure pathway is not complete without each of these five components. The individual components of the exposure pathway are defined as follows:

- **Contaminant Source:** For purposes of the OU13 conceptual models, the contaminant source is divided into primary sources (IHSSs) and secondary sources (media that have potentially been affected by these releases). Secondary sources will be focused on since they may currently contain contaminants that can still be released to the environment.
- **Release Mechanism:** Release mechanisms are physical and/or chemical processes by which contaminants are released from the source. The conceptual model

identifies mechanisms that released contaminants directly from the primary sources (i.e., leaks, spills, overflows, etc.), and mechanisms that may release contaminants from the secondary contaminant sources.

- **Transport Media:** Transport media are the environmental media into which contaminants are released from the source and are in turn released to a receptor. Potential transport media for OU13 include air, surface water, groundwater, and biota.
- **Exposure Route:** Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor. Exposure routes for receptors at OU13 are inhalation, ingestion, and dermal contact.
- **Receptor:** Receptors are human or environmental populations that are affected by the contamination released from a site. Human receptors for OU13 include the RFP workers and visitors, and offsite residents. Environmental receptors are biota (both flora and fauna) indigenous to the OU13 environs.

2.3.1 OU13 GENERALIZED CONCEPTUAL MODEL

Diagrams of the conceptual models for potential secondary contaminant sources, transport media, exposure routes, and receptors relating to the OU13 IHSSs are presented in Figures 2-28 and 2-29. The various aspects of the conceptual model are explained in the following sections.

2.3.1.1 Contaminant Sources

The 15 IHSSs that constitute OU13 are located to the south and west of the Protected Area of the RFP, in the general area of the 100 series buildings.

Primary contamination sources within the various IHSSs include above-ground and underground tanks, underground pipelines, storage areas, and solvent/metal destruction sites. Contaminants from these sources may have been introduced into the environment through spills on the ground surface, underground leakage and infiltration, explosion and/or fire, and in some cases through incident precipitation run-on and run-off. Contamination may still be entering the environment

from some of the sources; in other areas, the sources may be exhausted or may have been physically mitigated through remediation at the time of the initial release.

Exclusive of volatilization to the atmosphere, the contaminants first enter the environment through the soil, and are transported by various mechanisms from affected soil to unaffected media. Groundwater is another medium that once affected, could spread contaminants to unaffected media. Therefore, for conceptual purposes, contaminated soils and groundwater are considered secondary contaminant sources in both Groups. These secondary sources will receive the most attention during Phase I RI/RFI activities since it is a probable current source. Contaminants from secondary sources could be spread to other media through secondary release mechanisms including disturbance of soil dust, volatilization and resettling of dust, surface water runoff, infiltration/percolation of water, bioconcentration/accumulation, and physical tracking.

The chemical composition of the contaminants varies widely between the IHSSs, ranging from low-level mixed wastes to nonradioactive organic and inorganic compounds.

Most IHSSs in OU13 overlie or are immediately adjacent to other nearby IHSSs. Thus, it may not always be possible to differentiate between contamination from specific IHSSs. Therefore, the precise extent of contamination from a given IHSS, may be difficult or impossible to determine.

2.3.1.2. Potential Transport Mechanisms and Receptors

As mentioned above, potential transport mechanisms in OU13 include air, surface water, groundwater, and biota. Air pathways will be addressed by surface soil and soil gas characterization. The surface water pathway will be addressed by surface water sampling. The groundwater pathway will be addressed by subsurface soil and water sampling and hydrostratigraphic unit examination through the use of soil and bedrock boreholes and

groundwater wells. Individual IHSS potential contaminant pathways may commingle with pathways from other IHSSs.

Potential contaminant receptors may include the RFP workers and visitors, off-site residents, and terrestrial and aquatic biota. These receptors could be exposed to OU13 contaminants through ingestion, inhalation, or dermal contact (Figures 2-28 and 2-29).

Air

Potential movement of contaminants by wind is possible wherever contaminated soils exist. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity. Dust-borne contaminants mobilized by wind have been documented in some areas of the RFP.

Some releases involving constituents such as volatile organic compounds (VOCs), while impacting air quality for a time near the release, typically do not spread contamination to secondary media through the air transport mechanism. However, organic vapors emanating from soils in the vadose zone can serve as an indicator of subsurface releases and potential soil contamination. The movement of organic vapors through soil is controlled by the specific properties of the contaminant and the soil as well as other physical parameters and physical characteristics of the soil.

Surface Water

Surface soils and sediments may have been affected by releases that originated at the ground surface or releases that have surfaced from underground leaks. Precipitation runoff across these areas could then move the contamination into nearby drainages or surface impoundments. A system of collection ditches and ponds control runoff at the RFP. Some of these ditches and ponds are under investigation as separate IHSSs and sometimes separate OUs.

It is possible that surface water may also be indirectly affected by contaminated groundwater discharging to surface water bodies such as ditches, ponds, and creeks from natural seeps.

Groundwater

Groundwater recharge from incident precipitation may occur through uncovered ground surfaces within the RFP. It is anticipated that mobile constituents of contamination in uncovered areas may eventually migrate into the vadose zone, or eventually to the groundwater system. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP. Contaminants underlying these sources can be expected to reach the water table more quickly. Soils overlain by pavement and buildings, on the other hand, may be subject to little or no downward percolation of water, and contaminants in such soils may remain relatively immobile.

In the vadose (unsaturated) zone, free liquids are expected to move generally downward to the water table, which varies in the OU13 area from a few to more than 10 feet depending upon location and time of year. If, however, the leakage or release rate exceeds the infiltration capacity of the soil, or if the surface is covered with an impermeable material (i.e., asphalt), then the liquid may pool or flow across the material surface to a more permeable material where infiltration can occur. In an instance where the release is from a pressurized source (i.e., pressurized pipeline), or the rate of leakage from an underground release exceeds the soil's infiltration capacity, the release may rise to the surface. This has occurred during a number of historical pipeline and valve vault leaks at the RFP. Liquids infiltrating the soil may also encounter a less permeable layer (low-flow boundary) and flow laterally through the more permeable soil along the boundary. At the RFP, such permeability contrasts are likely at the alluvium/bedrock contact.

Most of the RFP pipelines are believed to be bedded either in sand or in native soil backfill. Hydraulic conductivity in clean sand ranges from approximately 10^{-3} to 1 cm/sec. The hydraulic

conductivity in the Rocky Flats Alluvium, the deposit in which the majority of the RFP pipelines are located, ranges from approximately 1×10^{-2} to 7×10^{-5} cm/sec. The Valley Fill Alluvium, another common deposit at the RFP, has a hydraulic conductivity that ranges from 3×10^{-3} to 5×10^{-6} cm/sec (EG&G, 1991c). The hydraulic conductivity of unconsolidated deposits such as the Rocky Flats Alluvium is expected to increase when the deposit is disturbed (i.e., excavated and replaced as backfill material) due to increased porosity in the disturbed material.

It is therefore considered likely that most pipeline releases initially flowed preferentially through the trench materials and permeated the surrounding native soils to a much lesser extent than the trench materials. Over time, the released materials may gradually have infiltrated surrounding native soil, particularly the soil beneath the trench. Thus, contaminant plumes from pipeline releases are expected to be strongly aligned along pipeline trenches, and perhaps to extend below the trenches into underlying soils. Groundwater that may periodically or perennially saturate pipe trenches can also be expected to flow preferentially through the trench materials. Any resulting spread of contamination should remain strongly oriented along the trench.

Contaminant plumes resulting from slow, gradual pipeline leaks may be less prevalent along pipeline trenches than those from releases with higher flow rates. It is probable that many leaks occurred from the pipelines that were never detected due to low flow rate. It is also possible that some major releases were preceded at the same location by a longer period of slow leakage as the pipeline gradually failed. However, it is still considered likely that the relatively much higher hydraulic conductivity of the trench materials will control the orientation of contaminant plumes from gradual pipeline leaks, albeit to a lesser degree than those from more sudden releases.

Tank releases are most likely to occur at tank openings (i.e., overflows), tank/pipe connections, the base of the tank where residual waste collects, where underground tanks may be in contact with groundwater, at cold joints along the walls of concrete tanks, and at structural beams that could be affected by differential settlement of the tank bedding or supports.

Releases from such locations would likely affect the environment immediately surrounding the tank, particularly where the release is from an underground tank bedded in backfill. Based on these conceptual tank release locations, contamination will most likely exist beneath or near external connections and openings, near joints or corners around underground tanks, and beneath the base of the tank.

2.3.2 GROUP-SPECIFIC CONCEPTUAL MODELS

This Section presents a general summary of the OU13 characteristics by group followed by descriptions of group-specific contaminant sources, release mechanisms, transport media, exposure routes, and receptors. Section 2.6.2 is summarized in Figures 2-28 and 2-29. Descriptions of the backgrounds and physical settings of the IHSSs making up these groups were presented in Section 2.1. Section 2.2 presented detailed information on the nature and extent of contamination specific to each IHSS.

2.3.2.1 Group I: Releases Originating Above Ground and Affecting Surficial Materials

The IHSSs associated with Group I include the North Chemical Storage Site (117.1), the Middle Chemical Storage Site (117.2), the South Chemical Storage Site (117.3), the Oil Burn Pit 1 (128), the Lithium Metal Destruction Site (134), the Waste Spills (148), the Fuel Oil Tank (152), the North Area Radioactive Site (157.1), the Building 551 Radioactive Site (158), the Solvent Burning Ground (171), the Caustic Leak (190), and the Hydrogen Peroxide Leak (191). These IHSSs were grouped based on the location of the releases (primarily above ground) and the media affected (primarily surficial materials). Some IHSSs are included in both groups (IHSS 128 and IHSS 148) since releases associated with them may have affected media both at and below the ground surface. Figure 2-30 presents a schematic diagram of the conceptual model for Group I.

IHSS 117.1--Chemical Storage North Site

Presently this area is used for scrap metal storage and contractor trailer parking. A portion of the IHSS is located within the Protected Area. Included within its boundaries are a transformer, a valve vault, and two small buildings. The area is mostly paved, except for a small northeast-southwest trending strip. The primary contaminant sources at IHSS 117.1 are believed to have been contaminated scrap metal and building construction debris stored at the site at some point in its history. Transformers and automotive batteries may have also been stored and/or disposed of at the site.

The primary release mechanism associated with this IHSS has not been identified, though residues may have been leached from the scrap metal and construction debris.

IHSS 117.2--Chemical Storage Middle Site

This area, which is currently paved, is used for outside storage. A large tent containing unknown materials exists within its boundaries. The primary contaminant sources at IHSS 117.2 are aluminum scrap metal, drums that contained unknown substances, and a drum that contained aluminum nitrate. Additional contaminant sources relating to this IHSS include uranium chips and turnings in an aluminum scrap pile, drums that contained beryllium chips and turnings, and a 55-gallon drum that contained aluminum nitrate. In 1974, the site was noted as being a non-radioactive storage yard at which acids, oils, soaps and solvents were stored.

The primary release mechanisms associated with this IHSS include leaks, spills and probably leaching.

IHSS 117.3--Chemical Storage South Site

This site, at the corner of Central Avenue and Seventh Street is currently partially covered by Tank 224 which contains No. 6 fuel oil. This area is documented as having been used for storage of various unidentified materials from at least 1964 until 1970. The primary source at this IHSS is believed to have been a wooden waste box containing a glovebox, which in turn

contained a highly contaminated residual oil. Since the glovebox originated in Building 776, it is believed that the contaminant was plutonium. The composition of the oil is unknown.

The release mechanism associated with this incident is a leak. The glovebox leaked the highly contaminated residual oil during transport along Central Avenue and on the ground in the storage area where the box was placed.

IHSS 128--Oil Burn Pit No. 1

The primary contaminant source at IHSS 128 is the Oil Burn Pit No. 1. Approximately 200 gallons of radioactively contaminated waste oil was burned at this location. It is speculated that there was disposal activity taking place in the same location prior to the oil burn experiment and that garage personnel may have burned waste motor oil in the pit prior to the burning of contaminated oil. This activity took place in an area now covered by Sage Avenue and its associated drainage ditch.

The primary release mechanisms for IHSS 128 are direct application of contaminated oil to an unlined oil burn pit and volatilization to the atmosphere through ignition of the oil.

IHSS 134--Lithium Metal Destruction Site

The primary contaminant source for IHSS 134 is from the destruction of lithium and magnesium. Lithium scrap was disposed of in the area north of Building 331 and currently under Building 335 from 1956 through 1966. Lithium and oil were burned together in a drum until that drum was full of ash and non-combustible residue. Fire-fighting training methods may have caused some residue to be expelled from the drum onto the ground around the immediate area. Two lithium explosion incidents may have caused lithium metal to be sprayed around the area behind the building and on the roof.

Although this IHSS addresses lithium destruction, magnesium destruction occurred far more frequently than lithium destruction in the area. The magnesium was typically destroyed in the

area of the two small ponds that were believed to have been the Oil Burn Pit No. 1 described above. The magnesium was spread out on the ground in the area of the two ponds and ignited. The magnesium was sprinkled with water to accelerate the burning. After the reaction was complete, the residue was left in place on the ground. Magnesium disposal was done in quantities of one or two 30-gallon drums approximately once a month.

The primary release mechanism for IHSS 134 is volatilization to the atmosphere through ignition of the lithium and magnesium. This ignition occasionally led to violent reactions and explosions.

IHSS 148--Waste Spills

Several small spills of nitrate-bearing wastes are said to have occurred around the outside of Building 123. These wastes may have contained radionuclides. No evidence has been found to verify the occurrence of these spills. Therefore, the primary source at IHSS 148 is considered to be the PWL buried beneath Building 123. Another primary source associated with this site is evaporation of isopropyl ether.

The release mechanisms associated with IHSS 148 are leaks, spills, and volatilization. It has been reported that the PWL beneath Building 123, being constructed of a type of iron, probably leaked considerable amounts of waste without personnel being aware of the leak. Volatilization is a second release mechanism that has been reported at this IHSS. During the middle to late 1970s, isopropyl ether was placed onto sand to allow for its outdoor evaporation outside of Building 123.

IHSS 152--Fuel Oil Tank

The primary contaminant source at IHSS 152 is fuel oil Tank 221 located east Building 452. Tank 221 is a 800,000-gallon fuel oil storage tank that was originally constructed with a 140-foot by 140-foot earthen berm surrounding it. This tank contains fuel oil for the RFP's central steam plant when natural gas is not available.

The primary release mechanisms for IHSS 152 are leaks and spills from pipelines associated with Tank 221.

IHSS 157.1--Radioactive Site North Area

The primary contaminant source at IHSS 157.1 is considered to be the laundry building located at the corner of Fifth Street and Central Avenue. Before the building was converted to a filter test laboratory in approximately 1972, the building received contaminated clothing from Buildings 444 and 883 and non-contaminated clothing from other areas of the plant site. Building 444 handled depleted uranium and later beryllium. An incident in 1964 involved enriched uranium in clothing from Building 883 causing "some contamination" in Building 442. It is believed that Building 442 discharged its laundry effluent to the sanitary sewer, which then entered the waste water treatment plant (Building 995).

The release mechanism(s) associated with this IHSS have not been identified; however, it is speculated that leaks and/or spills may have contributed to the contamination.

IHSS 158--Radioactive Site Building 551

The primary contaminant source at IHSS 158 is considered to be waste boxes that were loaded into railroad container cars in this area, north of Building 551.

The release mechanism at this IHSS is speculated to be leakage of the waste boxes as they were being loaded into the railroad cars.

IHSS 171--Solvent Burning Ground

The primary contaminant source at IHSS 171 is considered to be residues from solvents used during fire-fighting training in and around Building 335. When this area was first used for training purposes, lithium residue in an oily sludge was burned (see also IHSSs 128 and 134).

The primary release mechanism for IHSS 171 is volatilization to the atmosphere through ignition of diesel, gasoline, lithium, magnesium, and possibly waste solvents.

IHSS 186--Valve Vault 12

The primary contaminant source at IHSS 186 is considered to be Valve Vault 12. Valve Vault 12 is part of the existing process waste system. It is located west of Building 552, east of a paved parking lot, south of the Protected Area, and north of the intersection of Sixth and Sage Streets. It contains pumps, transformers, breakers, switches, and a sump pump.

The release mechanism associated with this IHSS is leakage. Several leaks of process water have occurred in pipelines associated with Valve Vault 12.

IHSS 190--Caustic Leak

The primary contaminant source at IHSS 190 is the caustic storage tank located near the southeast corner of Building 443. The tank, located near the southeastern corner of Building 443, is an above-ground, steel, 3,000-gallon tank used for concentrated sodium hydroxide storage. The secondary containment of the tank is a 3,000-gallon holding basin.

The primary release mechanism for IHSS 190 is leakage from the caustic storage tank.

IHSS 191--Hydrogen Peroxide Spill

The primary contaminant source at IHSS 191 was a 55-gallon drum of hydrogen peroxide. During the week ending April 24, 1981, warehouse personnel were transporting three 55-gallon drums of hydrogen peroxide (H_2O_2) when two of the drums fell off of a pallet. One of the drums burst open and the hydrogen peroxide drained into a culvert at the corner of Fifth Street and Central Avenue.

The primary release mechanism for IHSS 191 was a spill.

Secondary Sources and Release Mechanisms

It is possible that soils were contaminated at all of the IHSSs in Group I as a result of past releases.

No evidence has been found indicating that soils were contaminated at IHSS 171.1. Such evidence would likely have been found during excavation for construction of the Protected Area. It is possible that past releases have resulted in residual soil and groundwater contamination, at IHSS 117.2. In an effort to remediate the release at IHSS 117.3, contaminated soil was removed. However, it is possible that residual contamination still exists.

In the vicinity of the IHSSs where fire-fighting activities took place (128, 134, and 171), soil may have been affected as a result of splashes and fallout deposition. It is believed that these destruction sites were abandoned in place. Some of the affected soils were probably covered with fill and paved over for Sage Avenue. Soils that were left in place and undisturbed should be considered a secondary source. Since the activities associated with IHSS 171 occurred near what was then a natural drainage, groundwater may have also been impacted.

Surface soils at IHSS 148 may have residual isopropyl ether or peroxides, however they may have been removed at the time of the installation of a transformer that is currently located at this spot.

While contaminated soil from one of the spills at IHSS 152 was removed, it is possible that soil contaminated with hydrocarbons remains in the area of the tanks, especially within the berm.

At IHSS 157.1, the incidents of depleted uranium contamination in the soil around Building 442 may have left residual uranium on the ground surface. Uranium may also have found its way to groundwater. Though groundwater may be contaminated beneath Building 442, the contamination may be the result of activities that occurred inside the building and not as a direct result of this IHSS's release.

Soil in the area of IHSS 158 has been impacted by construction events since the releases were believed to have occurred. If contaminated soil exists, it may be fairly deep.

It is improbable that there is residual soil impact from the incidents relating to IHSSs 190 and 191. Constituents related to the incident, such as sodium, aluminum, sulfur, hydrogen and oxygen, are all naturally occurring, and therefore the presence of these elements would not be indicative of the incident except by concentration.

It is possible that in addition to soils, sediments and groundwater have been affected at all of the IHSSs within this group. Therefore, soils, sediments, and groundwater should be considered as potential secondary sources.

Secondary release mechanisms associated with Group I's soil contamination are considered to be disturbance of soil resulting in volatilization and dispersion, then settling of fugitive dust; precipitation events resulting in sediment transport in ditches and streams, and infiltration; and movement of contaminated groundwater.

2.6.1.2 Transport Media, Exposure Routes, and Receptors

Transport Media

Historical accounts of the IHSSs associated with Group I indicate that the releases could potentially have impacted the transport media of air, surface water, groundwater, and biota through pathways illustrated in Figure 2-28.

Air

Air should be considered a transport mechanism for Group I due to the likelihood of soils having been affected, and their consideration as a secondary source. Potential movement of contaminants by wind is possible wherever the ground surface is affected. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar

activity. If the locations of the IHSSs have been covered with fill, the likelihood of airborne contamination from secondary sources decreases greatly.

Air transport of vapors emanating from volatile organic compound (VOC) spills, while impacting air quality for a time near the release, typically do not spread contamination to the unaffected media.

Surface Water

Surface soils and sediments have been affected by releases that originated above the ground surface in Group I IHSSs. Activities associated with some of the IHSSs appear to have occurred near what at the time was a natural water course. At IHSS 152, contamination is known to have moved into nearby drainages. Precipitation runoff across these areas could also move the contamination into the nearby drainages or surface impoundments. A system of collection ditches and ponds, some of which are under investigation as separate IHSSs or separate OU's, control runoff at the RFP.

Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces. All of the IHSSs associated with Group I probably occurred in and around uncovered ground surfaces. It is anticipated that mobile constituents of contamination in these uncovered areas may have leached down into the groundwater system prior to pavement of the area. Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no infiltration of water, contaminants in such soils may remain relatively immobile.

Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge at the RFP. Contaminants underlying these features can be expected to reach the water table more quickly.

Exposure Routes

Contaminants released from Group I IHSSs could potentially affect receptors through inhalation of airborne particles or vapors, and through ingestion of or dermal contact with contaminated source or transport media.

Receptors

Potential human receptors may include the RFP workers and visitors to the site, and offsite residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group I IHSS localities and their environs.

2.3.2.2 Group II: Releases Originating and Affecting Transport Media Below Ground Surface

The IHSSs associated with Group II include the Oil Burn Pit 1 (128), the Waste Spills (148) the Hydrogen Peroxide Spill (191), and Valve Vault 12 (186). These IHSSs were grouped together based on the releases originating primarily below ground surface. Figure 2-40 presents a schematic diagram of the conceptual model for Group II.

IHSS 128--Oil Burn Pit No. 1

The primary contaminant source at IHSS 128 is the Oil Burn Pit No. 1. Approximately 200 gallons of radioactively contaminated waste oil was burned at this location. It is speculated that there was disposal activity taking place in the same location prior to the oil burn experiment and that garage personnel may have burned waste motor oil in the pit prior to the burning of contaminated oil.

The primary release mechanisms for IHSS 128 are direct application of contaminated oil to an unlined oil burn pit and volatilization to the atmosphere through ignition of the oil.

IHSS 148--Waste Spills

The primary source at IHSS 148 is considered to be the process waste line (PWL) buried beneath Building 123. Another primary source associated with this site is evaporation of isopropyl ether.

The release mechanisms associated with IHSS 148 are leaks, spills, and volatilization. It has been reported that the PWL beneath Building 123, being constructed of a type of iron, probably leaked considerable amounts of waste without personnel being aware of the leak. Volatilization is a second release mechanism that has been reported at this IHSS. During the middle to late 1970s, isopropyl ether was placed onto sand to allow for its outdoor evaporation outside of Building 123.

Secondary Sources and Release Mechanisms

Subsurface soils have been contaminated as a result of past releases associated with the IHSSs in Group II. It is likely that groundwater has also been affected. Residual ash and residue were probably left in place at IHSS 128, affecting soils which were subsequently filled and paved over. At IHSS 148, it is possible, if not likely that releases from the PWL under Building 123 affected groundwater. It is not likely that residual hydrogen peroxide, remains in the soil due to natural dilution over time. It is probable that soil contamination still exists at IHSS 186 due to the large area which was initially impacted and the remaining radioactivity at the time of cleanup completion.

In light of this information, both soils and groundwater are considered potential secondary sources within this group.

Secondary release mechanisms associated with Group II's soil contamination are considered to be disturbance of soil resulting in volatilization and dispersion, then settling of fugitive dust; leaching of contaminants from the subsurface soils by percolating groundwater; and movement of contaminated groundwater.

Transport Media

Historical accounts of the IHSSs associated with Group II indicate that the releases could potentially have impacted the transport media of air, surface water, groundwater, and biota through pathways illustrated in Figure 2-29.

Air

Air should be considered as a transport mechanism for Group II due to the likelihood of soils having been affected and their consideration as a secondary source. Potential movement of contaminants by wind is possible wherever the ground surface is affected. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity.

Surface Water

Precipitation runoff across affected areas could move the contamination into nearby drainages or surface impoundments. A system of collection ditches and ponds, some of which are under investigation as separate IHSSs, and sometimes separate OUs, control runoff at the RFP.

Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces within some of the IHSSs associated with Group II. It is anticipated that mobile constituents of contamination in uncovered areas will eventually leach into the groundwater. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP, and contaminants underlying these features can be expected to reach the water table more quickly. Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no infiltration of water, contaminants in such soils may remain relatively immobile.

In addition to contaminant migration to the water table, it is possible that direct releases to groundwater have occurred at IHSSs that involve underground storage tanks. The water table at the RFP has been known to fluctuate several feet. During seasonal highs in the water table

fluctuation cycle, the water table could rise above the base of the tank, making direct contamination likely.

Exposure Routes

Contaminants released from Group II IHSSs could potentially affect receptors through inhalation of airborne particles or vapors and through ingestion of or dermal contact with contaminated source or transport media.

Receptors

Potential human receptors include the RFP workers and visitors, and offsite residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group II IHSS environs.

Table 2.1
List of Selected Wells and Boreholes at Operable Unit 13 Area
Rocky Flats Plant

Well No.	State North	State East	Surface Elevation	T.O.C. Elevation	TD	TD Elevation	Type Alluvium	Thick Qrf	El. Top Bedrock	Upper Bedrock	Low	High	Screened Interval	
											Water Level Below Surface	Water Level Below Surface		
1	P416989	748,780	2,081,034	6,045.20	NA	220.0	5,825.20	Qrf	30.0	6,015.20	Claystone	38.72	NR	151.2 - 155.6
2	P115189	749,641	2,081,236	6,034.00	No survey	42.3	5,991.70	Qrf	38.3	5,995.70	Claystone	NR	NR	31.3 - 35.7
3	P416289	748,578	2,081,555	6,038.60	6,040.22	43.0	5,995.60	0 - 2.7 Fill/Qrf	20.3	6,015.60	Silty Claystone	14.97	9.76	19.1 - 23.5
4	P114989	749,959	2,081,661	6,029.80	6,031.84	43.5	5,986.30	0 - 9.5 Fill/Qrf	28.0	5,992.30	Claystone	12.25	12.23	33.6 - 38
5	P119389	750,280	2,081,921	6,011.70	6,013.18	26.0	5,985.70	Qrf	16.4	5,995.30	Silty Claystone	4.98	4.35	12.5 - 16.9
6	P114889	749,926	2,082,127	6,016.60	6,018.26	18.0	5,998.60	0 - 3 Fill/Qrf	10.8	6,002.80	Sandy Claystone	5.87	4.18	9.9 - 14.2
7	P115489	749,507	2,082,135	6,023.40	6,025.10	31.0	5,992.40	0 - 6 Fill/Qrf	20.0	5,997.40	Claystone	11.76	7.2	22.1 - 26.4
8	4486	749,254	2,082,234	6,021.96	6,019.93	33.0	5,986.93	Qrf	25.0	5,994.93	Silty Claystone	11.70	7.9	3.2 - 26.2
9	P416789	748,206	2,082,382	6,027.80	6,029.27	30.0	5,997.80	0 - 2.5 Fill /Qrf	23.9	6,001.65	Claystone	26.17	21.88	22.5 - 26.9
10	P419689	748,522	2,082,513	6,022.40	6,023.42	33.0	5,989.40	0 - .4 Fill/Qrf	21.6	6,000.40	Sandstone	19.74	16.16	19.1 - 22
11	P114789	749,940	2,082,610	6,010.70	6,012.40	31.0	5,979.70	0 - 1.5 Fill/Qrf	24.5	5,984.70	Claystone	9.81	6.17	21.8 - 26.2
12	P418289	748,952	2,082,653	6,016.90	6,018.20	33.0	5,983.90	0 - 2 Fill/Qrf	21.0	5,993.90	Claystone	9.53	6.08	9.5 - 23.5
13	P115589	749,551	2,082,658	6,014.10	6,015.77	33.6	5,980.50	0 - 29 Fill	0.0	5,985.10	Claystone	8.33	2.88	25. - 29.5
14	P414189	749,059	2,082,986	6,010.60	6,012.18	28.0	5,982.60	0 - 4 Fill/Qrf	14.0	5,992.60	Claystone	8.84	4.09	14.1 - 18.5
15	P115689	749,532	2,083,019	6,006.90	6,008.71	23.5	5,983.40	0 - 3.5 Fill/Qrf	16	5,987.20	Claystone	12.40	5.80	16.2 - 20.2
16	P214689	749,943	2,083,044	6,004.00	6,005.76	26.0	5,978.00	0 - .7 Fill/Qrf	21	5,982.00	Silty Claystone	12.07	6.73	17.8 - 22.2
17	P313489	748,913	2,083,062	6,011.70	6,013.58	24.0	5,987.70	0 - .7 Fill/Qrf	20	5,991.10	Claystone	13.91	8.29	16.7 - 21.1
18	P215789	749,470	2,083,430	6,002.00	6,003.66	22.0	5,980.00	0 - 2.8 Fill/Qrf	15.2	5,984.00	Claystone	14.50	12.17	14.5 - 18.5
19	P214089	749,461	2,083,653	5,996.70	5,998.49	19.0	5,977.70	0 - 3.3 Fill/Qrf	6.0	5,987.40	Claystone	Dry	7.88	5.4 - 9.8
20	6186	749,198	2,083,717	5,999.47	6,000.76	18.5	5,980.81	Qrf	11.5	5,987.81	Silty Claystone	9.73	8.85	5.0 - 12.0
21	P213689	749,460	2,083,736	5,994.30	5,996.04	23.0	5,971.30	0 - 6 Fill/Qrf	7.0	5,981.30	Claystone	8.29	6.75	9.1 - 13.5
22	P218089	749,941	2,084,020	5,985.80	5,987.55	16.0	5,969.80	Qrf	6.0	5,979.80	Claystone	Dry	4.54	3.0 - 7.4
23	P317989	748,891	2,084,272	5,990.90	5,992.84	16.0	5,974.90	Qrf	6.4	5,984.50	Claystone	7.87	2.39	3.0 - 7.5

- Notes:
1. This tabulation lists 23 wells and boreholes beginning in the area west of OU13 and proceeding eastward.
 2. This tabulation does not include wells/boreholes in the eastern part of OU13.
 3. List current as of 31 July 1991.
 4. High water levels 07 June to 20 June 1991; low water levels 03 January to 04 January 1991.
 5. Source: EG&G Rocky Flats, 1991. Geological Characterization Report, Appendix A, 31 July 1991.

NR = Water level not reported or not observed.

TABLE 2.2: Lithology in Selected Wells and Boreholes Within and Surrounding Operable Unit 13

Well No.	Within OU13	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	Presence of No. 1 Sandstone	Fining Upward Sequences	Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	Comments
4486	YES	5,994.93	7.5		UNKNOWN	Silty Claystone	25.5	7.5+	Highly weathered, trace sand
6186	YES	5,987.81	7		UNKNOWN	Silty Claystone	11.5	7.0+	Trace sand, vfg to coarse
P313489	YES	5,991.10	5.4		UNKNOWN	Claystone	20.6	1.4	Trace silt
						No Sample	22.0	2.0	
						Claystone	24.0	2.0+	Trace silt, iron staining
P313589	NO		10	No. 1 SS		Silty Clayey Sandstone	12.0	2.0	Interbedded claystone, highly weathered, vfg to fg
						Silty Sandstone	14.0	4.8	Interbedded sandy claystone, iron staining
						Silty Claystone	18.8	3.2+	
P213689	NO	5,981.30	8			Claystone	13.0	2.0	Trace silt and vfg sand
						No Sample	15.0	2.0	
				No. 1 SS		Claystone	17.0	2.0	Mod weathered, some vfg sand
						Clayey Sandstone	19.0	1.0	Top of No. 1 Sandstone, vfg, well sorted
						Silty Sandstone	20.0	1.0+	Vfg to mg, well rounded, subangular
P314089	NO	5,987.40	9.7		UNKNOWN	Claystone	9.3	4.7	Trace to some silt
						No Sample	14.0	2.0	
						Claystone	16.0	3.0	
P414189	YES	5,992.60	10			Claystone	18.0	8.0	Trace silt
						Silty Claystone	26.0	2.0+	
P214689	YES	5,982.00	4		UNKNOWN	Silty Claystone	22.0	4.0+	Trace vfg sand, well sorted
P114789	YES	5,984.70	5		UNKNOWN	No Sample	26.0	1.0	
						Claystone	27.0	2.0	
						No Sample	29.0	1.0	
						Claystone	30	1.0+	
P114889	YES	6,002.80	4.2		UNKNOWN	Sandy Claystone	13.8	4.2+	Moderately weathered, fg sand
P114989	NO	5,992.30	6			Claystone	37.5	4.0	Moderately weathered, some silt
						Silty Claystone	41.5	2.0+	Trace sand
P115189	NO		4.0		UNKNOWN	Claystone	38.3	2.0	Mod weathered
						No Sample	40.3	0.7	
						Claystone	41.0	1.3+	Mod weathered
P115489	YES	5,997.40	5		UNKNOWN	Claystone	26.0	5.0+	
P115589	YES	5,985.10	4.6		UNKNOWN	Claystone	29.0	4.6+	Silty

TABLE 2.2: Lithology in Selected Wells and Boreholes Within and Surrounding Operable Unit 13

Well No.	Within OU13	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	Presence of No. 1 Sandstone	Fining Upward Sequences	Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	Comments
P115689	YES	5,987.20	3.8		UNKNOWN	Claystone	19.7	3.8+	Moderately Weathered
P215789	NO	5,984.00	4		UNKNOWN	Claystone	18.0	4.0+	Highly Weathered
P416289	NO	6,015.60	20.5	No. 1 SS	UNKNOWN	Silty Claystone	22.5	3.5	No. 1 Sandstone 1.5 below top of bedrock, interbedded clay Some carbonaceous, heavy hematite zones Vfg & Fg, angular to subangular, well sorted, hematite staining Some sand, some hematitic zones Vfg to cg sand, mod well sorted, subrounded to rounded Sandy interval, disseminated and nodular hematite
						Clayey Siltstone	26.0	1.0	
						Silty Claystone	27.0	4.0	
						Clayey Siltstone	31.0	4.0	
						Clayey Sandstone	33.0	5.0	
						Silty Claystone	38.0	2.0	
						Clayey Sandstone	40.0	0.3	
				UNKNOWN	Silty Claystone	40.3	2.7+		
P416789	NO		3.6		UNKNOWN	Claystone	26.4	3.6+	Trace sand, some silt increasing with depth, some iron staining
P416989	NO	6,015.20	190	No. 1 SS	UNKNOWN	Claystone	30.0	4.9	Very highly weathered Very highly weathered Very highly weathered, some sand Very highly weathered Highly weathered, interbedded ironstone, some mg to cg sand Sand content increasing with depth, intervals of sandstone Vfg, subangular to subrounded, mod sorting Vfg, subangular to subrounded, well sorting Vfg, subangular, mod sorting, v. friable No Sample Some vfg sand No Sample Some vfg sand Some silt, sand is vfg, mod friable Some silt, some carbonaceous material
						Clayey Sandstone	34.9	0.3	
						Silty Claystone	35.9	3.0	
						Silty Sandstone	38.2	1.0	
						Silty Claystone	39.2	6.0	
						Sandy Claystone	45.2	3.2	
						Clayey Sandstone	48.2	0.8	
						Sandy Claystone	49.2	1.8	
						Clayey Sandstone	51.0	2.6	
						No Sample	53.6	1.3	
						Silty Claystone	54.9	0.5	
						No Sample	55.4	4.1	
						Silty Claystone	59.5	2.0	
						Sandy Claystone	61.5	5.2	
Claystone	66.7	13.3							
						(REMAINING LOWER LITHOLOGIES NOT INCLUDED)			
P417889	NO		0.5		UNKNOWN	Claystone	21.5	0.5+	Trace carbonaceous material
P317989	NO	5,984.50	9.6		UNKNOWN	Claystone	6.4	9.6	Mod weathered, tr silt, cg to vfg sand, well sorted and rounded
P218089	NO	5,979.80	10			Claystone	6.0	4.0	Highly Weathered, trace vfg sand, trace silt

TABLE 2.2: Lithology in Selected Wells and Boreholes Within and Surrounding Operable Unit 13

Well No.	Within OU13	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	Presence of No. 1 Sandstone	Fining Upward Sequences	Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	Comments
				No. 1 SS		Silty Claystone	10.0	2.4	Some vfg sand
					UNKNOWN	Clayey Silty Sandstone	12.4	0.6	Vfg, well sorted, mod rounded
					UNKNOWN	Silty Claystone	13.0	1.0	
					UNKNOWN	Claystone	14.0	2.0+	
P418289	NO	5,993.90	10		UNKNOWN	Claystone	23.0	10+	Moderately Weathered, trace silt
P119289	NO		9.8			Claystone	4.2	3.8	Iron staining, trace silt
						Silty Claystone	8.0	6.0+	Iron staining, increasing silt content with depth
P119389	NO		9.6		UNKNOWN	Silty Claystone	16.4	1.6	Iron staining, trace carbonaceous material
						Claystone	18.0	2.0	Claystone and Silty Claystone, iron staining, trace carbonaceous
						Silty Claystone	20.0	2.0	Iron staining, trace carbonaceous
						Claystone	22.0	2.0	
						Silty Claystone	24.0	2.0+	Iron staining, trace carbonaceous
P419689	NO		11.0	No. 1 SS	UNKNOWN	Silty Sandstone	22.0	1.0	Mg to cg, mod sorted, rounded to sub-rounded
						Silty Claystone	23.0	6.4	Weathered, iron staining, decreasing silt content with depth
						Claystone	29.4	3.6+	

- Notes:
1. Presence of No. 1 Sandstone is based on the Geological Characterization Report, Appendix A (EG&G, 1991)
 2. Lithology is based well logs found in the Geological Characterization Report, (EG&G, 1991)

Table 2.3

Selected Piezometer and Groundwater Monitor Wells
Water Level Readings through March 5, 1992

<u>Well No.</u>	<u>Depth</u>	<u>Date</u>									
4486	5.80	10-Nov-86	4486	13.87	06-Dec-89	6186	9.10	28-Oct-87	6186	9.84	03-Oct-90
4486	6.62	13-Nov-86	4486	12.97	16-Jan-90	6186	8.80	02-Nov-87	6186	10.28	02-Nov-90
4486	8.50	01-Jan-87	4486	5.60	23-Mar-90	6186	9.10	21-Dec-87	6186	10.37	13-Dec-90
4486	9.08	08-May-87	4486	5.98	12-Apr-90	6186	9.30	11-Jan-88	6186	10.86	04-Jan-91
4486	6.89	02-Jun-87	4486	7.72	14-Jun-90	6186	10.82	04-Feb-88	6186	9.98	12-Jun-91
4486	6.15	08-Jul-87	4486	6.68	10-Jul-90	6186	9.90	29-Feb-88	6186	9.92	03-Jul-91
4486	8.70	04-Aug-87	4486	6.91	15-Aug-90	6186	9.90	21-Mar-88	6186	9.53	05-Aug-91
4486	9.60	21-Aug-87	4486	7.15	27-Aug-90	6186	9.40	18-Apr-88	6186	9.33	07-Aug-91
4486	9.10	01-Sep-87	4486	7.64	14-Sep-90	6186	10.00	16-May-88	6186	10.20	05-Sep-91
4486	10.70	29-Sep-87	4486	7.32	04-Oct-90	6186	10.10	15-Jun-88	6186	9.90	02-Oct-91
4486	11.60	02-Nov-87	4486	7.33	05-Nov-90	6186	8.50	15-Jul-88	6186	10.30	17-Oct-91
4486	11.60	11-Nov-87	4486	8.10	07-Dec-90	6186	10.20	18-Aug-88	6186	9.49	04-Nov-91
4486	12.00	21-Dec-87	4486	8.22	11-Dec-90	6186	10.00	15-Sep-88	6186	9.32	03-Dec-91
4486	12.00	11-Jan-88	4486	14.43	03-Jan-91	6186	10.50	22-Oct-88	6186	10.29	07-Jan-92
4486	6.70	29-Feb-88	4486	7.61	18-Mar-91	6186	10.00	15-Nov-88	6186	9.75	21-Jan-92
4486	6.50	21-Mar-88	4486	7.27	02-Apr-91	6186	10.40	15-Dec-88	6186	9.75	21-Jan-92
4486	6.20	18-Apr-88	4486	5.69	06-May-91	6186	10.40	15-Jan-89	6186	10.27	06-Feb-92
4486	6.90	16-May-88	4486	5.87	07-Jun-91	6186	6.90	17-Feb-89	6186	10.49	02-Mar-92
4486	7.30	15-Jun-88	4486	6.67	20-Jun-91	6186	9.90	27-Mar-89	P313489	15.46	16-Jan-90
4486	7.70	15-Jul-88	4486	7.65	05-Jul-91	6186	10.90	27-Apr-89	P313489	10.85	25-Apr-90
4486	8.00	18-Aug-88	4486	6.10	08-Aug-91	6186	8.50	19-May-89	P313489	13.76	09-Aug-90
4486	7.20	15-Sep-88	4486	6.38	14-Aug-91	6186	10.00	29-Jun-89	P313489	14.62	11-Sep-90
4486	11.80	22-Oct-88	4486	7.87	03-Sep-91	6186	10.18	21-Jul-89	P313489	14.43	05-Nov-90
4486	9.10	15-Nov-88	4486	8.87	04-Oct-91	6186	9.43	25-Aug-89	P313489	14.90	04-Dec-90
4486	14.50	15-Dec-88	4486	8.51	04-Nov-91	6186	9.05	14-Sep-89	P313489	15.79	02-Apr-91
4486	8.40	15-Jan-89	4486	7.68	08-Nov-91	6186	10.30	06-Dec-89	P313489	12.88	02-May-91
4486	6.80	17-Feb-89	4486	6.44	07-Dec-91	6186	10.35	18-Jan-90	P313489	10.17	07-Jun-91
4486	6.80	27-Mar-89	4486	8.61	09-Jan-92	6186	7.75	23-Mar-90	P313489	DRY	05-Jul-91
4486	6.80	27-Apr-89	4486	8.23	03-Feb-92	6186	9.14	26-Apr-90	P313489	12.49	08-Aug-91
4486	6.20	19-May-89	4486	8.24	05-Feb-92	6186	9.82	18-May-90	P313489	14.07	03-Sep-91
4486	6.40	29-Jun-89	6186	9.80	08-Jul-87	6186	9.78	11-Jul-90	P313489	15.13	07-Oct-91

Table 2.3

Selected Piezometer and Groundwater Monitor Wells
Water Level Readings through March 5, 1992

<u>Well No.</u>	<u>Depth</u>	<u>Date</u>									
4486	7.80	14-Jul-89	6186	10.20	06-Aug-87	6186	9.82	03-Aug-90	P313489	15.12	05-Nov-91
4486	7.87	25-Aug-89	6186	9.30	25-Aug-87	6186	9.89	15-Aug-90	P313489	12.23	02-Dec-91
4486	5.85	13-Sep-89	6186	9.90	01-Sep-87	6186	9.86	07-Sep-90	P313489	14.60	03-Feb-92
P313489	15.51	03-Mar-92	P414189	8.18	02-May-91	P114789	10.23	02-Apr-91	P114989	14.61	15-Jan-90
P213689	9.24	07-Oct-89	P414189	5.67	07-Jun-91	P114789	8.61	01-May-91	P114989	14.65	25-Apr-90
P213689	12.21	15-Jan-90	P414189	7.56	05-Jul-91	P114789	7.87	07-Jun-91	P114989	13.90	12-Jul-90
P213689	8.47	25-Apr-90	P414189	8.23	08-Aug-91	P114789	9.48	02-Jul-91	P114989	14.27	07-Jun-91
P213689	8.62	14-Aug-90	P414189	8.37	03-Sep-91	P114789	7.64	08-Aug-91	P114989	13.75	02-Jul-91
P213689	8.65	10-Sep-90	P414189	10.22	07-Oct-91	P114789	9.63	04-Sep-91	P114989	14.00	08-Aug-91
P213689	8.76	04-Oct-90	P414189	10.60	05-Nov-91	P114789	9.67	04-Oct-91	P114989	12.52	03-Sep-91
P213689	9.06	05-Nov-90	P414189	7.35	02-Dec-91	P114789	9.13	04-Nov-91	P114989	12.71	04-Oct-91
P213689	9.28	04-Dec-90	P414189	8.04	02-Jan-92	P114789	7.86	02-Dec-91	P114989	12.97	05-Nov-91
P213689	10.03	03-Jan-91	P414189	8.07	03-Feb-92	P114789	9.44	02-Jan-92	P114989	12.82	02-Dec-91
P213689	9.59	02-Apr-91	P414189	8.82	03-Mar-92	P114789	9.30	03-Feb-92	P114989	13.63	02-Jan-92
P213689	9.16	01-May-91	P114489	12.75	15-Sep-89	P114789	10.01	02-Mar-92	P114989	14.57	03-Feb-92
P213689	8.49	07-Jun-91	P114489	15.80	15-Jan-90	P114889	10.04	19-Jan-90	P114989	15.13	02-Mar-92
P213689	8.58	02-Jul-91	P114489	16.64	01-Apr-91	P114889	7.33	25-Apr-90	P115089	17.34	15-Jan-90
P213689	8.52	08-Aug-91	P114489	15.99	01-May-91	P114889	5.78	11-Jul-90	P115089	13.79	12-Jul-90
P214089	10.25	12-Jul-90	P114489	11.27	11-Jun-91	P114889	5.60	09-Aug-90	P115089	14.07	10-Aug-90
P214089	10.93	14-Aug-90	P114489	12.25	08-Jul-91	P114889	5.62	10-Sep-90	P115089	14.74	10-Sep-90
P214089	11.36	10-Sep-90	P114489	12.95	08-Aug-91	P114889	5.71	03-Oct-90	P115089	15.05	04-Oct-90
P214089	11.80	04-Oct-90	P114489	13.39	04-Sep-91	P114889	6.35	05-Nov-90	P115089	15.67	05-Nov-90
P214089	12.26	05-Nov-90	P114489	14.84	07-Oct-91	P114889	6.98	04-Dec-90	P115089	15.96	07-Dec-90
P214089	12.76	04-Dec-90	P114489	13.44	06-Nov-91	P114889	7.53	03-Jan-91	P115089	17.33	03-Jan-91
P214089	DRY	03-Jan-91	P114489	14.58	02-Dec-91	P114889	7.35	02-Apr-91	P115089	18.14	02-Apr-91
P214089	11.74	02-Apr-91	P114489	15.07	02-Jan-92	P114889	6.83	01-May-91	P115089	17.42	01-May-91
P214089	11.56	01-May-91	P114489	15.41	03-Feb-92	P114889	5.84	11-Jun-91	P115089	13.23	07-Jun-91
P214089	9.67	07-Jun-91	P114489	15.67	02-Mar-92	P114889	5.44	02-Jul-91	P115089	13.30	02-Jul-91
P214089	9.53	02-Jul-91	P114789	10.66	15-Jan-90	P114889	5.18	08-Aug-91	P115089	14.07	08-Aug-91
P214089	9.30	08-Aug-91	P114789	8.13	25-Apr-90	P114889	5.22	04-Sep-91	P115089	14.67	03-Sep-91
P214089	9.53	05-Sep-91	P114789	9.00	12-Jul-90	P114889	5.57	04-Oct-91	P115089	16.14	04-Oct-91

Table 2.3

Selected Piezometer and Groundwater Monitor Wells
Water Level Readings through March 5, 1992

Well No.	Depth	Date	Well No.	Depth	Date	Well No.	Depth	Date	<u>Well No.</u>	<u>Depth</u>	<u>Date</u>
P214089	9.79	07-Oct-91	P114789	9.60	09-Aug-90	P114889	6.13	04-Nov-91	P115089	17.00	05-Nov-91
P214089	9.87	04-Nov-91	P114789	9.59	10-Sep-90	P114889	6.56	02-Dec-91	P115089	15.82	02-Dec-91
P214089	8.34	02-Dec-91	P114789	9.87	03-Oct-90	P114889	6.93	02-Jan-92	P115089	16.34	02-Jan-92
P214089	9.00	02-Jan-92	P114789	9.52	05-Nov-90	P114889	7.17	03-Feb-92	P115089	16.76	03-Feb-92
P214089	9.34	03-Feb-92	P114789	10.30	04-Dec-90	P114889	7.04	02-Mar-92	P115089	17.04	02-Mar-92
P214089	9.68	03-Mar-92	P114789	11.51	03-Jan-91	P114989	12.80	15-Sep-89	P115489	11.97	15-Jan-90
P115489	9.47	12-Jul-90	P115689	12.82	04-Oct-91	P415889	13.40	05-Jul-91	P416089	8.47	15-Aug-90
P115489	9.70	09-Aug-90	P115689	12.35	04-Nov-91	P415889	14.35	09-Aug-91	P416089	9.37	10-Sep-90
P115489	10.23	11-Sep-90	P115689	9.42	04-Dec-91	P415889	14.49	03-Sep-91	P416089	9.99	03-Oct-90
P115489	10.87	04-Oct-90	P115689	11.57	09-Jan-92	P415889	16.98	04-Oct-91	P416089	10.16	05-Nov-90
P115489	11.22	05-Nov-90	P115689	11.18	03-Feb-92	P415889	18.14	05-Nov-91	P416089	10.11	04-Dec-90
P115489	11.54	05-Dec-90	P115689	12.36	02-Mar-92	P415889	14.51	04-Dec-91	P416089	15.25	04-Jan-91
P115489	13.46	03-Jan-91	P215789	15.25	10-Sep-90	P415889	15.80	02-Jan-92	P416089	14.44	02-Apr-91
P115489	12.51	02-Apr-91	P215789	15.38	03-Oct-90	P415889	16.08	03-Feb-92	P416089	8.01	01-May-91
P115489	10.46	02-May-91	P215789	15.34	05-Nov-90	P415889	17.43	02-Mar-92	P416089	4.35	11-Jun-91
P115489	8.90	11-Jun-91	P215789	15.62	05-Dec-90	P415989	10.50	16-Jan-90	P416089	7.57	05-Jul-91
P115489	10.74	08-Jul-91	P215789	16.16	03-Jan-91	P415989	6.25	12-Jul-90	P416089	5.87	08-Aug-91
P115489	9.57	08-Aug-91	P215789	16.16	02-Apr-91	P415989	6.46	10-Aug-90	P416089	8.84	03-Sep-91
P115489	10.21	04-Sep-91	P215789	15.06	01-May-91	P415989	7.76	10-Sep-90	P416089	11.69	04-Oct-91
P115489	11.56	04-Oct-91	P215789	13.83	07-Jun-91	P415989	8.10	03-Oct-90	P416089	12.35	05-Nov-91
P115489	11.58	05-Nov-91	P215789	15.33	02-Jul-91	P415989	8.96	05-Nov-90	P416089	6.92	04-Dec-91
P115489	10.07	02-Dec-91	P215789	14.28	08-Aug-91	P415989	8.71	04-Dec-90	P416089	8.67	02-Jan-92
P115489	11.11	03-Jan-92	P215789	15.52	05-Sep-91	P415989	11.86	04-Jan-91	P416089	8.65	03-Feb-92
P115489	10.97	03-Feb-92	P215789	15.82	07-Oct-91	P415989	11.88	02-Apr-91	P416089	11.97	02-Mar-92
P115489	11.87	02-Mar-92	P215789	15.70	04-Nov-91	P415989	8.47	01-May-91	P416189	8.46	02-Dec-89
P115589	7.73	09-Jan-90	P215789	14.40	04-Dec-91	P415989	3.90	11-Jun-91	P416189	12.82	16-Jan-90
P115589	8.34	15-Jan-90	P215789	15.38	02-Jan-92	P415989	6.00	05-Jul-91	P416189	8.97	12-Jul-90
P115589	5.63	12-Jul-90	P215789	15.44	03-Feb-92	P415989	5.60	08-Aug-91	P416189	8.89	10-Aug-90
P115589	6.39	09-Aug-90	P415889	13.25	15-Sep-89	P415989	6.92	03-Sep-91	P416189	10.56	10-Sep-90
P115589	6.86	11-Sep-90	P415889	18.37	15-Jan-90	P415989	9.65	04-Oct-91	P416189	10.73	03-Oct-90
P115589	7.40	04-Oct-90	P415889	13.77	12-Jul-90	P415989	10.93	04-Nov-91	P416189	12.06	05-Nov-90

Table 2.3

Selected Piezometer and Groundwater Monitor Wells
Water Level Readings through March 5, 1992

Well No.	Depth	Date	Well No.	Depth	Date	Well No.	Depth	Date	<u>Well No.</u>	<u>Depth</u>	<u>Date</u>
P115589	7.30	05-Nov-90	P415889	13.98	10-Aug-90	P415989	6.65	04-Dec-91	P416189	11.07	04-Dec-90
P115589	7.84	04-Oct-91	P415889	15.22	10-Sep-90	P415989	7.80	02-Jan-92	P416189	14.99	04-Jan-91
P115589	6.70	04-Nov-91	P415889	15.47	03-Oct-90	P415989	7.86	03-Feb-92	P416189	14.53	02-Apr-91
P115589	4.77	02-Dec-91	P415889	16.47	05-Nov-90	P415989	69.33	04-Feb-92	P416189	9.68	02-May-91
P115589	7.11	03-Jan-92	P415889	16.37	04-Dec-90	P415989	9.58	02-Mar-92	P416189	5.80	11-Jun-91
P115589	7.25	03-Feb-92	P415889	19.08	04-Jan-91	P416089	5.30	15-Sep-89	P416189		08-Jul-91
P115589	8.60	02-Mar-92	P415889	19.71	02-Apr-91	P416089	12.38	16-Jan-90	P416189	8.31	08-Aug-91
P115689	8.85	08-Aug-91	P415889	17.08	01-May-91	P416089	6.81	12-Jul-90	P416189	9.50	05-Sep-91
P115689	11.49	04-Sep-91	P415889	12.00	11-Jun-91	P416089	8.02	10-Aug-90	P416189	12.45	04-Oct-91
P416189	13.38	05-Nov-91	P416389	5.86	11-Jun-91	P416589	27.10	04-Oct-90	P416789	27.46	03-Feb-92
P416189	9.91	02-Jan-92	P416389	10.90	05-Jul-91	P416589	27.32	05-Nov-90	P416789	27.63	02-Mar-92
P416189	9.83	03-Feb-92	P416389	10.64	08-Aug-91	P416589	27.43	05-Dec-90	P416889	18.56	16-Jan-90
P416189	12.97	02-Mar-92	P416389	13.13	05-Sep-91	P416589	28.72	03-Jan-91	P416889	16.98	12-Jul-90
P416289	15.87	16-Jan-90	P416389	17.12	04-Oct-91	P416589	29.56	02-Apr-91	P416889	17.28	10-Aug-90
P416289	12.75	12-Jul-90	P416389	18.02	06-Nov-91	P416589	DRY	02-May-91	P416889	17.83	10-Sep-90
P416289	12.19	10-Aug-90	P416389	11.87	02-Dec-91	P416589	24.68	11-Jun-91	P416889	17.98	04-Oct-90
P416289	13.59	10-Sep-90	P416389	13.42	02-Jan-92	P416589	25.82	05-Jul-91	P416889	17.78	05-Nov-90
P416289	13.48	04-Oct-90	P416389	13.09	03-Feb-92	P416589	26.45	08-Aug-91	P416889	18.08	05-Dec-90
P416289	14.19	05-Nov-90	P416389	16.21	02-Mar-92	P416589	12.27	03-Sep-91	P416889	18.78	03-Jan-91
P416289	16.59	03-Jan-91	P416489	19.99	16-Jan-90	P416589	27.76	04-Oct-91	P416889	18.81	02-Apr-91
P416289	16.72	02-Apr-91	P416489	16.83	12-Jul-90	P416589	28.50	05-Nov-91	P416889	16.86	02-May-91
P416289	14.23	02-May-91	P416489	16.40	10-Aug-90	P416589	27.01	02-Dec-91	P416889	14.46	07-Jun-91
P416289	11.38	07-Jun-91	P416489	18.15	10-Sep-90	P416589	27.05	02-Jan-92	P416889	17.02	05-Jul-91
P416289	12.63	05-Jul-91	P416489	18.40	04-Oct-90	P416589	27.87	03-Feb-92	P416889	16.15	08-Aug-91
P416289	12.40	08-Aug-91	P416489	19.43	05-Nov-90	P416589	28.24	02-Mar-92	P416889	17.51	03-Sep-91
P416289	12.73	05-Sep-91	P416489	18.61	05-Dec-90	P416789	27.70	16-Jan-90	P416889	18.14	07-Oct-91
P416289	14.58	04-Oct-91	P416489	21.58	04-Jan-91	P416789	26.28	12-Jul-90	P416889	18.26	05-Nov-91
P416289	15.89	05-Nov-91	P416489	22.10	02-Apr-91	P416789	26.48	10-Aug-90	P416889	16.12	02-Dec-91
P416289	13.05	04-Dec-91	P416489	DRY	02-May-91	P416789	27.01	10-Sep-90	P416889	17.75	02-Jan-92
P416289	13.74	03-Jan-92	P416489	10.42	11-Jun-91	P416789	27.19	04-Oct-90	P416889	18.08	03-Feb-92
P416289	14.32	03-Feb-92	P416489	15.17	05-Jul-91	P416789	27.40	05-Nov-90	P416889	18.58	02-Mar-92

Table 2.3

Selected Piezometer and Groundwater Monitor Wells
Water Level Readings through March 5, 1992

Well No.	Depth	Date	Well No.	Depth	Date	Well No.	Depth	Date	<u>Well No.</u>	<u>Depth</u>	<u>Date</u>
P416289	15.32	02-Mar-92	P416489	15.98	08-Aug-91	P416789	27.36	05-Dec-90	P218089	9.14	17-Jan-89
P416389	8.95	15-Sep-89	P416489	16.70	03-Sep-91	P416789	27.64	03-Jan-91	P218089	8.30	01-Dec-89
P416389	17.34	16-Jan-90	P416489	19.74	04-Oct-91	P416789	27.85	02-Apr-91	P218089	9.14	17-Jan-90
P416389	12.60	12-Jul-90	P416489	20.85	05-Nov-91	P416789	26.45	02-May-91	P218089	8.52	14-Feb-90
P416389	12.28	10-Aug-90	P416489	15.46	02-Dec-91	P416789	23.35	11-Jun-91	P218089	5.45	25-Apr-90
P416389	14.50	10-Sep-90	P416489	16.93	02-Jan-92	P416789	26.33	05-Jul-91	P218089	5.82	31-May-90
P416389	14.90	04-Oct-90	P416489	16.90	03-Feb-92	P416789	25.12	08-Aug-91	P218089	9.74	11-Jul-90
P416389	16.23	05-Nov-90	P416489	19.19	02-Mar-92	P416789	26.73	03-Sep-91	P218089	8.82	13-Aug-90
P416389	16.57	05-Dec-90	P416589	28.48	16-Jan-90	P416789	27.50	07-Oct-91	P218089	8.82	13-Aug-90
P416389	19.38	04-Jan-91	P416589	26.76	12-Jul-90	P416789	27.67	05-Nov-91	P218089	9.57	03-Oct-90
P416389	19.46	02-Apr-91	P416589	26.03	10-Aug-90	P416789	25.23	02-Dec-91	P218089	9.57	03-Oct-90
P416389	13.67	01-May-91	P416589	26.87	10-Sep-90	P416789	27.03	02-Jan-92	P218089	9.51	22-Oct-90
P218089	9.51	22-Oct-90	P218089	8.22	26-Feb-92	P119389	5.95	10-Aug-90	P419689	19.23	05-Sep-91
P218089	DRY	04-Jan-91	P418289	9.70	07-Oct-89	P119389	5.85	04-Sep-90	P419689	19.87	04-Nov-91
P218089	DRY	04-Jan-91	P418289	10.49	14-Dec-89	P119389	5.72	02-Nov-90	P419689	17.40	03-Dec-91
P218089	DRY	04-Jan-91	P418289	10.25	16-Jan-90	P119389	6.46	04-Jan-91	P419689	19.65	07-Jan-92
P218089	DRY	04-Jan-91	P418289	5.12	22-Mar-90	P119389	5.83	07-Jun-91	P419689	19.71	06-Feb-92
P218089	6.29	11-Jun-91	P418289	5.32	11-Apr-90	P119389	5.25	03-Jul-91	P419689	20.47	02-Mar-92
P218089	6.29	11-Jun-91	P418289	7.38	19-May-90	P119389	4.85	02-Aug-91	P220089	9.66	16-Apr-90
P218089	9.68	03-Jul-91	P418289	7.25	12-Jul-90	P119389	4.82	04-Sep-91	P220089	12.48	07-Jun-90
P218089	9.68	03-Jul-91	P418289	8.78	11-Sep-90	P119389	5.30	01-Oct-91	P220089	13.15	12-Jul-90
P218089	9.10	08-Aug-91	P418289	9.21	04-Oct-90	P119389	5.58	04-Nov-91	P220089	14.12	24-Sep-90
P218089	9.10	08-Aug-91	P418289	8.09	19-Nov-90	P119389	5.08	03-Dec-91	P220089	14.58	04-Oct-90
P218089	9.64	22-Aug-91	P418289	11.53	03-Jan-91	P119389	5.24	08-Jan-92	P220089	14.30	30-Nov-90
P218089	9.64	22-Aug-91	P418289	10.57	19-Mar-91	P119389	5.42	06-Feb-92	P220089	15.64	04-Jan-91
P218089	10.09	07-Oct-91	P418289	7.38	18-Jun-91	P119389	6.00	02-Mar-92	P220089	15.32	19-Mar-91
P218089	10.09	07-Oct-91	P418289	8.93	05-Jul-91	P419689	18.80	15-Aug-90	P220089	15.41	02-Apr-91
P218089	10.05	16-Oct-91	P418289	7.24	16-Aug-91	P419689	19.37	14-Sep-90	P220089	9.84	12-Jun-91
P218089	10.05	16-Oct-91	P418289	8.60	11-Nov-91	P419689	19.33	03-Oct-90	P220089	12.15	05-Jul-91
P218089	5.92	08-Jan-92	P418289	9.83	09-Jan-92	P419689	19.90	02-Nov-90	P220089	11.99	13-Aug-91
P218089	5.92	08-Jan-92	P418289	9.35	05-Feb-92	P419689	20.76	04-Jan-91	P220089	14.71	04-Oct-91

Table 2.3

Selected Piezometer and Groundwater Monitor Wells
 Water Level Readings through March 5, 1992

Well No.	Depth	Date	Well No.	Depth	Date	Well No.	Depth	Date	<u>Well No.</u>	<u>Depth</u>	<u>Date</u>
P218089	5.95	15-Jan-92	P119389	17.88	18-Jan-90	P419689	17.18	20-Jun-91	P220089	15.50	22-Oct-91
P218089	5.95	15-Jan-92	P119389	16.60	26-Apr-90	P419689	18.61	03-Jul-91	P220089	14.13	09-Jan-92
P218089	8.22	26-Feb-92	P119389	7.29	11-Jul-90	P419689	16.86	09-Aug-91	P220089	14.25	04-Feb-92

Table 2.4
Relationship of Other OUs and IHSS's to OU13

<u>OU Number</u>	<u>IHSS Number</u>	<u>Drainage Basin</u>
OU5 ¹⁾	---	South Interceptor Ditch
OU6 ¹⁾	141	upper South Walnut Creek
	165 ²⁾	upper South Walnut Creek
OU8	118.2 ²⁾	upper South Walnut Creek
	123.1 ²⁾	upper South Walnut Creek
	123.2 ²⁾	upper South Walnut Creek
	150.4 ²⁾	upper South Walnut Creek
	150.5 ²⁾	upper South Walnut Creek
	150.7 ²⁾	upper South Walnut Creek
	159 ²⁾	upper South Walnut Creek
	172	North Walnut Creek and upper and lower South Walnut Creek
	173 ²⁾	upper South Walnut Creek
	184 ²⁾	upper South Walnut Creek
OU9	121	North Walnut Creek and lower South Walnut Creek
OU10	129	lower South Walnut Creek
	181	North Walnut Creek and upper South Walnut Creek
	213	lower South Walnut Creek
OU12	116.2 ²⁾	lower South Walnut Creek
	120.1 ²⁾	lower South Walnut Creek
	120.2 ²⁾	lower South Walnut Creek
	147.1	upper South Walnut Creek
	157.2 ²⁾	lower South Walnut Creek

TABLE 2.4

RELATIONSHIP OF OTHER OUs TO OU13 - Concluded

OU Number	IHSS Number	Drainage Basin
OU14	156.1	North Walnut Creek
	160	lower South Walnut Creek
	161	lower South Walnut Creek
	162	upper and lower South Walnut Creek
	164.2	lower South Walnut Creek
	164.3	lower South Walnut Creek
	179	lower South Walnut Creek
OU15	180 ²⁾	lower South Walnut Creek
	185 ²⁾	upper South Walnut Creek
OU16	192 ²⁾	upper South Walnut Creek
	193	lower South Walnut Creek
	194 ²⁾	upper South Walnut Creek
	196 ²⁾	lower South Walnut Creek

- 1) Located downstream of OU13.
- 2) Located within the area that drains onto OU13. Not located within the OU13 boundary. Historical accounts reference the laundry building as being potentially affected by radionuclides and chemical materials. The notable constituents were depleted uranium and beryllium with at least one incident involving enriched uranium. The soil around the building was affected by radioactive releases. Contamination around Building 442 has been identified as resulting from the laundry operations and not from the activities that have occurred since approximately 1972. At that time, filter testing replaced laundry operations as the function of the building. No documentation was found which indicate that the activities of the filter testing laboratory contributed to contamination to the environment.

**TABLE 2.5
BACKGROUND CONCENTRATIONS FOR ROCKY FLATS ALLUVIAL GROUNDWATER**

Dissolved Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium
Upper Tolerance Limit (mg/l)	..	..	..	..	..	..	43.5726	..	..	..	..	..	..	..
Maximum Concentration (mg/l)	0.2U	0.5U	0.01U	0.116U	0.005U	0.011U	75.0	2.5U	0.02U	0.05U	0.0201U	0.266	0.0054	0.1U

	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Vanadium	Zinc
Upper Tolerance Limit (mg/l)	..	0.1356	..	..	..	..	..	..	8.8696	..	..	..	..	..
Maximum Concentration (mg/l)	5.79	0.268	0.0002U	0.5U	0.0432	7.73	0.05U	0.03U	11.0	1.0U	0.04U	1.0U	0.05U	0.141U

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride ¹	Cyanide	pH	Nitrate/ Nitrite	Sulfate
Upper Tolerance Limit (mg/l except pH)	146.7346	..	7.5743	..	8.3193	2.1734	25.2270
Lower Tolerance Limit (mg/l except pH)	NA	NA	NA	NA	6.0781	NA	NA
Maximum Concentration (mg/l except pH)	450.0	5.0U	16.0	0.01U	8.6	..	..
Minimum Concentration (mg/l except pH)	NA	NA	NA	NA	6.3	NA	NA

Radionuclides

	Americium- 241	Cesium- 137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium	Uranium -233,234	Uranium- 235	Uranium -238
Upper Tolerance Limit (pCi/l)	0.0197	0.6237	7.7990	8.7694	0.0118	..	..	1.2300	454.2380	..	0.1601	0.9806
Maximum Concentration (pCi/l)	0.031	0.5	12.0	13.0	0.017	170.0		2.13	390.0	0.1	0.23	1.19

NA = Not applicable .. = Value not calculated U = Concentration below detection limit ¹ Value for North Rocky Flats Alluvial Groundwater

**TABLE 2.6
BACKGROUND CONCENTRATIONS FOR ROCKY FLATS ALLUVIUM**

Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium ¹	Cesium	Chromium ¹	Cobalt	Copper ¹	Iron	Lead ¹	Lithium ¹
Upper Tolerance Limit (mg/kg)	13419.4947	..	4.2988	79.4928	4.7040	..	8430.1986	..	19.9897	..	11.1314	13753.5715	12.1546	..
Maximum Concentration (mg/kg)	40800.0	33.2U	41.7	209.0	19.0	3.2	157000.0	968.0U	69.6	28.1	16.6	33700.0	25.7	31.3

	Magnesium	Manganese	Mercury ¹	Molybdenum ¹	Nickel ¹	Potassium	Selenium	Silver	Sodium	Strontium ¹	Thallium ¹	Tin ¹	Vanadium ¹	Zinc ¹
Upper Tolerance Limit (mg/kg)	2484.2373	234.9950	..	..	21.4229	1557.9829	..	..	..	..	..	..	37.1857	39.7143
Maximum Concentration (mg/kg)	5570.0	656.0	0.32	41.0	54.2	4020.0	12.0U	40.9	4840.0U	226	5.4U	312.0	70.0	77.6

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite ¹	Sulfate
Upper Tolerance Limit (mg/kg except pH)	..	..	..	..	9.5174	..	..
Lower Tolerance Limit (mg/kg except pH)	NA	NA	NA	NA	6.3858	NA	NA
Maximum Concentration (mg/kg except pH)					9.1	4.3	
Minimum Concentration (mg/kg except pH)					7.0	NA	NA

Radionuclides

	Americium- 241	Cesium- 137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium ²	Uranium -233,234	Uranium- 235	Uranium -238
Upper Tolerance Limit (pCi/g)	0.0135	0.0669	39.3636	36.8150	0.0150	0.6513	1.9561	0.7256	0.4147	0.6558	0.0741	0.6830
Maximum Concentration (pCi/g)	0.01	0.2	42.0	44.0	0.02	0.9	2.2	1.2	0.44	3.4	0.1	3.2

NA = Not applicable .. = Value not calculated U = Concentration below detection limit ¹ Value for North Rocky Flats Alluvium ² Concentration in pCi/ml

**TABLE 2.7
BACKGROUND CONCENTRATIONS FOR COLLUVIUM, WEATHERED CLAYSTONE AND WEATHERED SANDSTONE**

Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium ¹	Cesium	Chromium ¹	Cobalt	Copper ¹	Iron	Lead ¹	Lithium ¹
Upper Tolerance Limit (mg/kg)	10427.7752	..	4.0203	121.8903	3.4013	..	7566.5613	..	10.3477	..	16.2533	14726.3649	18.6811	11.6003
Maximum Concentration (mg/kg)	22900.0	16.2	10.8	491.0	10.3	2.6U	44300.0	516.0U	21.3	29.7	26.7	38100.0	28.2	48.4U

	Magnesium	Manganese	Mercury ¹	Molybdenum ¹	Nickel ¹	Potassium	Selenium	Silver	Sodium	Strontium ¹	Thallium ¹	Tin ¹	Vanadium ¹	Zinc ¹
Upper Tolerance Limit (mg/kg)	2799.1426	203.0125	..	13.4310	20.1842	..	..	..	..	64.0675	..	..	23.7320	62.3409
Maximum Concentration (mg/kg)	5580.0	737.0	0.44	48.4U	62.4	3090.0	12.8U	33.5	3680.0	113.0	5.0U	441.0	40.9	129.0

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite ¹	Sulfate
Upper Tolerance Limit (mg/kg except pH)	..	..	..	..	9.5161	..	..
Lower Tolerance Limit (mg/kg except pH)	NA	NA	NA	NA	7.2914	NA	NA
Maximum Concentration (mg/kg except pH)					9.7	2.5	
Minimum Concentration (mg/kg except pH)					7.2	NA	NA

Radionuclides

	Americium- 241	Cesium- 137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium ²	Uranium -233,234	Uranium- 235	Uranium -238
Upper Tolerance Limit (pCi/g)	..	0.0745	48.4255	34.1512	0.0209	1.1379	2.0537	0.6719	0.2875	0.9830	0.1756	1.0429
Maximum Concentration (pCi/g)		0.2	48.0	34.0	0.02	1.3	2.1	0.8	0.39	2.6	0.3	2.3

NA = Not applicable .. = Value not calculated U = Concentration below detection limit ¹ Value for North Rocky Flats Samples ² Concentration in pCi/ml

TABLE 2.8. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P214689

Sample No.	Depth (ft.)	Benzene (ug/Kg)	Carbon Disulfide (ug/Kg)	Ethylbenzene (ug/Kg)	Toulene (ug/Kg)	Total Xylenes (ug/Kg)	Acetone (ug/Kg)	Barium (mg/Kg)	Cadmium (mg/Kg)	Copper (mg/Kg)	Iron (mg/Kg)
PZ4289002	0.0-1.6										
PZ4289003	0.0-3.0								29.5	19.3	
PZ42890204	2.0-4.0	5V	13V	1AJ	16V	4AJ					
PZ42890306	3.0-6.0										
PZ42890406	4.0-6.0		19V	2AJ	21V	6AJ					
PZ42890608	6.0-8.0										
PZ42890810	8.0-10.0										
PZ42890812	8.0-12.0									14.6	
PZ42891012	10.0-12.0										
PZ42891214	12.0-13.8										
PZ42891216	12.0-16.0									26.8	15100
PZ42891416	14.0-16.0										
PZ42891618	16.0-17.8	2AJ		15V	60V	36AJ					
PZ42891620	16.0-20.0									19.7	15200
PZ42891820	18.0-20.0	2AJ		14V	55V	34AJ					
PZ42891820D	18.0-20.0 (Dup.)	2AJ		14V	58V	37AJ					
PZ42892022	20.0-22.0	5J	14	1J	17		17	81.3		12.1	
PZ42892224	22.0-24.0	4AJ	9V		11V	3AJ					
PZ42892226	22.0-26.0									19.7	16300
PZ42892426	24.0-26.0	8	22	2J	25						

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.8. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P214689 – Continued

Sample No.	Depth (ft.)	Manganese	Potassium	Sodium	Vanadium	Zinc	Plutonium –	Strontium –	Radium – 226	Uranium –	
		(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	239/240 (pCi/g)	89,90 (pCi/g)	(pCi/g)	233,234 (pCi/g)	Uranium – 238 (pCi/g)
PZ4289002	0.0–1.6										
PZ4289003	0.0–3.0										
PZ42890204	2.0–4.0			7540		45.3	0.031		1.1	0.69	0.84
PZ42890306	3.0–6.0		1680				0.018		0.7		
PZ42890406	4.0–6.0										
PZ42890608	6.0–8.0							0.83	0.8		0.83
PZ42890810	8.0–10.0										
PZ42890812	8.0–12.0		2360					1.33	0.9	1.04	
PZ42891012	10.0–12.0										
PZ42891214	12.0–13.8										
PZ42891216	12.0–16.0		2190		37.9				0.7		
PZ42891416	14.0–16.0										
PZ42891618	16.0–17.8										
PZ42891620	16.0–20.0							0.95	1.3		0.86
PZ42891820	18.0–20.0										
PZ42891820D	18.0–20.0 (Dup.)						0.016	0.99			0.73
PZ42892022	20.0–22.0	263							0.8	0.7	0.91
PZ42892224	22.0–24.0										
PZ42892226	22.0–26.0									0.77	0.92
PZ42892426	24.0–26.0										

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.8. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P214689 – Continued

<u>Sample No.</u>	<u>Depth (ft.)</u>	<u>Radium-228</u> <u>(pCi/g)</u>	<u>Gross</u> <u>Beta</u> <u>(pCi/g)</u>	<u>Nitrate/</u> <u>Nitrite</u> <u>(mg/Kg)</u>
PZ4289002	0.0-1.6			
PZ4289003	0.0-3.0	2		6.3
PZ42890204	2.0-4.0			
PZ42890306	3.0-6.0			
PZ42890406	4.0-6.0			
PZ42890608	6.0-8.0			
PZ42890810	8.0-10.0			
PZ42890812	8.0-12.0			
PZ42891012	10.0-12.0			
PZ42891214	12.0-13.8			
PZ42891216	12.0-16.0			
PZ42891416	14.0-16.0			
PZ42891618	16.0-17.8			
PZ42891620	16.0-20.0			
PZ42891820	18.0-20.0			
PZ42891820D	18.0-20.0 (Dup.)		37.7	
PZ42892022	20.0-22.0			
PZ42892224	22.0-24.0			
PZ42892226	22.0-26.0			
PZ42892426	24.0-26.0			

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.9. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P114789

<u>Sample No.</u>	<u>Depth (ft.)</u>	<u>Benzene (ug/Kg)</u>	<u>Carbon Disulfide (ug/Kg)</u>	<u>Ethylbenzene (ug/Kg)</u>	<u>Toulene (ug/Kg)</u>	<u>Total Xylenes (ug/Kg)</u>	<u>Acetone (ug/Kg)</u>	<u>Arsenic (mg/Kg)</u>	<u>Copper (mg/Kg)</u>	<u>Iron (mg/Kg)</u>	<u>Vanadium (mg/Kg)</u>
PZ43890002	0.0-2.0	7 AJ	21 AJ	2 AJ	24 AJ	6 AJ					
PZ43890003	0.0-3.0							4.7			
PZ43890204	2.0-3.1	3 AJ			10 AJ	2 AJ	9 AJ				
PZ43890307	3.0-7.0								17	15600	38.9
PZ43890406	4.0-4.8	5 AJ		10 AJ	16 AJ	4 AJ					
PZ43890608	6.0-8.0	5 AJ		6 AJ	87 AJ	21 AJ					
PZ43890711	7.0-10.0										
PZ43890810	8.0-9.0						12 AJ				
PZ43891115	11.0-14.6										
PZ43891214	12.0-14.0										
PZ43891416	14.0-16.0	5 AJ		9 AJ	100 AJ	24 AJ	23 AJ				
PZ43891519	15.0-18.9								12.2		
PZ43891618	16.0-18.0	4 AJ		6 AJ	73 AJ	18 AJ					
PZ43891820	18.0-20.0										
PZ43891922	18.9-22.0								11.5		
PZ43892022	20.0-22.0										
PZ43892224	22.0-22.5						12 LJ				
PZ43892226	22.0-22.5								13.1		
PZ43892631	27.0-31.0								39.4	24500	41.4
PZ43892728	27.0-27.7										
PZ43893031	30.0-31.0										

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.9. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P114789 – Continued

Sample No.	Depth (ft.)	Manganese (mg/Kg)	Barium (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Plutonium – 239/240 (pCi/g)	Strontium – 89,90 (pCi/g)	Uranium –233, –234 (pCi/g)	Uranium –235 (pCi/g)	Radium –226 (pCi/g)	Uranium –238 (pCi/g)
PZ43890002	0.0–2.0										
PZ43890003	0.0–3.0					0.09	1.5	0.8	0.73		
PZ43890204	2.0–3.1										
PZ43890307	3.0–7.0					0.022					
PZ43890406	4.0–4.8										
PZ43890608	6.0–8.0										
PZ43890711	7.0–10.0	268									
PZ43890810	8.0–9.0										
PZ43891115	11.0–14.6							0.66			
PZ43891214	12.0–14.0										
PZ43891416	14.0–16.0										
PZ43891519	15.0–18.9	358	86.4				2.19			0.8	
PZ43891618	16.0–18.0										
PZ43891820	18.0–20.0										
PZ43891922	18.9–22.0						1.76			0.7	0.88
PZ43892022	20.0–22.0										
PZ43892224	22.0–22.5										
PZ43892226	22.0–22.5								0.33	1.6	0.83
PZ43892631	27.0–31.0		116	28.1	108				0.25		0.95
PZ43892728	27.0–27.7										
PZ43893031	30.0–31.0										

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.10. SUMMARY OF CONTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P115589

Sample No.	Depth (ft.)	Methylene Chloride (ug/Kg)	Acetone (ug/Kg)	1,1,1-Trichloroethane (ug/Kg)	1,1,2-Tetrachloroethane (ug/Kg)	1,1-Dichloroethane (ug/Kg)	1,1-Dichloroethene (ug/Kg)	1,2-Dichloroethene (ug/Kg)	Tetrachloroethene (ug/Kg)	Trichloroethene (ug/Kg)	Arsenic (mg/Kg)	Copper (mg/Kg)
PZ50890002	0-1.3	8B	5J								5	
PZ50890003	0-3.0											
PZ50890204	2.0-3.7	8 UJ	38 AJ									
PZ50890308	3.0-6.0											
PZ50890306D	3.0-6.0(Dup.)											
PZ50890408	4.0-6.0	8 UJ	35 AJ									
PZ50890406D	4.0-6.0(Dup.)	8 UJ	42 UJ									
PZ50890608	6.0-7.4	5 UJ										
PZ50890609	6.0-9.0											
PZ50890810	8.0-9.5	8 UJ	8 AJ									
PZ50890912	9.0-11.6											
PZ50891012	10.0-11.6	8 UJ										
PZ50891214	12.0-14.0	8 UJ	13 AJ								5	20
PZ50891218	12.0-14.0											
PZ50891416	14.0-16.0	6 UJ										
PZ50891618	16.0-18.0	9 UJ	14 AJ								4	18
PZ50891820	18.0-20.0											
PZ50891820	18.0-20.0	6 UJ	7 AJ									
PZ50892022	20.0-22.0	6 UJ	6 AJ	10 AJ	7 AJ	20 AJ	17 AJ	13 AJ	30 AJ			21
PZ50892024	20.0-24.0											
PZ50892224	22.0-24.0	16 UJ	8 AJ	4 AJ		12 AJ	8 AJ	6 AJ	12 AJ	3 AJ		
PZ50892426	24.0-25.0	11 UJ	21 AJ									
PZ50892428	24.0-26.0											
PZ50892628	26.0-27.5	12 UJ	29 AJ									

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.10. SUMMARY OF CONTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P115589

Sample No.	Depth (ft.)	Manganese (mg/Kg)	Potassium (mg/Kg)	Vanadium (mg/Kg)	Zinc (mg/Kg)	pH (pH unit)	Plutonium -	Uranium -	Uranium -238 (pCi/g)	Radium -226 (pCi/g)	Uranium -235 (pCi/g)	Strontium -	Radium -226 (pCi/g)
							239/240 (pCi/g)	233,234 (pCi/g)				89,90 (pCi/g)	
PZ50890002	0-1.3												
PZ50890003	0-3.0						0.03	1.1	0.9	1	0.2		
PZ50890204	2.0-3.7					6.3							
PZ50890306	3.0-6.0						0.03	0.9	0.8	0.8			2.1
PZ50890306D	3.0-6.0(Dup.)						0.02	0.8	0.8				
PZ50890406	4.0-6.0												
PZ50890406D	4.0-6.0(Dup.)												
PZ50890608	6.0-7.4												
PZ50890609	6.0-9.0										0.2		
PZ50890810	8.0-9.5												
PZ50890912	9.0-11.6						0.02		0.9		0.2		1.9
PZ50891012	10.0-11.6												
PZ50891214	12.0-14.0	364	1720										
PZ50891216	12.0-14.0						0.05						1.3
PZ50891416	14.0-16.0												
PZ50891616	16.0-18.0												
PZ50891620	16.0-20.0						0.05		0.7				1.5
PZ50891820	18.0-20.0												
PZ50892022	20.0-22.0			41	48								
PZ50892024	20.0-24.0						0.05	0.8			0.1		
PZ50892224	22.0-24.0												
PZ50892428	24.0-25.0												
PZ50892428	24.0-26.0						0.02	0.7	1.2	1			1.1
PZ50892628	26.0-27.5												

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifer(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.11. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P218089

Sample No.	Depth (ft.)	Methylene Chloride (ug/Kg)	Acetone (ug/Kg)	Barium (mg/Kg)	Calcium (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Magnesium (mg/Kg)	Vanadium (mg/Kg)	Zinc (mg/Kg)
OP03890002	0-1.2	7 UJ									
OP03890003	0-3.0				8950	53.4	11.3	17.9			
OP03890204	2.0-3.3	8 UJ									
OP03890306	3.0-5.1			115			12.8	25.1	3950	39.7	46.5
OP03890406	4.0-5.1		5 AJ								
OP03890608	6.0-8.0	9 UJ	5 AJ								
OP03890610	8.0-10.0			538			13.2	12.9	4110		57.6
OP03890810	6.0-10.0	8B	3J								

V=Validated and valid

NA=Not analyzed

A=Validated and valid with qualifier(s)

NR=Result not reported

J=Detected at concentration less than detection limit

B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.12. SUMMARY OF CONSTITUENTS DETECTED IN
CONCENTRATIONS ABOVE BACKGROUND IN
GROUNDWATER SAMPLES FROM WELL P218089

Sample Date	Methylene Chloride (ug/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Nitrate/ Nitrite (mg/l)	Sulfate (mg/l)	Uranium- 233,234 (pCi/l)	Uranium- 235 (pCi/l)	Uranium- 238 (pCi/l)
14-Feb-90	NA	NA	NA	NA	NA	84	2.3	22
31-May-90	10	NA	NA	6.8	NA	45.60	0.80	14.97
12-Jun-91	1BJ	400	10	4.0	230	NA	NA	NA

V=Validated and valid A=Validated and valid with qualifier(s) J=Detected at concentration less than detection limit
 ND=Not Detected NA=Not analyzed NR=Result not reported B=Constituent detected in laboratory blank

TABLE 2.13. SUMMARY OF CONTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P213689

Sample No.	Depth (ft.)	Methylene Chloride (ug/Kg)	Toulene (ug/Kg)	Total Xylenes (ug/Kg)	Acetone (ug/Kg)	2-Butanone (ug/Kg)	Arsenic (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Magnesium (mg/Kg)	Mercury (mg/Kg)	Zinc (mg/Kg)	Aluminum (mg/Kg)
PZ10890002	0-1.4	27 UJ			55 V								
PZ10890003	0-3.0							17.5				129	
PZ10890204	2.0-3.3	13 AJ		3 AJ	200 V	43 V							
PZ10890307	3.0-6.5							12.2		3400		67.2	16100
PZ10890406	4.0-4.4	16 UJ		3 AJ	130 V								
PZ10890608	6.0-6.5			1 AJ	130 V	21 V							
PZ10890712	7.0-10.5						7.2	14.9	39.3	3280		195	19900
PZ10890712D	7.0-10.5(Dup.)						6.4	14	15.5	2800	1.1	157	
PZ10890810	8.0-10.0		3 AJ		56 V								
PZ10891012	10.0-10.5				44 V								
PZ10891317	13.0-15.2							18.8	19.5	2500		101	

Sample No.	Depth (ft.)	Barium (mg/Kg)	Calcium (mg/Kg)	Iron (mg/Kg)	Mangesium (mg/Kg)	Potassium (mg/Kg)	Strontium (mg/Kg)	Vanadium (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Cesium-137 (pCi/g)	Gross Beta (pCi/g)	Plutonium -230/240 (pCi/g)
PZ10890002	0-1.4												
PZ10890003	0-3.0											39.4	1.8
PZ10890204	2.0-3.3												
PZ10890307	3.0-6.5	120	25500	15600		1560	229	44			0.3		0.1
PZ10890406	4.0-4.4												
PZ10890608	6.0-6.5												
PZ10890712	7.0-10.5	171	30500	17300	594	1790	260	51	10.4	26.5			0.1
PZ10890712D	7.0-10.5(Dup.)										0.8	48.8	0.2
PZ10890810	8.0-10.0												
PZ10891012	10.0-10.5												
PZ10891317	13.0-15.2						250						

TABLE 2.13. SUMMARY OF CONTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P213689

Sample No.	Depth (ft.)	Radium-226 (pCi/g)	Radium-228 (pCi/g)	Strontium- 89,90 (pCi/g)	Uranium- 233,234 (pCi/g)	Uranium- 235 (pCi/g)	Uranium- 238 (pCi/g)	Tritium (pCi/g)
PZ10890002	0-1.4							
PZ10890003	0-3.0	1.0	2.0		1.2		0.8	3260
PZ10890204	2.0-3.3							
PZ10890307	3.0-6.5	0.9		1.4	1.0	0.1	0.8	1000
PZ10890406	4.0-4.4							
PZ10890608	5.0-6.5							
PZ10890712	7.0-10.5			0.8	2.0		1.3	
PZ10890712D	7.0-10.5(Dup.)	1.2	2.0	1.1	3.4	0.2	2.3	
PZ10890810	8.0-10.0							
PZ10891012	10.0-10.5							
PZ10891317	13.0-15.2	1.4	2.4		0.7			420.0

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifer(s)
NR=Result not reported

J=Detected at concentration less than detection limND=Not detected
B=Constituent detected in laboratory blank

TABLE 2.14. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P214089

Sample No.	Depth (ft.)	Methylene											
		Chloride (ug/Kg)	Acetone (ug/Kg)	Copper (mg/Kg)	Iron (mg/Kg)	Magnesium (mg/Kg)	Manganese (mg/Kg)	Potassium (mg/Kg)	Strontium (mg/Kg)	Zinc (mg/Kg)	Lead (mg/Kg)	Aluminum (mg/Kg)	Antimony (mg/Kg)
PZ23890002	0-1.7	9 UJ											
PZ23890003	0-3.0			16.9	14600	2790	248	1790	232	63.9	14.1		
PZ23890204	2.0-4.0	12 UJ											
PZ23890307	3.0-7.0			17.9	39300	3270	520		236	173	21.1	14200	39.6
PZ23890406	4.0-5.0	41 UJ											
PZ23890608	6.0-7.0	32 UJ	140 V										
PZ23890709	7.0-9.3					3000	487		255	45	17.7	14000	
PZ23890810	8.0-10.0	36 UJ											
PZ23890913	9.0-13.0					2830			244	64.5	17.8		
PZ23891212	10.0-12.0	40 UJ											
PZ23891319	13.0-19.0			15.2					233	82.8	18		
Sample No.	Depth (ft.)	Nitrate/ Nitrite											
		Arsenic (mg/Kg)	Barium (mg/Kg)	Nickel (mg/Kg)	Vanadium (mg/Kg)	Calcium (mg/Kg)							
PZ23890002	0-1.7												
PZ23890003	0-3.0									6.3			
PZ23890204	2.0-4.0												
PZ23890307	3.0-7.0	5.2	101	23.7	53								
PZ23890406	4.0-5.0												
PZ23890608	6.0-7.0												
PZ23890709	7.0-9.3	7	109		44.3	46000							
PZ23890810	8.0-10.0												
PZ23890913	9.0-13.0	4.5	553			15200							
PZ23891212	10.0-12.0												
PZ23891319	13.0-19.0					8540							

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.15. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P313489

Sample No.	Depth (ft.)	Acetone (ug/Kg)	Methylene Chloride (ug/Kg)	1,1,1- Trichloroethane (ug/Kg)	Arsenic (mg/Kg)	Barium (mg/Kg)	Calcium (mg/Kg)	Chromium (mg/Kg)
PZ05890002	0-1.4	18 UJ	9 AJ	11 V				
PZ05890003	0-3.0				4.8		36100	
PZ05890204	2.0-3.8	75 UJ		9 V				
PZ05890307	3.0-7.0						13300	27.4
PZ05890406	4.0-5.2	38 UJ		6 V				
PZ05890608	6.0-6.9	50 UJ		7 V				
PZ05890810	8.0-8.7			10 V				
PZ05890812	8.0-12.0				5	124		26.4
PZ05891012	10.0-11.4	34 UJ	6 V					
PZ05891214	12.0-14.0	20 UJ						
PZ05891218	12.0-18.0							
PZ05891416	14.0-14.2	14 UJ						
PZ05891618	16.0-16.8	44 UJ						
PZ05891820	18.0-19.3	100 AJ						
PZ05891821	18.0-21.0							
PZ05891821D	18.0-21.0(Dup.)	40 ug/g			4.5			
PZ05892022	20.0-22.0	36 UJ						
PZ05892124	21.0-24.0					530		
PZ05892224	22.0-24.0	17 AU	6 UJ					

Sample No.	Depth (ft.)	Copper (mg/Kg)	Iron (mg/Kg)	Lead (mg/Kg)	Magnesium (mg/Kg)	Manganese (mg/Kg)	Potassium (mg/Kg)	Zinc (mg/Kg)
PZ05890002	0-1.4							
PZ05890003	0-3.0			1	2630			
PZ05890204	2.0-3.8							
PZ05890307	3.0-7.0							
PZ05890406	4.0-5.2							
PZ05890608	6.0-6.9							
PZ05890810	8.0-8.7							
PZ05890812	8.0-12.0	12.7	15100			350		
PZ05891012	10.0-11.4							
PZ05891214	12.0-14.0							
PZ05891218	12.0-18.0	11.8						
PZ05891416	14.0-14.2							
PZ05891618	16.0-16.8							
PZ05891820	18.0-19.3							
PZ05891821	18.0-21.0	12.9			2590	246	1590	42.3
PZ05891821D	18.0-21.0(Dup.)	13.1						
PZ05892022	20.0-22.0							
PZ05892124	21.0-24.0	23.6		26.3		551		46.2
PZ05892224	22.0-24.0							

V=Validated and valid
NA=Not analyzed

J=Detected at concentrations less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.15. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P313489 – Continued

<u>Sample No.</u>	<u>Depth (ft.)</u>	<u>Gross Beta</u> <u>(pCi/g)</u>	<u>Plutonium–</u> <u>239/240</u> <u>(pCi/g)</u>	<u>Radium–</u> <u>226</u> <u>(pCi/g)</u>	<u>Radium–</u> <u>228</u> <u>(pCi/g)</u>	<u>Strontium–</u> <u>89,90</u> <u>(pCi/g)</u>	<u>Uranium–</u> <u>233,234</u> <u>(pCi/g)</u>	<u>Uranium–</u> <u>235</u> <u>(pCi/g)</u>	<u>Uranium–</u> <u>238</u> <u>(pCi/g)</u>
PZ05890002	0–1.4								
PZ05890003	0–3.0		16			1.0			
PZ05890204	2.0–3.8								
PZ05890307	3.0–7.0		0.02			2.8			
PZ05890406	4.0–5.2								
PZ05890608	6.0–6.9								
PZ05890810	8.0–8.7								
PZ05890812	8.0–12.0	49.9					0.8		0.9
PZ05891012	10.0–11.4								
PZ05891214	12.0–14.0								
PZ05891218	12.0–18.0								0.7
PZ05891416	14.0–14.2								
PZ05891618	16.0–16.8								
PZ05891820	18.0–19.3								
PZ05891821	18.0–21.0		0.02	0.9			0.8	0.1	0.9
PZ05891821D	18.0–21.0(Dup.)			0.7			0.8		0.7
PZ05892022	20.0–22.0				1.2				
PZ05892124	21.0–24.0			1.5		1.8	1.0		1.1
PZ05892224	22.0–24.0								

V=Validated and valid
NA=Not analyzed

J=Detected at concentrations less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.16. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P418289

Sample No.	Depth (ft.)	Methylene	Acetone (ug/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Vanadium (mg/Kg)	Calcium (mg/Kg)	Manganese (mg/Kg)	Potassium (mg/Kg)	Nitrate/ Nitrite	Cesium-	Plutonium-	Radium-	Radium-	Uranium-	
		Chloride (ug/Kg)								(mg/Kg)	137 (pCi/g)	239 (pCi/g)	226 (pCi/g)	228 (pCi/g)	235 (pCi/g)	
P4182890002	0-1.6	5 UJ	11 UJ													
P4182890003	0-3.0			13.3	13.2					7.2		0.04	0.7			0.08
P4182890204	2.0-3.5	6 AU	28 UJ													
P4182890306	3.0-6.0					40.5										
P4182890406	4.0-6.0	5 UJ	22 UJ													
P4182890608	6.0-8.0	6 UJ	36 UJ													
P4182890610	6.0-10.0						30300	285					0.9	2.1		0.08
P4182890810	8.0-10.0	6 UJ	21 UJ													
P4182891012	10.0-11.2	5 UJ	22 UJ													
P4182891014	10.0-14.0															0.08
P4182891214	12.0-14.0		25 ug/g													
P4182891416	14.0-15.3	8 UJ	18 UJ	16.2				2600								
P4182891618	16.0-17.4	5 UJ	27 UJ													
P4182891619	16.0-19.0			11.4												
P4182891820	18.0-19.6	7 UJ	20 UJ													
P4182891923	19.0-23.0			16.6					1590		0.2					
P4182892022	20.0-21.8	7 UJ	13 UJ													
P4182892224	22.0-24.0	8 UJ	17 UJ													
P4182892326	23.0-26.0			12.5												
P4182892526	25.0-26.0	8 UJ	12 UJ													

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualification
NR=Result not reported
U=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.17. SUMMARY OF CONSTITUENTS DETECTED IN
CONCENTRATIONS ABOVE BACKGROUND IN
GROUNDWATER SAMPLES FROM WELL P418289

Sample Date	1,1-Dichloroethane (ug/l)	1,1-Dichloroethene (ug/l)	1,2-Dichloroethene (ug/l)	Chlorobenzene (ug/l)	Tetrachloroethene (ug/l)	Trichloroethene (ug/l)	Vinyl Chloride (ug/l)	Barium (mg/l)	Calcium (mg/l)	Chromium (mg/l)	Magnesium (mg/l)	Mercury (mg/l)
22-Mar-90	1J	2J	140	2J	110	22	63	NR	NR	NR	NR	NR
22-Mar-90 (Rep.)	2J	5	110	4J	160	28B	70	NA	NA	NA	NA	NA
19-May-90	ND	2J	93	3J	80	17	15	0.284	159.0	ND	20.9	0.0017
11-Sep-90	1J	ND	NR	5	81	17	9J	0.236	132.0	0.0203	17.4	0.0012
19-Nov-90	1J	3J	42	6	100	18	9J	0.267	155.0	ND	20.0	0.0014
19-Mar-91	ND	4J	140	6	140	24	ND	0.255	142.0		18.4	0.00058
18-Jun-91	ND	3J	110	ND	96	16	14		145.0	0.0103	18.4	0.0014
16-Aug-91	ND	ND	ND	ND	ND	ND	ND		126.0		15.4	0.00026
11-Nov-91	ND	3J	100	5	99	19	16	0.277	150.0	0.0159	19.1	0.0016

Sample Date	Sodium (mg/l)	Strontium (mg/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Nitrate/ Nitrite (mg/l)	Sulfate (mg/l)	Uranium- 233,234 (pCi/l)	Uranium- -238 (pCi/l)
22-Mar-90	NR	NR	360V	110v		38V	2.727	1.636
19-May-90	29.8		314	109	2.8	40.2	NA	NA
11-Sep-90	31.4		310	120		43	1.295	
19-Nov-90	33.0		300	110		NA	1.552	
19-Mar-91	29.1	0.582	300	57		40	NA	NA
18-Jun-91	30.6	0.59	290	97		39	1.421	
16-Aug-91	38.2	0.497	260	130	2.3	33	1.982	1.114
11-Nov-91	30.9	0.622	300	120		40	NA	NA

V=Validated and valid A=Validated and valid with qualifier(s) J=Detected at concentration less than detection limit ND=Not detected NA=Not analyzed NR=Result not reported
B=Constituent detected in laboratory blank

TABLE 2.18. SUMMARY OF CONSTITUENTS DETECTED IN
CONCENTRATIONS ABOVE BACKGROUND IN
GROUNDWATER SAMPLES FROM WELL 6186

Sample Date	Tetrachloroethene (ug/l)	Acetone (ug/l)	Calcium (mg/l)	Chromium (mg/l)	Lead (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Nitrate/ Nitrite (mg/l)	Sulfate (mg/l)	Cesium-137 (pCi/l)
24-Jul-89	2AJ	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
23-Mar-90	ND	45	74	ND	ND	12		160	12	5.6	60	0.8
18-May-90	ND	ND	67	0.007B	0.01	12		170	NA	6.1	NA	
03-Aug-90	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
13-Dec-90	NA	NA	NA	NA	NA	NA	NA	170		6.8	90	NA
13-Jun-91	ND	ND	77		ND	13	11	400	10	4.0	230	NA
08-Aug-91	ND	5J	80	0.015	ND	13	11	NA	NA	NA	NA	NA
18-Oct-91	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Strontium-89,90 (pCi/l)	Uranium- 233,234 (pCi/l)	Uranium- 238 (pCi/l)
24-Jul-89	NA	NA	NA
23-Mar-90		NA	NA
18-May-90		NA	NA
03-Aug-90	NA	NA	NA
13-Dec-90	NA	NA	NA
13-Jun-91	NA	2.3	1.5
08-Aug-91	1.9	2.0	2.0
18-Oct-91	NA	NA	NA

V=Validated and valid A=Validated and valid with qualifier(s) J=Detected at concentration less than detection limit ND=Not detected NA=Not analyzed
NR=Result not reported B=Constituent detected in laboratory blank

TABLE 2.19. SUMMARY OF CONTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P 114889

<u>Sample No.</u>	<u>Depth (ft.)</u>	Carbon Disulfide <u>(ug/Kg)</u>	Methylene Chloride <u>(ug/Kg)</u>	Acetone <u>(ug/Kg)</u>	Aluminum <u>(mg/Kg)</u>	Iron <u>(mg/Kg)</u>	Magnesium <u>(mg/Kg)</u>	Zinc <u>(mg/Kg)</u>	Arsenic <u>(mg/Kg)</u>	Copper <u>(mg/Kg)</u>
PZ44890002	0-1.6	2 AJ	19 UJ	190 AJ						
PZ44890003	0-3.0				17500	15200	2800	50.2		
PZ44890204	2.0-3.7		17 UJ							
PZ44890306	3.0-6.0									
PZ44890506	5.0-6.0	1 AJ	15 UJ	34 AJ						
PZ44890608	6.0-7.3		17 UJ	75 AJ		15200			9.8	11.3
PZ44890911	9.0-11.0		14 ug/g	44 ug/g						
PZ44890911D	9.0-11.0(Dup.)		15 UJ	11 UJ						
PZ44890913	9.0-13.8				13600				5.1	
PZ44890913D	9.0-13.8(Dup.)									
PZ44891214	12.0-13.9	19 V	12 UJ	130 AJ						
PZ44891318	13.8-18.0				17100	21400	4270		8.9	16.3
PZ44891416	14.0-16.0	3 AJ	22 UJ	77 AJ						
PZ44891618	16.0-18.0		19 UJ	12 UJ						

<u>Sample No.</u>	<u>Depth (ft.)</u>	Vanadium <u>(mg/Kg)</u>	Potassium <u>(mg/Kg)</u>	Radium-228 <u>(pci/g)</u>	Radium-226 <u>(pci/g)</u>	Uranium -233, -234 <u>(pci/g)</u>	Plutonium -239/240 <u>(pci/g)</u>	Uranium-238 <u>(pci/g)</u>	Uranium-235 <u>(pci/g)</u>
PZ44890002	0-1.6								
PZ44890003	0-3.0			2.5	0.7	1.2	0.02	0.8	
PZ44890204	2.0-3.7								
PZ44890306	3.0-6.0				0.8	0.7			
PZ44890506	5.0-6.0								
PZ44890608	6.0-7.3	41.4			1				
PZ44890911	9.0-11.0								
PZ44890911D	9.0-11.0(Dup.)								
PZ44890913	9.0-13.8				1			0.7	
PZ44890913D	9.0-13.8(Dup.)			2	1	0.8			
PZ44891214	12.0-13.9								
PZ44891318	13.8-18.0	49.6	2190			0.9		1.1	0.1
PZ44891416	14.0-16.0								
PZ44891616	16.0-18.0								

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifier(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Contituent detected in laboratory blank

ND=Not detected

TABLE 2.20. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P115489

Sample No.	Depth (ft.)	Methylene											
		Chloride (ug/Kg)	Toulene (ug/Kg)	Acetone (ug/Kg)	Aluminum (mg/Kg)	Barium (mg/Kg)	Copper (mg/Kg)	Iron (mg/Kg)	Vanadium (mg/Kg)	Calcium (mg/Kg)	Arsenic (mg/Kg)	Lead (mg/Kg)	Magnesium (mg/Kg)
PZ49890002	0-1.2	17 UJ	2 VU	6 AJ									
PZ49890003	0-3.0				17100	89.2	14	17900	52.2				
PZ49890204	2.0-3.8	19 UJ		11 AJ									
PZ49890306	3.0-6.0						28.1	26700	77.2	23000			
PZ49890406	4.0-6.0	18 UJ	1 AJ										
PZ49890608	6.0-7.8	17 UJ								43800			
PZ49890810	8.0-9.4	18 UJ											
PZ49890812	9.0-11.0												
PZ49891012	10.0-11.0	22 UJ											
PZ49891214	12.0-14.0	29 ug/g		7 ug/g									
PZ49891416	14.0-16.0	23 UJ											
PZ49891418	14.0-18.0						22.4	15500	42.3		6.7	16.5	2830
PZ49891618	16.0-18.0	24 UJ											
PZ49891822	18.0-22.0												
PZ49892022	20.0-22.0	20 UJ		14 UJ									
PZ49892224	22.0-24.0	23 UJ											
PZ49892226	22.0-26.0												
PZ49892426	24.0-26.0	26 UJ											
PZ49892628	26.0-27.8	22 UJ		17 UG									
PZ49892631	26.0-31.0												
PZ49893031	30.0-31.0	29 UJ											

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifiers(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.20. SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM WELL P115489 – Continued

Sample No.	Depth (ft.)	Zinc (mg/Kg)	Nitrate/ Nitrite (mg/Kg)	Plutonium – 239/240 (pCi/g)	Radium – 226 (pCi/g)	Uranium – 233,234 (pCi/g)	Uranium – 235 (pCi/g)	Uranium – 238 (pCi/g)	Radium – 228 (pCi/g)	Tritium (pCi/g)	Gross Beta (pCi/g)	Strontium – 89,90 (pCi/g)
PZ49890002	0–1.2											
PZ49890003	0–3.0		15	0.03	12	1.3	0.1	1.0				
PZ49890204	2.0–3.8											
PZ49890306	3.0–6.0		5.3		0.8	0.7		1.0	2.1			
PZ49890406	4.0–6.0											
PZ49890608	6.0–7.8				0.9							
PZ49890810	8.0–9.4											
PZ49890812	9.0–11.0						0.1					
PZ49891012	10.0–11.0											
PZ49891214	12.0–14.0									430		
PZ49891416	14.0–16.0											
PZ49891418	14.0–18.0	40.2			0.7						432	
PZ49891618	16.0–18.0											
PZ49891822	18.0–22.0				0.7	0.8						1.9
PZ49892022	20.0–22.0											
PZ49892224	22.0–24.0											
PZ49892226	22.0–26.0				0.7	1.7	0.1	1.7				
PZ49892426	24.0–26.0											
PZ49892628	26.0–27.8											
PZ49892631	26.0–31.0				0.9	1.4		1.1				
PZ49893031	30.0–31.0											

V=Validated and valid
NA=Not analyzed

A=Validated and valid with qualifiers(s)
NR=Result not reported

J=Detected at concentration less than detection limit
B=Constituent detected in laboratory blank

ND=Not detected

TABLE 2.21. SUMMARY OF CONSTITUENTS DETECTED IN
CONCENTRATIONS ABOVE BACKGROUND IN
GROUNDWATER SAMPLES FROM WELL 4486

Sample Date	Tetra chloroethene	1,1,1- Trichloroethane	Acetone	Chloroform	Trichloroethene	1,1-Dichloroethane	Barium	Calcium	Chromium	Magnesium	Manganese	Mercury
	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
20-Mar-89	37V	ND	ND	ND	ND	ND		95	ND	9		ND
19-Jun-89	20V	ND	ND	ND	ND	ND		81	ND	8	ND	ND
29-Sep-89	14V	3AJ	ND	ND	ND	ND		86	ND	8		ND
29-Sep-89 (Dup.)	ND	ND	ND	ND	ND	ND		86	ND	8		ND
23-Mar-90	ND	ND	ND	ND	ND	ND		65	ND	7	ND	ND
14-Jun-90	14	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR
27-Aug-90	22	ND	16	ND	ND	ND			ND			ND
18-Mar-91	6	ND	ND	16	1J	ND		52	ND		ND	ND
20-Jun-91	12	4J	ND	ND	ND	ND	0.144B	89	0.02	9	ND	ND
20-Jun-91 (Dup.)	14	4J	ND	ND	ND	ND	0.142B	87	0.01	9	ND	ND
14-Aug-91	15	6	ND	ND	1J	2J	0.124B	73	0.0079B	7		ND
08-Nov-91	10	ND	ND	ND	ND	ND	0.136B	79	ND	8		0.0002

Sample Date	Sodium	Bicarbonate	Chloride	Nitrate/ Nitrite	Gross Beta	Strontium-89,90	Tritium	Uranium- 233,234	Uranium- -238
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)
20-Mar-89	45	167AJ	93.8V	14.0AJ		NA		NA	NA
19-Jun-89	33	194V	38.4V	9.92V	10.4	NA		NA	NA
29-Sep-89	33	200	23.2	6.13	9.5	NA	NA	3.5	2.2
29-Sep-89 (Dup.)	32	199	23.0	6.02	NA	NA	NA	NA	NA
23-Mar-90	34	150	81	6.8	NA		NA	NA	NA
14-Jun-90	NR	169V	36.7V	5.1AJ	NA			1.1	2.8
27-Aug-90	21		21	3.9			632.5	1.1	1.7
11-Dec-90	35	180	62	4.1	NA	NA	NA	NA	NA
18-Mar-91	43		78	2.7	NA	NA	NA	NA	NA
20-Jun-91	42	180	83	6.9		1.4		2.3	3.3
20-Jun-91 (Dup.)	35	180	85	6.9				1.4	2.4
14-Aug-91	47	200	45	4.2				1.2	1.8
14-Aug-91 (Rep.)		NA	NA	NA				1.7	2.9
08-Nov-91		160	110	3.6	NA	NA	NA	NA	NA

V=Validated and valid A=Validated and valid with qualifier(s) J=Detected at concentration less than detection limit ND=Not detected NA=Not analyzed
NR= Result not Reported B=Constituent detected in laboratory blank

Table 2.22
Summary of Indicator-Radionuclide Data

Surface Water Site Description	Species	Gross Alpha	Gross Beta	No. of Samples
SW018	Dissolved	4.81	8.95	2
SW019	Dissolved	4.10	6.65	1
SW020	Dissolved	1.57	6.32	1
SW022	Dissolved	10.59	14.42	6
SW022	Total	16.41	27.33	5
SW022 Ppt ¹⁾	Total	1.18	3.25	3
SW023	Dissolved	5.41	5.70	7
SW023	Total	8.86	18.80	10
SW093	Dissolved	6.77	8.85	6
SW093	Total	19.29	23.96	15
SW118	Dissolved	2.66	4.75	7
SW118	Total	32.41	39.02	8
SW118 Ppt ¹⁾	Total	0.27	2.91	4
1) Bulk				
Sediment Samples				
SED118	Dissolved	7.62	24.81	3

Table 2.23
Trace-Metal Sample Coverage

Site	No.	1990 Survey Dates	No.	1991 Survey Dates
SW018	0		7	3/25, 4/16, 5/30, 6/17, 8/19, 9/9, 10/7 (dissolved only)
SW019	0		1	4/12/91
SW020	0		1	4/12/91
SW022	4	7/23 ³⁾ , 9/7 ²⁾ , 11/7 ²⁾ , 11/18 ²⁾	5	5/17 ²⁾ , 5/23 ²⁾ , 6/3 ²⁾ , 6/11 ²⁾ , 8/19 ²⁾
SW023	6	10/16 ³⁾ , 11/16 ³⁾ , 7/23 ³⁾ , 7/24 ²⁾ , 11/8 ²⁾ , 11/19 ²⁾	17	4/17 ³⁾ , 9/16 ³⁾ , 1/14 ³⁾ , 3/27 ³⁾ , 5/20 ³⁾ , 8/6 ³⁾ , 9/16 ³⁾ , 10/15 ³⁾ , 2/22 ²⁾ , 4/10 ²⁾ , 4/15 ²⁾ , 5/17 ²⁾ , 5/23 ²⁾ , 5/28 ²⁾ , 4/17 ³⁾ , 9/16 ³⁾ , 4/8 ³⁾
SW093	15	7/30 ³⁾ , 6/22 ³⁾ , 7/30 ³⁾ , 8/30 ³⁾ , 9/25 ³⁾ , 10/17 ³⁾ , 11/19 ³⁾ , 1/29 ³⁾ , 2/21 ³⁾ , 3/16 ³⁾ , 5/29 ³⁾ , 7/23 ³⁾ , 7/24 ²⁾ , 9/6 ²⁾ , 10/24 ²⁾	8	4/15 ³⁾ , 5/22 ³⁾ , 8/14 ¹⁾ , 9/19 ³⁾ , 5/17 ²⁾ , 6/11 ²⁾ , 7/29 ²⁾ , 8/19 ²⁾
SW118	2	10/29 ³⁾ , 11/23 ³⁾	8	3/21 ³⁾ , 4/10 ³⁾ , 9/9 ³⁾ , 8/7 ¹⁾ , 5/17 ²⁾ , 5/23 ²⁾ , 6/3 ²⁾ , 6/11 ²⁾
SED118	2	9/18/90, 11/28/90	3	3/27/91, 5/21/91, 8/13/91

- 1) Dissolved
- 2) Total
- 3) Both Dissolved and Total

Table 2.24
Summary of Primary Pollutants

Site	Date	Chemical Compound	Concentration (units)
SW118	10/29/90	Methylene chloride	6 ug/L
SW018	05/30/91	Methylene chloride	6 ug/L
	06/17/91	Carbon Tetrachloride	8 ug/L
	06/17/91	Chloramethane	130 ug/L
	06/17/91	Methylene chloride	36 ug/L
	09/09/91	Methylene chloride	9 ug/L
SW023	09/16/91	Methylene chloride	8 ug/L
	08/06/91	Acetone	15 ug/L
	08/06/91	Methylene chloride	9 ug/L
	09/16/91	Methylene chloride	7 ug/L
SW093	07/30/90	Methylene chloride	4 ug/L
	01/29/90	Methylene chloride	6 - 7 ug/L
	04/15/91	Methylene chloride	19 ug/L
	08/14/91	Methylene chloride	38 ug/L
	09/19/91	Methylene chloride	6 ug/L
	09/19/91	Tetrachloroethene	6 ug/L
SW118	10/29/90	Methylene chloride	6 ug/L
	08/07/91	Acetone	15 ug/L
	08/07/91	Methylene chloride	12 ug/L
SED118	09/18/90	Methylene chloride	10 ug/Kg
	11/28/90	2-Butanone	59 ug/Kg
	05/21/91	Methylene chloride	110 ug/Kg
	08/13/91	Acetone	21 ug/Kg
	08/13/91	Methylene chloride	23 ug/Kg

Table 2.25

**Summary Statistics – Selected Trace Metals, OU13 Area
Surface– Water and Sediment Sites**

A. Trace Metals, Surface-Water Sites

<u>Aluminum, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	7	82.59	130.00	17.00
		SW019	1	108.00	108.00	108.00
		SW020	1	108.00	108.00	108.00
		SW022	—	—	—	—
		SW023	13	56.15	108.00	13.00
		SW037	—	—	—	—
		SW038	7	84.01	108.00	22.30
		SW083	18	103.52	457.00	10.00
		SW118	8	86.03	184.00	10.00
		SW129	7	80.79	108.00	18.00
		SED118	—	—	—	—
<u>Aluminum, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	97.40	188.00	32.00
		SW019	1	8280.00	8280.00	8280.00
		SW020	1	13000.00	13000.00	13000.00
		SW022	10	24150.00	48400.00	4710.00
		SW023	22	10397.75	73600.00	48.00
		SW037	—	—	—	—
		SW038	8	177.07	672.00	36.80
		SW083	23	14347.18	110000.00	71.00
		SW118	9	31291.20	120000.00	83.80
		SW129	8	323.83	845.00	80.00
		SED118	4	9482.50	14300.00	8250.00
<u>Antimony, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	7	19.40	42.20	11.00
		SW019	1	25.80	25.80	25.80
		SW020	1	25.80	25.80	25.80
		SW022	—	—	—	—
		SW023	13	18.73	26.00	11.00
		SW037	—	—	—	—
		SW038	7	22.07	42.20	6.00
		SW083	15	27.49	60.00	7.00
		SW118	8	18.82	25.80	7.00
		SW129	7	18.80	25.80	11.00
		SED118	4	125.25	188.00	98.00
<u>Antimony, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	15.98	25.80	11.00
		SW019	1	25.80	25.80	25.80
		SW020	1	25.80	25.80	25.80
		SW022	10	28.38	40.2	11
		SW023	22	22.88	37.00	8.00
		SW037	—	—	—	—
		SW038	8	21.53	30.00	11.70
		SW083	23	28.71	60.00	11.00
		SW118	9	30.18	62.60	7.00
		SW129	8	23.02	30.00	16.70
		SED118	4	7.00	13.30	2.40
<u>Arsenic, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	7	1.38	2.00	0.70
		SW019	1	0.90	0.90	0.90
		SW020	1	0.90	0.90	0.90
		SW022	—	—	—	—
		SW023	13	1.42	2.00	0.80
		SW037	—	—	—	—
		SW038	7	1.37	3.00	0.70
		SW083	15	3.72	10.00	0.80
		SW118	8	1.45	2.00	0.80
		SW129	7	1.31	2.30	0.80
		SED118	—	—	—	—
<u>Arsenic, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	1.88	4.00	0.80
		SW019	1	0.90	0.90	0.90
		SW020	1	1.80	1.80	1.80
		SW022	10	4.89	9.00	1.30
		SW023	22	3.08	10.00	0.80
		SW037	—	—	—	—
		SW038	8	1.47	2.00	0.80
		SW083	23	3.58	10.00	0.80
		SW118	9	2.77	5.80	0.80
		SW129	8	1.28	2.00	0.80
		SED118	4	6.53	10.20	5.00

Table 2.25

Summary Statistics – Selected Trace Metals, OUI3 Area
Surface–Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

<u>Barium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		7	119.21	140.00	90.80
	SW019		1	26.40	26.40	26.40
	SW020		1	17.30	17.30	17.30
	SW022		—	—	—	—
	SW023		13	89.10	154.00	4.40
	SW037		—	—	—	—
	SW038		7	151.57	180.00	137.00
	SW093		15	146.18	200.00	83.00
	SW118		8	105.37	130.00	85.20
	SW129		7	126.81	186.00	49.70
	SED118		—	—	—	—

<u>Barium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	129.00	140.00	102.00
	SW019		1	88.60	88.60	88.60
	SW020		1	94.50	94.50	94.50
	SW022		10	289.85	486.00	93.50
	SW023		22	179.09	742.00	4.40
	SW037		—	—	—	—
	SW038		8	150.33	186.00	141.00
	SW093		23	225.52	1000.00	83.10
	SW118		9	459.08	1980.00	91.50
	SW129		6	125.70	173.00	47.20
	SED118		4	125.25	188.00	98.00

<u>Beryllium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		8	0.84	1.40	0.50
	SW019		1	0.50	0.50	0.50
	SW020		1	0.50	0.50	0.50
	SW022		—	—	—	—
	SW023		18	1.01	3.00	0.50
	SW037		—	—	—	—
	SW038		7	0.73	1.00	0.50
	SW093		18	2.39	5.00	0.50
	SW118		7	0.94	2.00	0.50
	SW129		8	0.89	2.00	0.50
	SED118		—	—	—	—

<u>Beryllium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		7	1.10	2.40	0.80
	SW019		1	0.50	0.50	0.50
	SW020		1	0.70	0.70	0.70
	SW022		13	2.12	3.20	1.00
	SW023		29	1.72	5.20	0.60
	SW037		—	—	—	—
	SW038		6	1.00	2.00	0.50
	SW093		28	2.22	6.80	0.50
	SW118		11	2.73	10.80	0.50
	SW129		6	0.93	2.00	0.50
	SED118		5	0.80	1.20	0.44

<u>Cadmium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		4	3.25	4.80	2.40
	SW019		1	3.30	3.30	3.30
	SW020		1	3.30	3.30	3.30
	SW022		—	—	—	—
	SW023		10	2.97	5.00	2.00
	SW037		—	—	—	—
	SW038		7	3.14	5.00	2.00
	SW093		12	3.18	5.00	2.00
	SW118		5	2.78	3.30	2.00
	SW129		6	3.37	5.00	2.00
	SED118		—	—	—	—

<u>Cadmium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		2	3.00	3.30	2.70
	SW019		1	3.30	3.30	3.30
	SW020		1	3.30	3.30	3.30
	SW022		7	4.70	5.90	3.00
	SW023		14	5.71	11.30	2.00
	SW037		—	—	—	—
	SW038		8	2.83	5.00	2.00
	SW093		18	3.59	5.80	2.00
	SW118		7	4.00	9.80	2.00
	SW129		6	3.15	5.00	2.00
	SED118		3	1.14	1.50	0.81

Table 2.25

**Summary Statistics – Selected Trace Metals, OU13 Area
Surface– Water and Sediment Sites**

A. Trace Metals, Surface-Water Sites

Calcium, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	7	77828.57	84000.00	59400.00
		SW019	1	10900.00	10900.00	10900.00
		SW020	1	10800.00	10800.00	10800.00
		SW022	—	—	—	—
		SW023	13	60572.54	99700.00	105.00
		SW037	—	—	—	—
		SW038	7	79200.00	89500.00	62700.00
		SW093	18	82458.25	118000.00	41400.00
		SW118	6	57518.87	67200.00	48000.00
		SW129	7	66400.00	80200.00	32100.00
		SED118	—	—	—	—

Calcium, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	78680.00	89000.00	60800.00
		SW019	1	12200.00	12200.00	12200.00
		SW020	1	18800.00	18800.00	18800.00
		SW022	10	58980.00	108000.00	24500.00
		SW023	22	54202.73	94900.00	180.00
		SW037	—	—	—	—
		SW038	8	80418.87	89300.00	68000.00
		SW093	23	63421.74	108000.00	24000.00
		SW118	9	56577.78	101000.00	25000.00
		SW129	8	67218.87	89700.00	28300.00
		SED118	4	9082.50	12000.00	6800.00

Cesium, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	7	308.57	500.00	50.00
		SW019	1	500.00	500.00	500.00
		SW020	1	500.00	500.00	500.00
		SW022	—	—	—	—
		SW023	13	330.85	500.00	50.00
		SW037	—	—	—	—
		SW038	7	380.43	500.00	51.00
		SW093	18	581.50	2500.00	50.00
		SW118	6	321.00	500.00	50.00
		SW129	7	371.57	500.00	50.00
		SED118	—	—	—	—

Cesium, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	232.00	500.00	50.00
		SW019	1	500.00	500.00	500.00
		SW020	1	500.00	500.00	500.00
		SW022	7	180.43	500.00	1.00
		SW023	18	239.58	500.00	50.00
		SW037	—	—	—	—
		SW038	8	277.50	500.00	2.00
		SW093	18	448.25	2500.00	0.50
		SW118	9	233.22	500.00	1.00
		SW129	6	342.17	500.00	2.00
		SED118	4	53.90	150.00	2.60

Chromium, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	83	4.39	6.80	2.00
		SW019	1	4.10	4.10	4.10
		SW020	1	4.10	4.10	4.10
		SW022	—	—	—	—
		SW023	13	4.48	7.80	2.00
		SW037	—	—	—	—
		SW038	7	4.28	6.50	2.60
		SW093	15	6.75	19.40	2.00
		SW118	8	7.03	18.50	2.00
		SW129	7	4.31	6.80	2.20
		SED118	—	—	—	—

Chromium, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	3.96	6.80	2.00
		SW019	1	12.80	12.80	12.80
		SW020	1	10.80	10.80	10.80
		SW022	10	30.00	82.20	7.30
		SW023	22	16.08	95.00	2.00
		SW037	—	—	—	—
		SW038	8	5.32	10.00	3.30
		SW093	23	20.11	99.00	2.00
		SW118	9	35.38	130.00	4.10
		SW129	6	5.80	10.00	4.00
		SED118	4	9.03	11.30	7.40

Table 2.25
 Summary Statistics – Selected Trace Metals, OU13 Area
 Surface–Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

Cobalt, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	83	3.34	7.30	2.00
		SW019	1	3.80	3.80	3.80
		SW020	1	3.80	3.80	3.80
		SW022	—	—	—	—
		SW023	13	3.17	4.00	2.00
		SW037	—	—	—	—
		SW038	7	3.90	7.30	2.80
		SW083	15	15.84	50.00	2.00
		SW118	8	3.52	5.80	2.00
		SW129	7	3.14	4.00	2.00
		SED118	—	—	—	—

Cobalt, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	2.52	3.80	2.00
		SW019	1	5.40	5.40	5.40
		SW020	1	4.10	4.10	4.10
		SW022	10	12.73	24.40	3.80
		SW023	22	8.53	38.70	2.40
		SW037	—	—	—	—
		SW038	8	4.53	10.00	3.00
		SW083	23	15.98	53.00	2.00
		SW118	9	18.98	87.10	3.00
		SW129	8	4.53	10.00	3.00
		SED118	4	9.08	15.00	6.30

Copper, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	88	4.83	13.80	2.00
		SW019	1	4.70	4.70	4.70
		SW020	1	19.70	19.70	19.70
		SW022	—	—	—	—
		SW023	13	5.08	13.20	2.00
		SW037	—	—	—	—
		SW038	7	5.27	11.00	3.00
		SW083	15	9.28	25.00	2.00
		SW118	6	5.33	13.80	2.00
		SW129	7	5.83	14.10	3.00
		SED118	—	—	—	—

Copper, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	7.34	19.00	2.00
		SW019	1	18.20	18.20	18.20
		SW020	1	17.80	17.80	17.80
		SW022	10	58.83	109.00	18.00
		SW023	22	28.80	128.00	2.00
		SW037	—	—	—	—
		SW038	8	6.40	11.00	3.00
		SW083	23	28.27	120.00	2.00
		SW118	11	35.79	182.00	1.50
		SW129	7	8.23	13.70	2.00
		SED118	4	18.70	35.80	11.10

Iron, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	98	105.13	240.00	8.50
		SW019	1	108.00	108.00	108.00
		SW020	1	83.50	83.50	83.50
		SW022	—	—	—	—
		SW023	13	39.38	131.00	3.00
		SW037	—	—	—	—
		SW038	7	33.33	137.00	3.00
		SW083	18	182.89	750.00	8.00
		SW118	8	85.17	87.00	20.80
		SW129	7	45.10	90.50	18.70
		SED118	—	—	—	—

Iron, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	280.40	480.00	20.00
		SW019	1	8400.00	8400.00	8400.00
		SW020	1	12200.00	12200.00	12200.00
		SW022	10	25578.00	49800.00	5280.00
		SW023	22	11462.83	77200.00	27.80
		SW037	—	—	—	—
		SW038	8	178.73	514.00	12.80
		SW083	23	18052.22	110000.00	488.00
		SW118	9	35480.58	158000.00	149.00
		SW129	8	361.17	730.00	10.00
		SED118	4	14500.00	21700.00	10800.00

Table 2.25
 Summary Statistics – Selected Trace Metals, OUI3 Area
 Surface–Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

<u>Lead, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		98	1.37	2.40	0.90
	SW019		1	3.10	3.10	3.10
	SW020		1	1.90	1.90	1.90
	SW022		—	—	—	—
	SW023		13	1.52	4.90	0.40
	SW037		—	—	—	—
	SW038		7	1.09	1.40	0.90
	SW093		15	8.23	100.00	0.40
	SW118		6	1.23	1.50	1.00
	SW129		17	2.91	10.00	0.90
	SED118		—	—	—	—

<u>Lead, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	2.74	3.20	2.40
	SW019		1	29.10	29.10	29.10
	SW020		1	28.40	28.40	28.40
	SW022		9	68.80	128.00	24.50
	SW023		21	18.15	130.00	1.00
	SW037		—	—	—	—
	SW038		6	1.43	2.00	1.00
	SW093		23	28.81	100.00	0.70
	SW118		9	25.68	103.00	1.00
	SW129		6	1.90	3.00	1.40
	SED118		4	16.88	21.80	14.90

<u>Lithium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		98	6.36	8.10	4.30
	SW019		1	2.00	2.00	2.00
	SW020		1	2.00	2.00	2.00
	SW022		—	—	—	—
	SW023		13	10.27	26.00	4.30
	SW037		—	—	—	—
	SW038		7	6.01	10.00	2.00
	SW093		18	42.24	100.00	3.70
	SW118		6	11.85	20.00	7.40
	SW129		7	7.03	10.00	4.30
	SED118		—	—	—	—

<u>Lithium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	7.22	8.40	4.30
	SW019		1	6.90	6.90	6.90
	SW020		1	10.40	10.40	10.40
	SW022		7	16.30	27.40	7.80
	SW023		18	9.48	26.00	3.70
	SW037		—	—	—	—
	SW038		6	13.20	50.00	2.00
	SW093		18	33.02	100.00	0.50
	SW118		9	26.78	84.50	7.40
	SW129		6	14.10	50.00	4.40
	SED118		4	8.90	11.20	6.90

<u>Magnesium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		93	15257.14	17700.00	11500.00
	SW019		1	1150.00	1150.00	1150.00
	SW020		1	1130.00	1130.00	1130.00
	SW022		—	—	—	—
	SW023		13	15468.60	25000.00	36.60
	SW037		—	—	—	—
	SW038		7	17371.43	20900.00	15200.00
	SW093		16	18655.83	27100.00	10.00
	SW118		8	14633.33	17500.00	11000.00
	SW129		7	17177.14	20400.00	5340.00
	SED118		—	—	—	—

<u>Magnesium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	15880.00	17700.00	11700.00
	SW019		1	2590.00	2590.00	2590.00
	SW020		1	4080.00	4080.00	4080.00
	SW022		10	11557.00	20800.00	4940.00
	SW023		22	12871.66	23000.00	36.60
	SW037		—	—	—	—
	SW038		8	17988.67	20900.00	18200.00
	SW093		23	16176.98	31000.00	5770.00
	SW118		9	20255.56	50000.00	12000.00
	SW129		6	17013.33	20400.00	4890.00
	SED118		4	2935.00	4270.00	2400.00

Table 2.25
Summary Statistics – Selected Trace Metals, OU13 Area
Surface– Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

<u>Manganese, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		83	147.88	204.00	120.00
	SW019		1	15.20	15.20	15.20
	SW020		1	8.20	8.20	8.20
	SW022		—	—	—	—
	SW023		13	28.40	75.00	1.00
	SW037		—	—	—	—
	SW038		7	12.14	27.30	3.80
	SW083		17	580.44	1420.00	78.70
	SW118		8	13.22	28.80	5.40
	SW129		7	18.88	72.00	9.40
	SED118		—	—	—	—

<u>Manganese, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	148.00	170.00	120.00
	SW019		1	87.00	87.00	87.00
	SW020		1	148.00	148.00	148.00
	SW022		10	520.70	942.00	108.00
	SW023		22	324.38	1300.00	1.00
	SW037		—	—	—	—
	SW038		8	20.15	32.00	11.10
	SW083		22	804.71	2100.00	87.80
	SW118		9	721.74	3840.00	7.50
	SW129		8	37.45	58.40	18.20
	SED118		4	315.00	457.00	210.00

<u>Mercury, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		83	0.20	0.20	0.20
	SW019		1	0.20	0.20	0.20
	SW020		1	0.20	0.20	0.20
	SW022		—	—	—	—
	SW023		13	0.19	0.20	0.10
	SW037		—	—	—	—
	SW038		7	0.20	0.20	0.20
	SW083		14	0.20	0.54	0.10
	SW118		8	0.20	0.20	0.20
	SW129		7	0.25	0.54	0.20
	SED118		—	—	—	—

<u>Mercury, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	0.20	0.20	0.20
	SW019		1	0.20	0.20	0.20
	SW020		1	0.20	0.20	0.20
	SW022		9	0.22	0.40	0.20
	SW023		20	0.22	0.40	0.10
	SW037		—	—	—	—
	SW038		8	0.20	0.20	0.20
	SW083		21	0.21	0.40	0.10
	SW118		9	0.22	0.41	0.20
	SW129		8	0.28	0.53	0.20
	SED118		5	0.24	0.50	0.10

<u>Molybdenum, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		88	6.08	10.80	3.00
	SW019		1	5.70	5.70	5.70
	SW020		1	5.70	5.70	5.70
	SW022		—	—	—	—
	SW023		13	8.57	28.00	3.00
	SW037		—	—	—	—
	SW038		7	5.89	10.00	2.00
	SW083		18	47.19	100.00	3.00
	SW118		8	5.88	10.80	2.00
	SW129		7	8.18	20.00	3.00
	SED118		—	—	—	—

<u>Molybdenum, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	6.48	11.40	3.00
	SW019		1	5.70	5.70	5.70
	SW020		1	5.70	5.70	5.70
	SW022		7	11.88	28.00	3.00
	SW023		18	18.04	28.00	4.00
	SW037		—	—	—	—
	SW038		8	5.90	10.00	2.00
	SW083		10	39.80	100.00	1.00
	SW118		9	12.07	28.00	2.00
	SW129		8	7.38	10.80	3.00
	SED118		4	3.42	7.20	0.88

Table 2.25
 Summary Statistics – Selected Trace Metals, OUI3 Area
 Surface–Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

<u>Nickel, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	93	8.03	14.70	3.90
		SW019	1	14.70	14.70	14.70
		SW020	1	15.50	15.50	15.50
		SW022	—	—	—	—
		SW023	13	8.05	14.70	3.90
		SW037	—	—	—	—
		SW038	7	10.71	17.00	3.00
		SW093	15	15.93	40.00	4.00
		SW118	6	8.42	14.70	3.90
		SW129	7	10.09	17.00	3.90
		SED118	—	—	—	—

<u>Nickel, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	7.52	14.70	3.90
		SW019	1	14.70	14.70	14.70
		SW020	1	20.80	20.80	20.80
		SW022	10	29.27	56.40	9.00
		SW023	22	19.04	86.80	3.90
		SW037	—	—	—	—
		SW038	6	13.07	20.00	3.00
		SW093	23	25.63	100.00	4.00
		SW118	9	42.27	183.00	3.90
		SW129	6	13.22	20.00	3.90
		SED118	4	15.83	24.30	11.00

<u>Potassium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	98	2762.88	4150.00	2100.00
		SW019	1	19900.00	19900.00	19900.00
		SW020	1	4270.00	4270.00	4270.00
		SW022	—	—	—	—
		SW023	13	2294.23	4720.00	675.00
		SW037	—	—	—	—
		SW038	7	1256.14	2050.00	549.00
		SW093	15	3976.00	5000.00	2810.00
		SW118	6	2215.00	3000.00	1480.00
		SW129	7	2371.43	3850.00	1700.00
		SED118	—	—	—	—

<u>Potassium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	3280.00	4700.00	2000.00
		SW019	1	21600.00	21600.00	21600.00
		SW020	1	6750.00	6750.00	6750.00
		SW022	10	14829.00	53300.00	4800.00
		SW023	22	7131.82	53400.00	1700.00
		SW037	—	—	—	—
		SW038	6	1335.00	2630.00	636.00
		SW093	23	5552.17	18000.00	1620.00
		SW118	9	6022.22	17200.00	1700.00
		SW129	6	2308.87	3520.00	1480.00
		SED118	4	1425.00	2130.00	1050.00

<u>Selenium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	98	2.41	4.00	1.10
		SW019	1	1.10	1.10	1.10
		SW020	1	1.10	1.10	1.10
		SW022	—	—	—	—
		SW023	13	2.68	6.90	1.10
		SW037	—	—	—	—
		SW038	7	1.51	2.00	1.10
		SW093	16	4.89	18.40	1.00
		SW118	6	1.72	4.00	1.00
		SW129	7	1.79	4.00	1.10
		SED118	—	—	—	—

<u>Selenium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	2.84	4.00	1.10
		SW019	1	1.10	1.10	1.10
		SW020	1	1.10	1.10	1.10
		SW022	10	3.10	10.00	1.00
		SW023	21	3.02	15.00	1.00
		SW037	—	—	—	—
		SW038	6	1.70	2.00	1.10
		SW093	23	3.67	20.00	1.00
		SW118	9	3.26	15.00	1.00
		SW129	6	1.88	2.80	1.10
		SED118	4	0.80	0.84	0.32

Table 2.25
Summary Statistics – Selected Trace Metals, OU13 Area
Surface– Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

Silicon, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	83	8154.29	7480.00	4450.00
		SW019	1	989.00	989.00	989.00
		SW020	1	1030.00	1030.00	1030.00
		SW022	—	—	—	—
		SW023	12	3783.23	6450.00	25.70
		SW037	—	—	—	—
		SW038	6	7633.33	9150.00	6310.00
		SW093	8	5930.00	7450.00	3720.00
		SW118	6	4861.67	6140.00	2580.00
		SW129	8	5170.00	7530.00	2630.00
		SED118	—	—	—	—

Silicon, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	3	5463.33	5620.00	4780.00
		SW019	1	14700.00	14700.00	14700.00
		SW020	1	29300.00	29300.00	29300.00
		SW022	—	—	—	—
		SW023	8	3450.71	10500.00	25.70
		SW037	—	—	—	—
		SW038	3	7880.00	9820.00	6000.00
		SW093	5	8132.00	9070.00	4110.00
		SW118	4	4340.00	6000.00	2500.00
		SW129	5	5378.00	8320.00	3340.00
		SED118	2	1180.00	1320.00	1040.00

Silver, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	83	3.93	6.80	2.00
		SW019	1	5.00	5.00	5.00
		SW020	1	5.00	5.00	5.00
		SW022	—	—	—	—
		SW023	13	4.07	6.80	2.00
		SW037	—	—	—	—
		SW038	7	3.94	6.80	2.00
		SW093	15	5.49	10.00	2.00
		SW118	6	4.22	6.50	2.00
		SW129	7	4.36	9.80	2.00
		SED118	—	—	—	—

Silver, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	3.56	5.00	2.00
		SW019	1	5.00	5.00	5.00
		SW020	1	5.00	5.00	5.00
		SW022	10	4.3	8.2	2
		SW023	22	4.84	7.00	3.00
		SW037	—	—	—	—
		SW038	6	5.56	12.80	2.00
		SW093	23	4.84	10.00	2.00
		SW118	9	3.78	5.00	2.00
		SW129	6	6.07	13.30	2.00
		SED118	4	1.49	2.30	0.44

Sodium, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	83	30300.00	37100.00	28000.00
		SW019	1	64000.00	64000.00	64000.00
		SW020	1	32900.00	32900.00	32900.00
		SW022	—	—	—	—
		SW023	13	37014.77	60800.00	172.00
		SW037	—	—	—	—
		SW038	7	13281.43	16400.00	9670.00
		SW093	18	44700.00	84800.00	22000.00
		SW118	6	34588.67	41400.00	30000.00
		SW129	7	15285.71	20000.00	13600.00
		SED118	—	—	—	—

Sodium, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
		SW018	5	32280.00	36800.00	29000.00
		SW019	1	63000.00	63000.00	63000.00
		SW020	1	32900.00	32900.00	32900.00
		SW022	10	20790	96600	3680
		SW023	22	40030.45	148000.00	170.00
		SW037	—	—	—	—
		SW038	6	14350.00	16600.00	11100.00
		SW093	23	32330.43	87400.00	8800.00
		SW118	9	31800.00	51100.00	18000.00
		SW129	6	14863.33	19100.00	12800.00
		SED118	5	253.40	402.00	112.00

Table 2.25
Summary Statistics – Selected Trace Metals, OU13 Area
Surface–Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

Strontium, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		88	432.57	480.00	336.00
	SW019		1	55.20	55.20	55.20
	SW020		1	52.00	52.00	52.00
	SW022		—	—	—	—
	SW023		13	413.18	690.00	9.00
	SW037		—	—	—	—
	SW038		7	455.86	540.00	400.00
	SW063		18	590.25	1000.00	243.00
	SW118		8	360.83	422.00	289.00
	SW129		7	407.29	528.00	118.00
	SED118		—	—	—	—

Strontium, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	440.00	480.00	336.00
	SW019		1	65.00	65.00	65.00
	SW020		1	88.80	88.80	88.80
	SW022		7	213.57	331	124
	SW023		18	334.74	663.00	7.30
	SW037		—	—	—	—
	SW038		6	469.50	540.00	415.00
	SW063		18	428.36	1000.00	0.50
	SW118		8	369.00	739.00	180.00
	SW129		6	407.83	532.00	106.00
	SED118		4	49.88	74.80	41.00

Thallium, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		63	2.19	5.00	1.00
	SW019		1	1.40	1.40	1.40
	SW020		1	1.40	1.40	1.40
	SW022		—	—	—	—
	SW023		13	3.69	15.00	0.80
	SW037		—	—	—	—
	SW038		7	1.78	3.00	1.00
	SW063		35	3.95	15.00	0.60
	SW118		8	3.87	15.00	1.40
	SW129		7	1.73	3.00	1.00
	SED118		—	—	—	—

Thallium, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	1.76	4.00	1.00
	SW019		1	1.40	1.40	1.40
	SW020		1	1.40	1.40	1.40
	SW022		10	1.8	3	1
	SW023		22	2.24	5.00	1.00
	SW037		—	—	—	—
	SW038		6	1.92	3.00	1.00
	SW063		23	2.84	10.00	1.00
	SW118		8	1.80	3.00	1.00
	SW129		6	1.53	2.00	1.00
	SED118		4	0.68	1.40	0.41

Tin, Dissolved		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		68	19.24	38.80	10.40
	SW019		1	14.80	14.80	14.80
	SW020		1	14.80	14.80	14.80
	SW022		—	—	—	—
	SW023		13	18.07	30.00	10.40
	SW037		—	—	—	—
	SW038		7	27.17	75.70	10.40
	SW063		16	44.69	100.00	11.00
	SW118		8	16.15	24.20	7.00
	SW129		7	20.31	48.00	10.40
	SED118		—	—	—	—

Tin, Total		Sampling Site	Number of Samples	Mean	Maximum	Minimum
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	17.08	24.20	11.00
	SW019		1	14.80	14.80	14.80
	SW020		1	14.80	14.80	14.80
	SW022		7	31.13	85.4	13
	SW023		18	19.56	30.00	11.00
	SW037		—	—	—	—
	SW038		6	23.70	50.00	14.80
	SW063		18	33.85	100.00	2.00
	SW118		8	31.09	84.80	12.00
	SW129		6	25.13	50.00	14.80
	SED118		4	11.58	24.80	2.80

Table 2.25
 Summary Statistics – Selected Trace Metals, OU13 Area
 Surface–Water and Sediment Sites

A. Trace Metals, Surface-Water Sites

<u>Vanadium, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		98	3.21	6.50	2.00
	SW019		1	5.70	5.70	5.70
	SW020		1	5.70	5.70	5.70
	SW022		—	—	—	—
	SW023		13	4.23	9.10	2.00
	SW037		—	—	—	—
	SW038		7	4.90	7.50	2.30
	SW093		15	17.13	50.00	2.00
	SW118		6	4.43	8.20	2.00
	SW129		7	4.93	9.80	2.00
	SED118		—	—	—	—

<u>Vanadium, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)			3			
(Mg/Kg-sediment)						
	SW018		5	2.74	5.70	2.00
	SW019		1	18.80	18.80	18.80
	SW020		1	30.30	30.30	30.30
	SW022		10	128.81	670	18
	SW023		22	31.18	206.00	2.00
	SW037		—	—	—	—
	SW038		6	6.37	10.00	3.40
	SW093		23	44.87	250.00	3.90
	SW118		9	78.21	305.00	2.00
	SW129		6	8.13	10.00	2.80
	SED118		4	27.93	42.40	21.20

<u>Zinc, Dissolved</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		93	13.89	27.00	4.30
	SW019		1	33.70	33.70	33.70
	SW020		1	18.20	18.20	18.20
	SW022		—	—	—	—
	SW023		13	12.57	41.00	3.00
	SW037		—	—	—	—
	SW038		7	15.10	68.50	1.80
	SW093		18	41.22	297.00	3.00
	SW118		6	50.38	258.00	3.30
	SW129		7	5.43	8.50	3.00
	SED118		—	—	—	—

<u>Zinc, Total</u>		<u>Sampling Site</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
(ug/L-water)						
(Mg/Kg-sediment)						
	SW018		5	16.42	24.60	5.00
	SW019		1	144.00	144.00	144.00
	SW020		1	164.00	164.00	164.00
	SW022		10	347.14	582	98.4
	SW023		22	304.86	1200.00	4.70
	SW037		—	—	—	—
	SW038		6	16.58	59.20	1.80
	SW093		20	220.30	750.00	31.00
	SW118		9	274.52	1280.00	4.30
	SW129		6	8.80	22.20	1.80
	SED118		4	75.43	111.00	57.60

Table 2.26

Perimeter and Community Ambient Air Sampler Plutonium Concentrations.

Perimeter Ambient Air Sampler Plutonium Concentrations^a

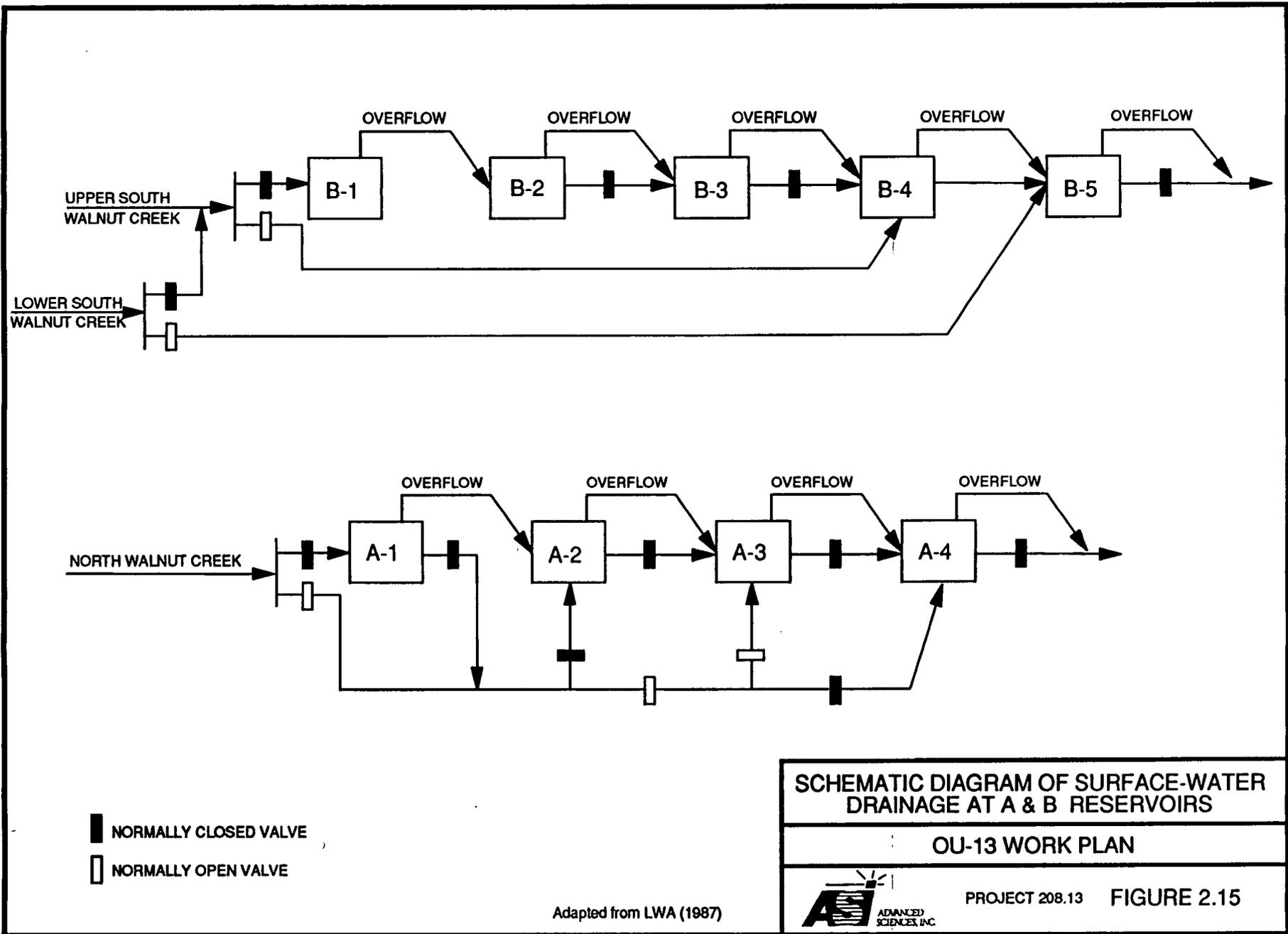
Station	Number of Samples	Concentration (10^{-15} $\mu\text{Ci/ml}$) (^b)			Standard Deviation (C Standard)	Percent of DCG (%) (C Mean)
		C Minimum	C Maximum	C Mean		
S-31	11	-0.001	0.002	0.001	0.001	0.003
S-32	12	0.000	0.003	0.001	0.001	0.007
S-33	12	-0.001	0.004	0.000	0.001	0.002
S-34	12	0.000	0.005	0.002	0.002	0.009
S-35	12	-0.001	0.003	0.001	0.001	0.004
S-36	12	0.000	0.003	0.001	0.001	0.005
S-37	12	0.000	0.007	0.003	0.002	0.014
S-38	12	0.000	0.181	0.017	0.052	0.083
S-39	12	10.001	0.002	0.001	0.001	0.003
S-40*	11	0.000	0.032	0.004	0.009	0.019
S-41	12	0.000	-.003	0.001	0.001	0.005
S-41	12	0.000	0.004	0.001	0.001	0.005
S-43	12	-0.001	0.003	0.001	0.001	0.003
S-44	12	-0.001	0.004	0.001	0.001	0.003
Overall	166	-0.001	0.181	0.005	0.005	0.013

Table 2.26 (continued)

Perimeter and Community Ambient Air Sampler Plutonium Concentrations

Station	Number of Samples	Concentration (10^{-15} μ Ci/ml) ^(b)			Standard Deviation (C standard)	Percent of DCG (%) (C mean)
		C minimum	C maximum	C mean		
S-51	12	0.0001	0.003	0.001	0.001	0.004
S-52	12	0.0000	0.018	0.004	0.005	0.019
S-53	12	-0.001	0.002	0.001	0.001	0.003
S-54	12	-0.001	0.004	0.001	0.001	0.003
S-55	12	-0.001	0.002	0.000	0.001	0.001
S-56	12	0.000	0.004	0.001	0.001	0.007
S-57	12	0.000	0.004	0.001	0.001	0.005
S-58*	10	0.0000	0.003	0.001	0.051	0.086
S-59	12	0.000	0.005	0.001	0.002	0.005
S-60	12	-0.001	0.003	0.001	0.001	0.005
S-62	12	-0.001	0.002	0.000	0.001	0.001
S-68	12	-0.001	0.005	0.001	0.002	0.004
S-73	12	-0.001	0.005	0.001	0.002	0.006
Overall	154	-0.001	0.018	0.002	0.002	0.005

- a. Data provided in this table are based on a 12-month period except those marked with an asterisk.
- b. Concentrations reflect monthly composites of biweekly station concentrations; C minimum = minimum composited concentration; C maximum = maximum composited concentration; C mean = mean composited concentration.
- c. The DOE Derived Concentration Guide (DCG) for inhalation of class W plutonium by members of the public is 20×10^{-15} μ Ci/ml (Appendix B). Protection standards for members of the public are applicable for offsite locations and are based on calculated radiation dose.



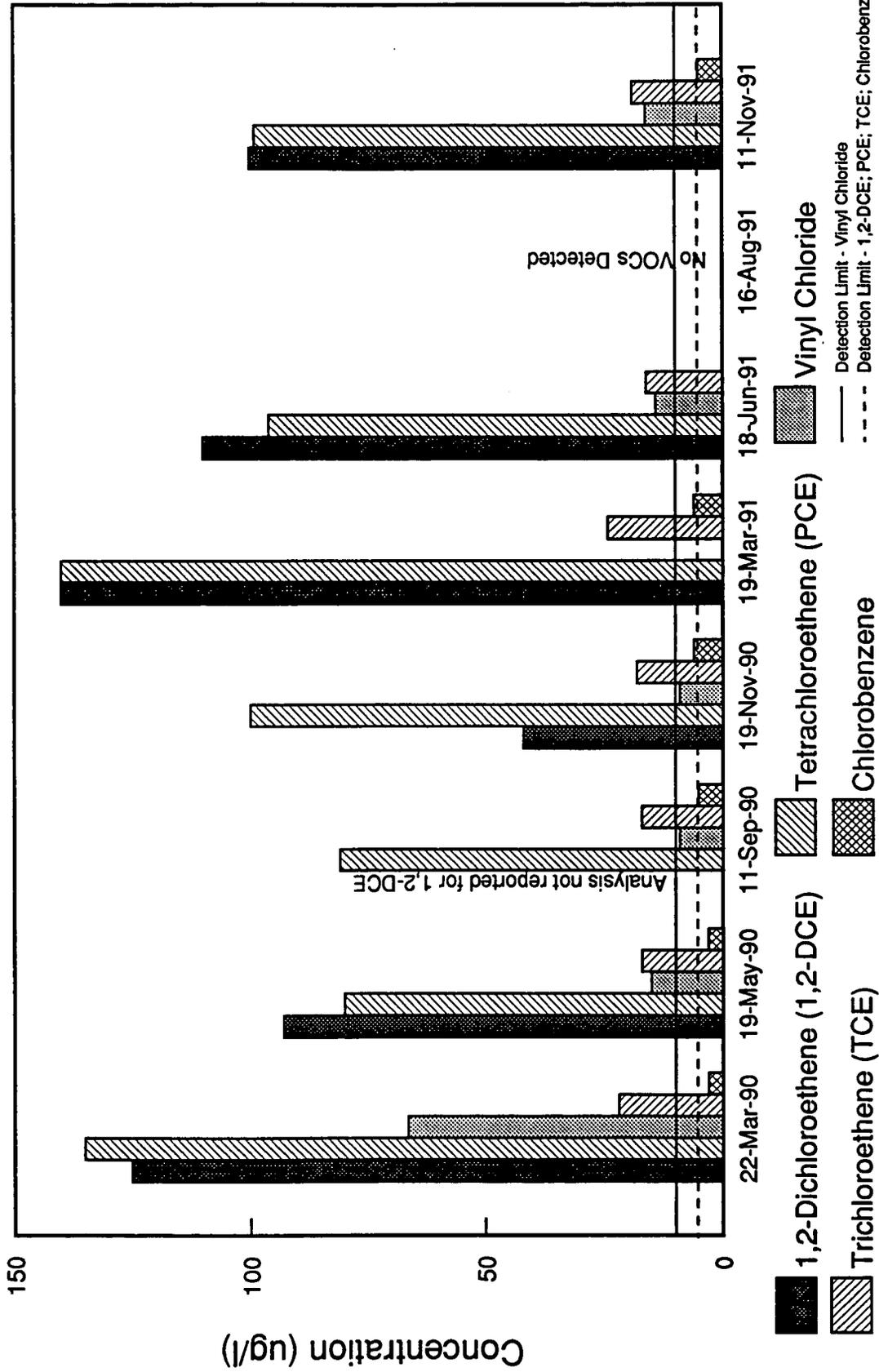
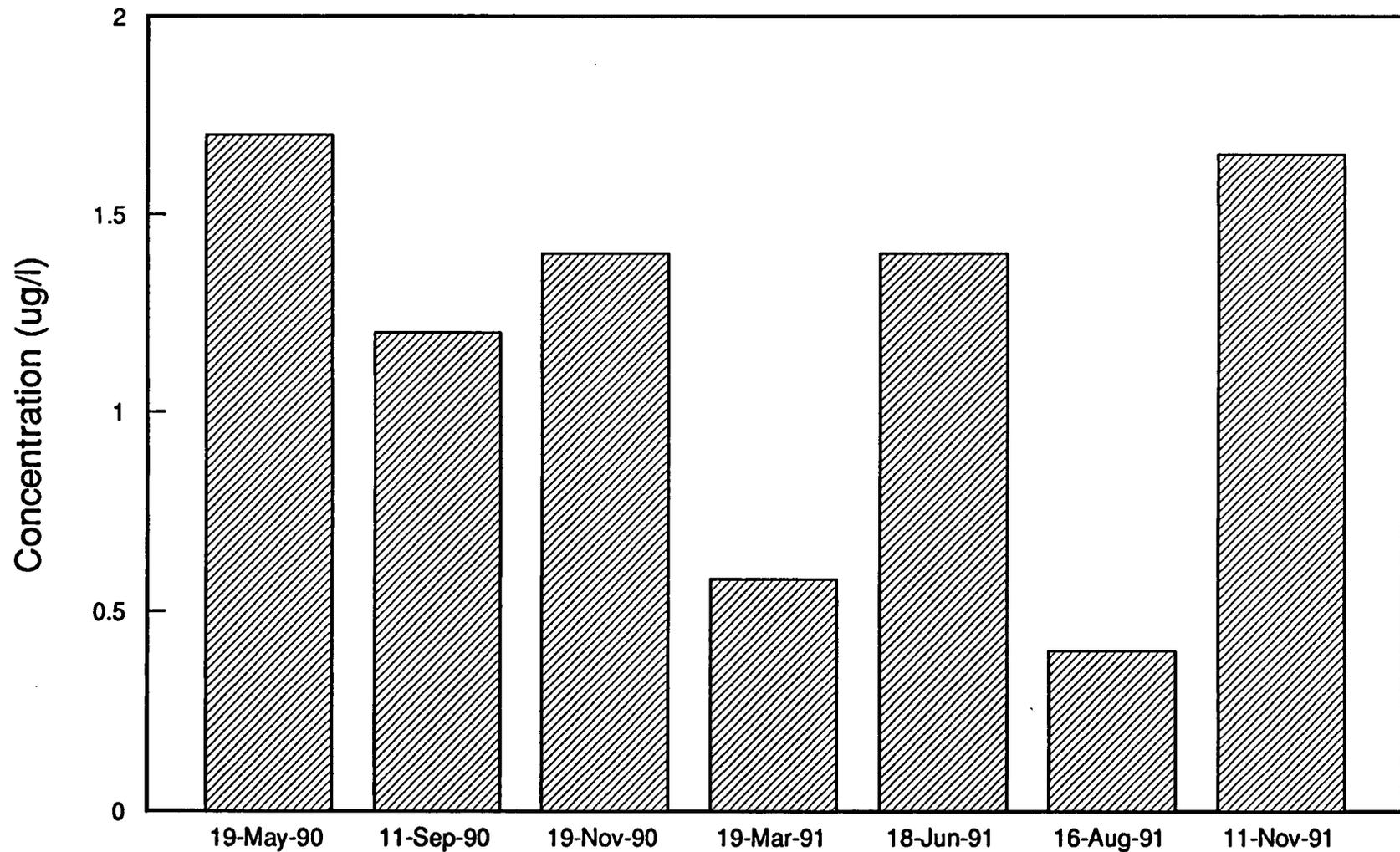


FIGURE 2-18

CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER SAMPLES FROM WELL P418289



Background Rocky Flats Alluvial Ground Water
 Maximum Concentration = 0.0002 mg/l (Less Than Detection Limit)

FIGURE 2-19
CONCENTRATION OF MERCURY IN GROUNDWATER SAMPLES
FROM WELL P418289

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado

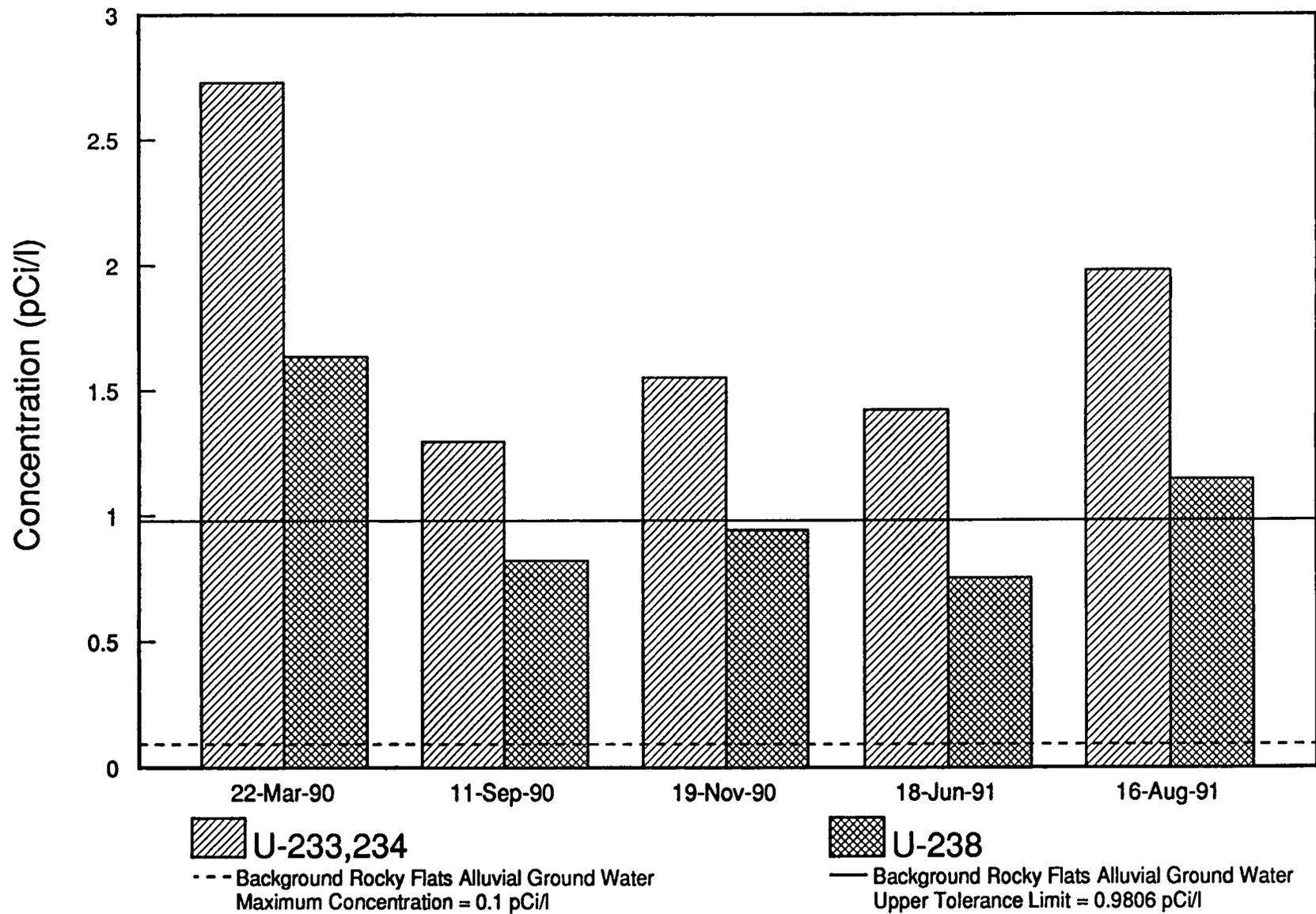


FIGURE 2-20
CONCENTRATIONS OF URANIUM IN GROUNDWATER SAMPLES
FROM WELL P418289

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado

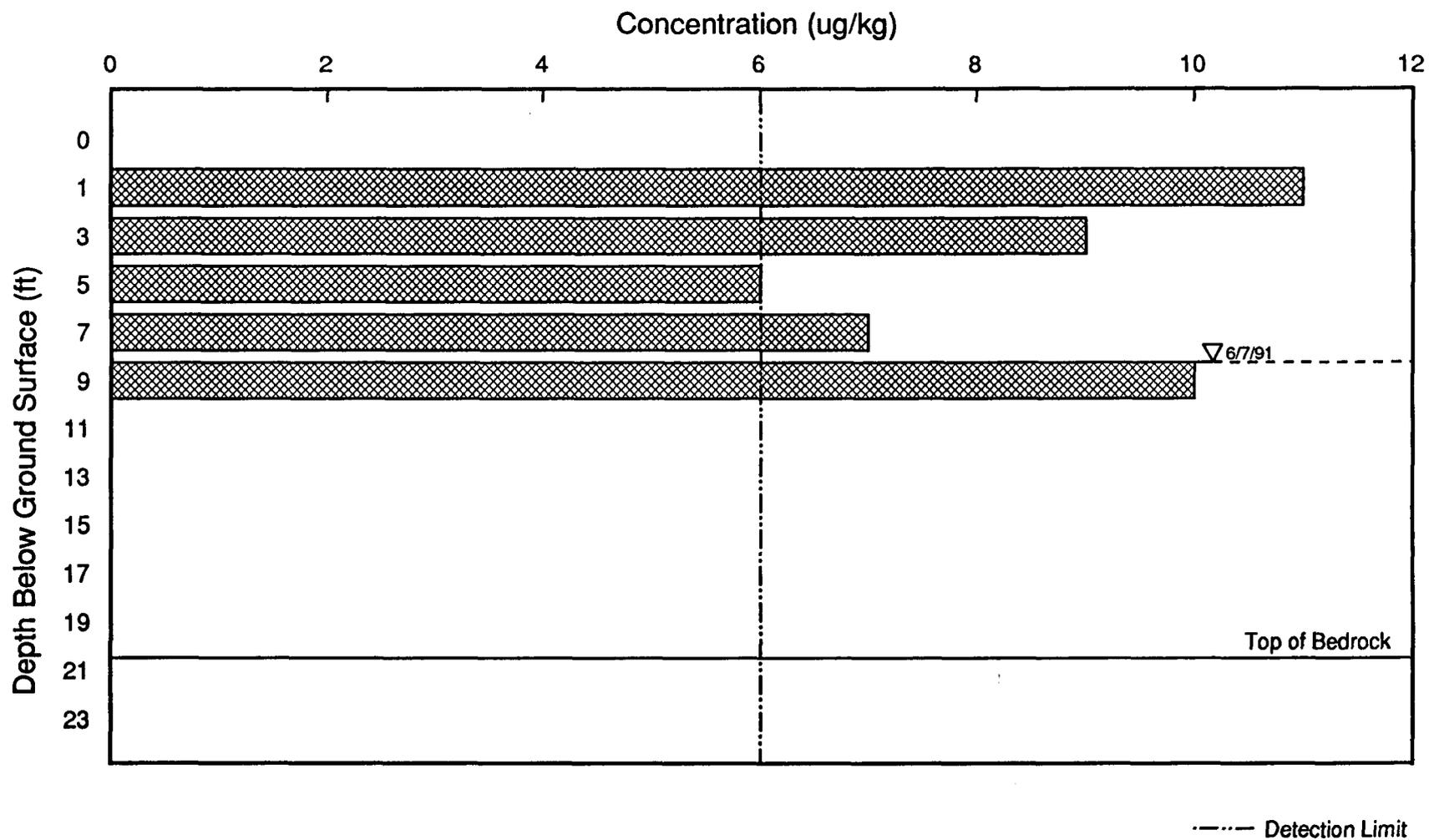


FIGURE 2-21
DISTRIBUTION OF 1,1,1-TRICHLOROETHANE IN
BOREHOLE SAMPLES FROM WELL P313489

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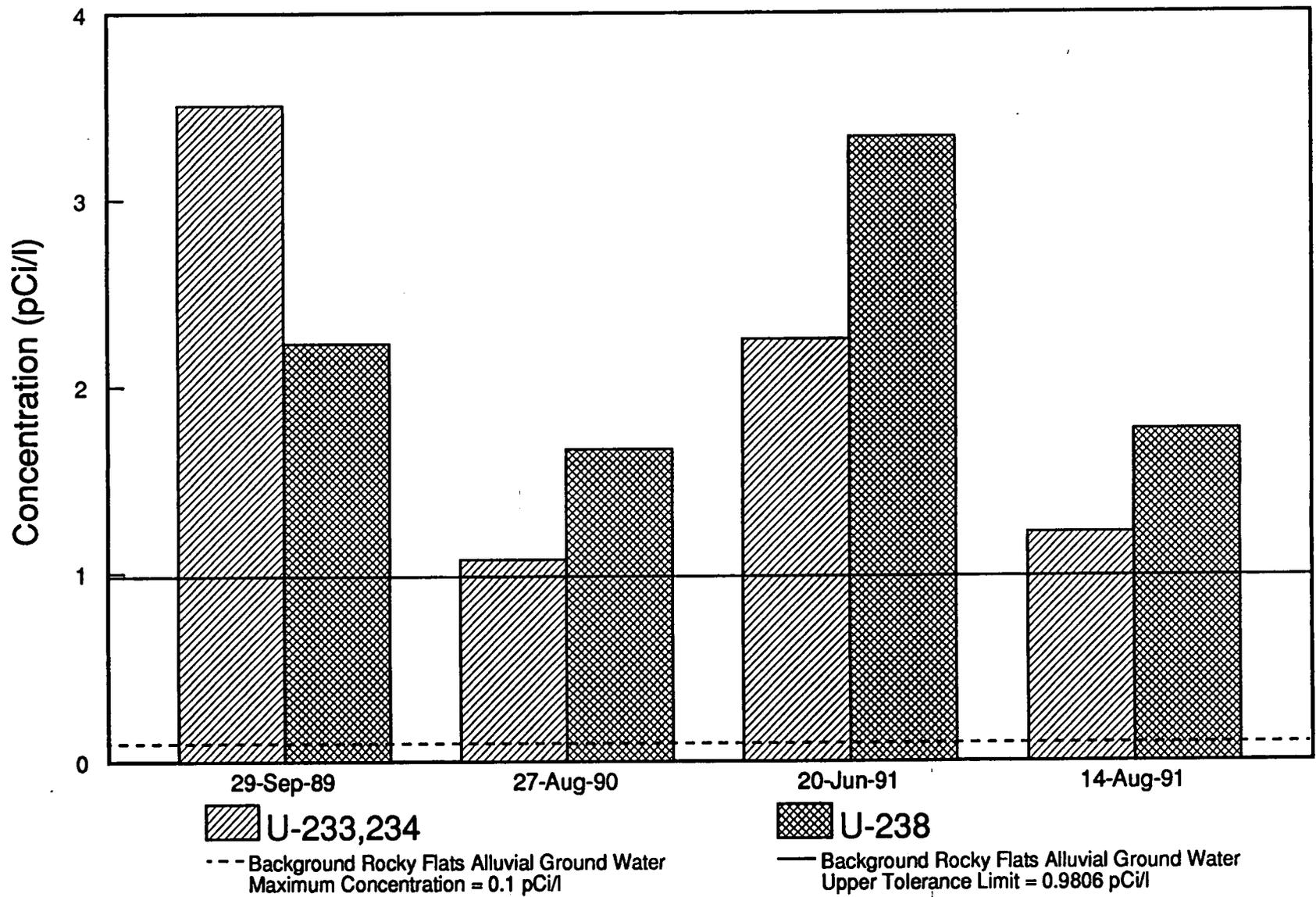


FIGURE 2-22
CONCENTRATIONS OF URANIUM IN GROUNDWATER SAMPLES
FROM WELL 4486

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
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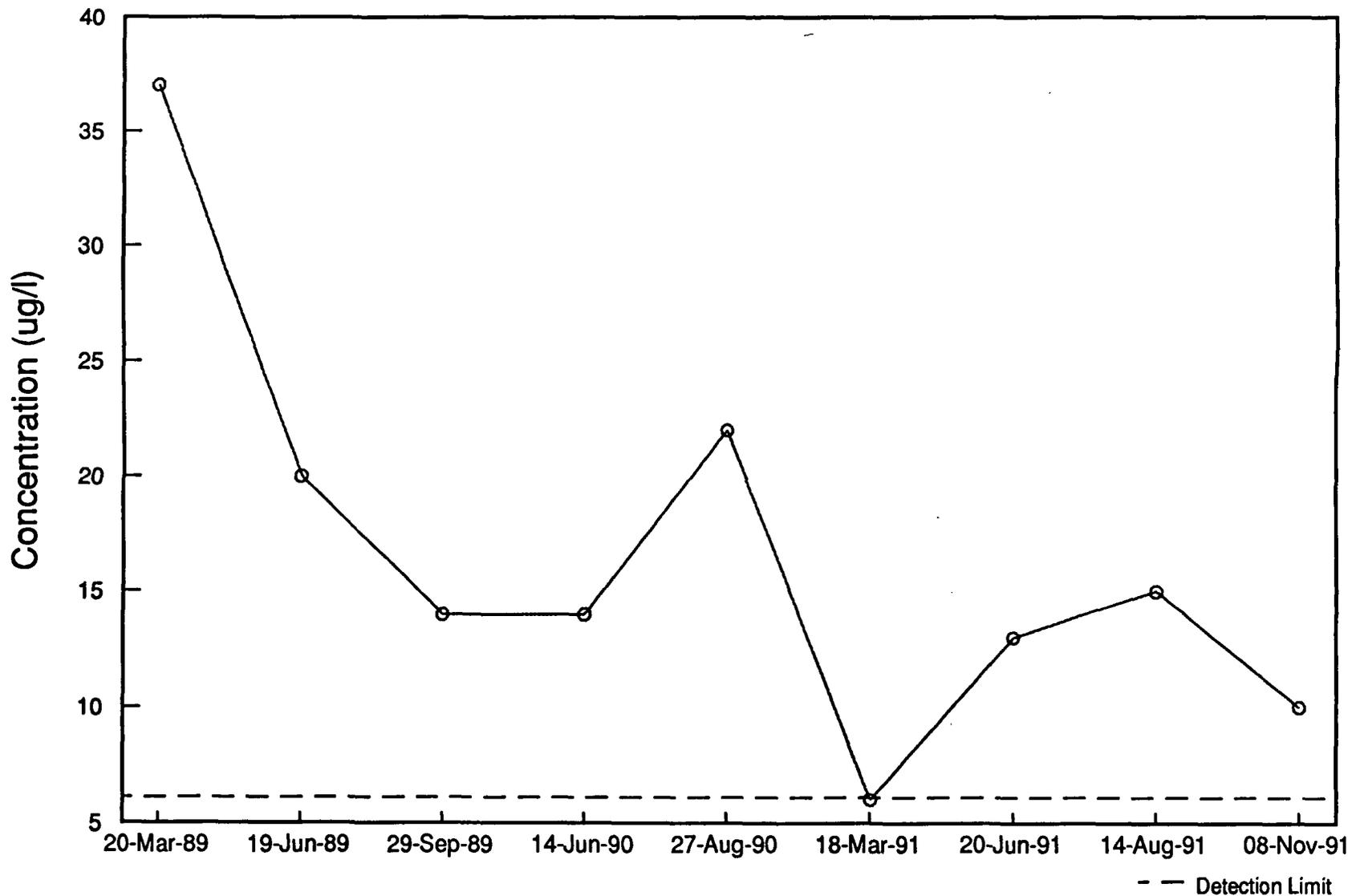
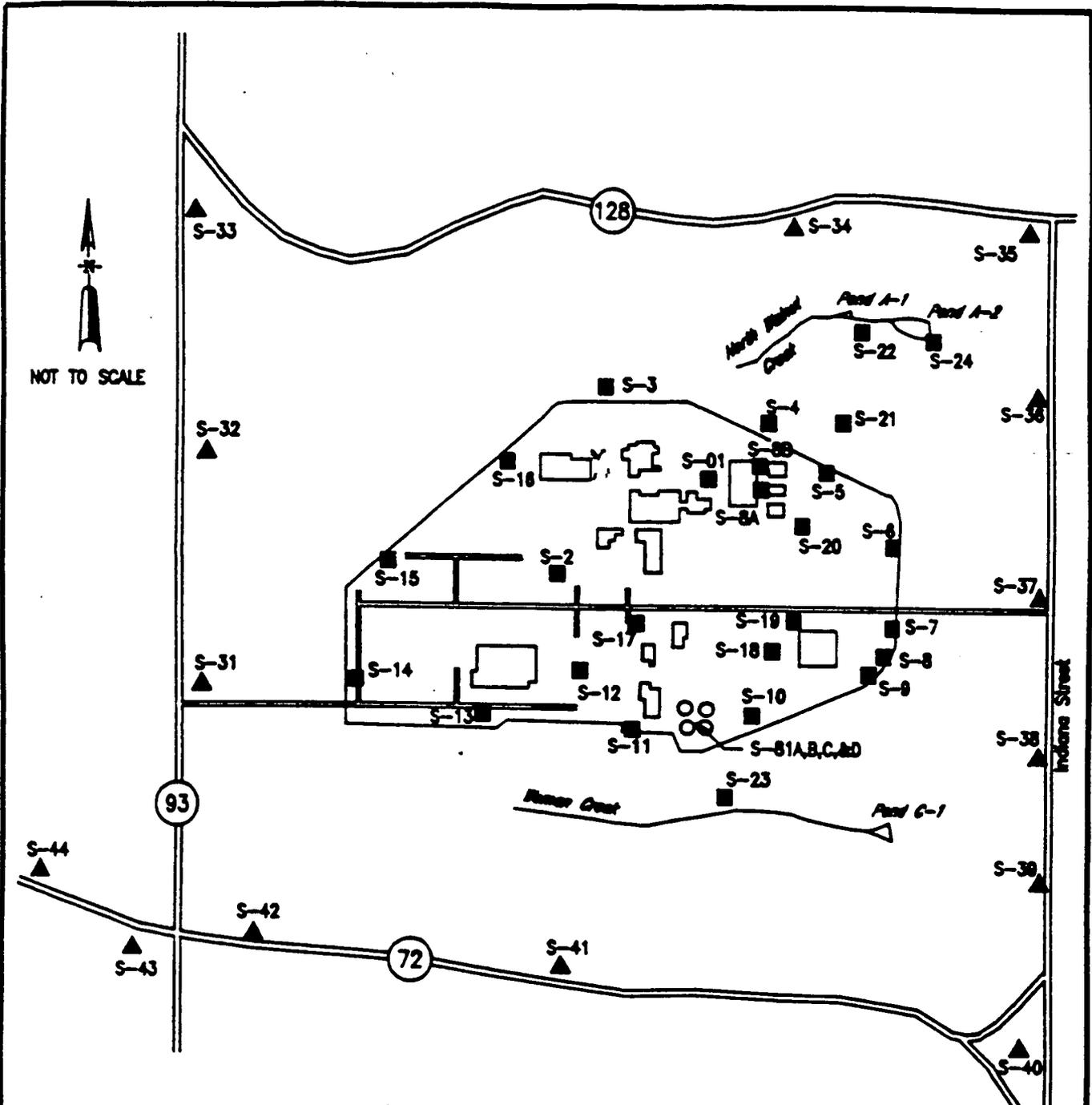


FIGURE 2-23
CONCENTRATION OF TETRACHLOROETHENE (PCE) IN
GROUNDWATER SAMPLES FROM WELL 4486

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado



EXPLANATION

- TEMPORARY SAMPLERS
- ▲ PERIMETER SAMPLERS
- ON-SITE SAMPLERS

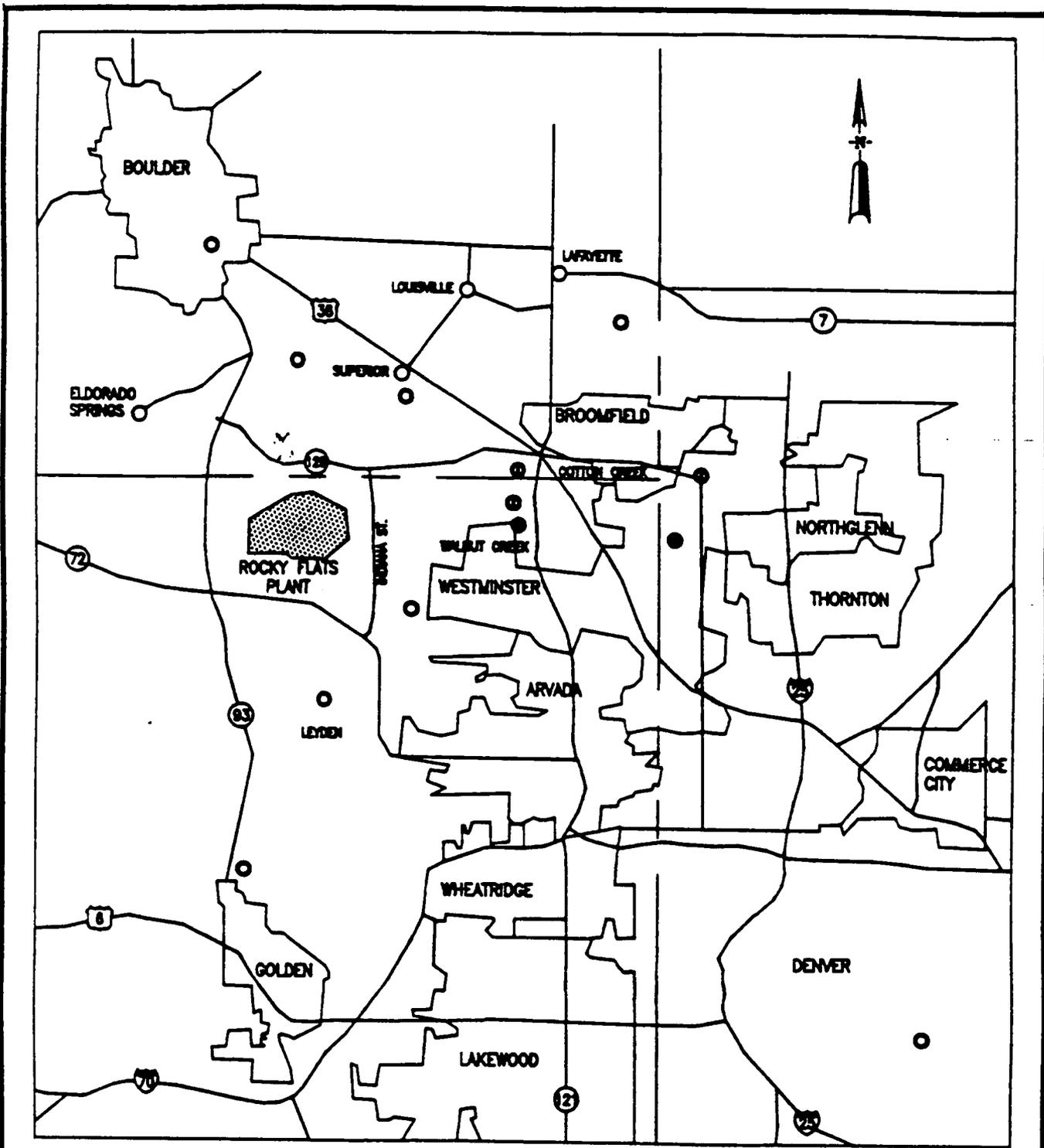
U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 2
 PHASE II RFI/RI WORK PLAN (ALLUVIAL)

LOCATION OF ON-SITE AND
 PLANT PERIMETER AMBIENT AIR
 SAMPLERS

FIGURE 2-25
 July, 1991

R33073JUN-071101



NOT TO SCALE

EXPLANATION

- OFF-SITE COMMUNITY AMBIENT AIR SAMPLES (ANALYZED AS MONTHLY COMPOSITES FOR PLUTONIUM-239/240)

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

OPERABLE UNIT NO. 2
PHASE II RFI/TRI WORK PLAN (ALLUVIAL)

LOCATION OF OFF-SITE COMMUNITY
AMBIENT AIR SAMPLERS

FIGURE 2-26

July, 1991

933077.DWG-071191

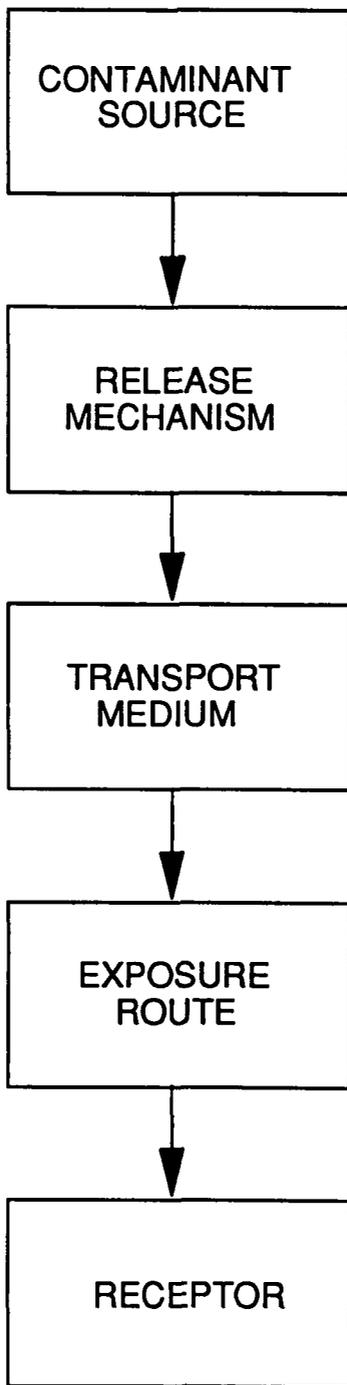


FIGURE 2-27
COMPONENTS OF A COMPLETED
EXPOSURE PATHWAY

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

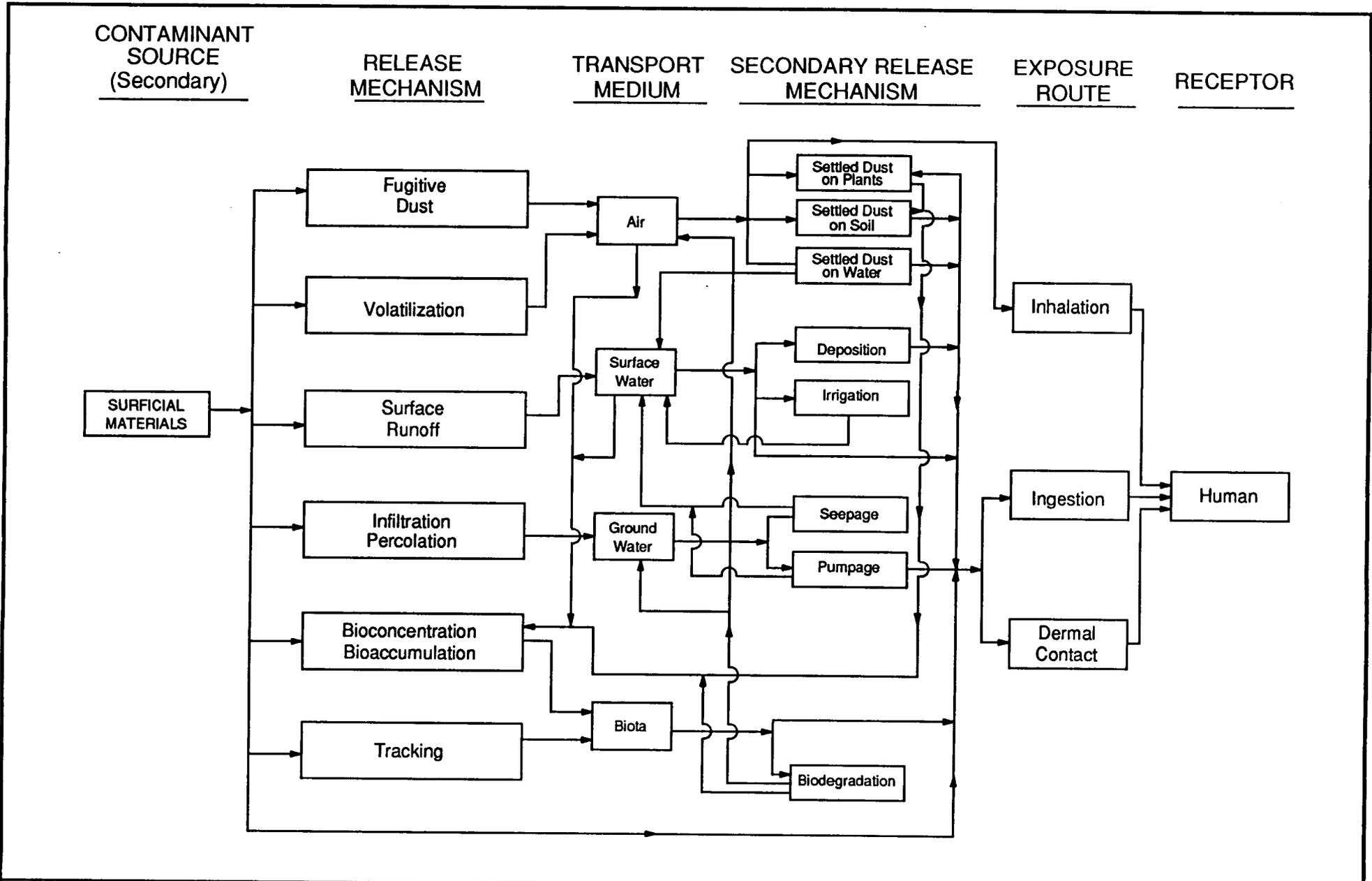


FIGURE 2-28
 CONCEPTUAL MODEL FLOW CHART - GROUP I

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado

CONTAMINANT SOURCE (Secondary)

RELEASE MECHANISM

TRANSPORT MEDIUM

SECONDARY RELEASE MECHANISM

EXPOSURE ROUTE

RECEPTOR

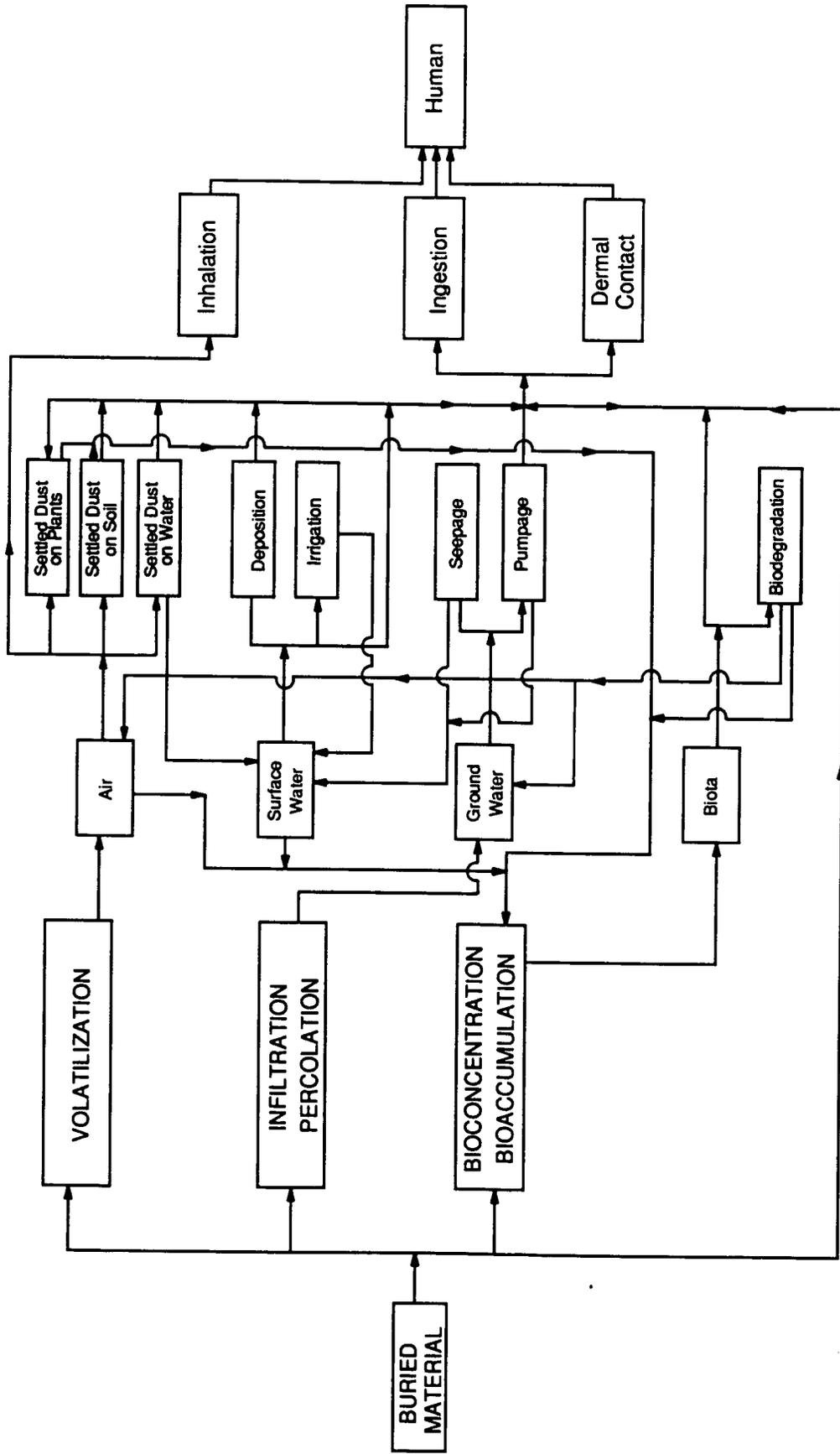


FIGURE 2-29

CONCEPTUAL MODEL FLOW CHART - GROUP II

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

SURFACE SOIL CONTAMINATION

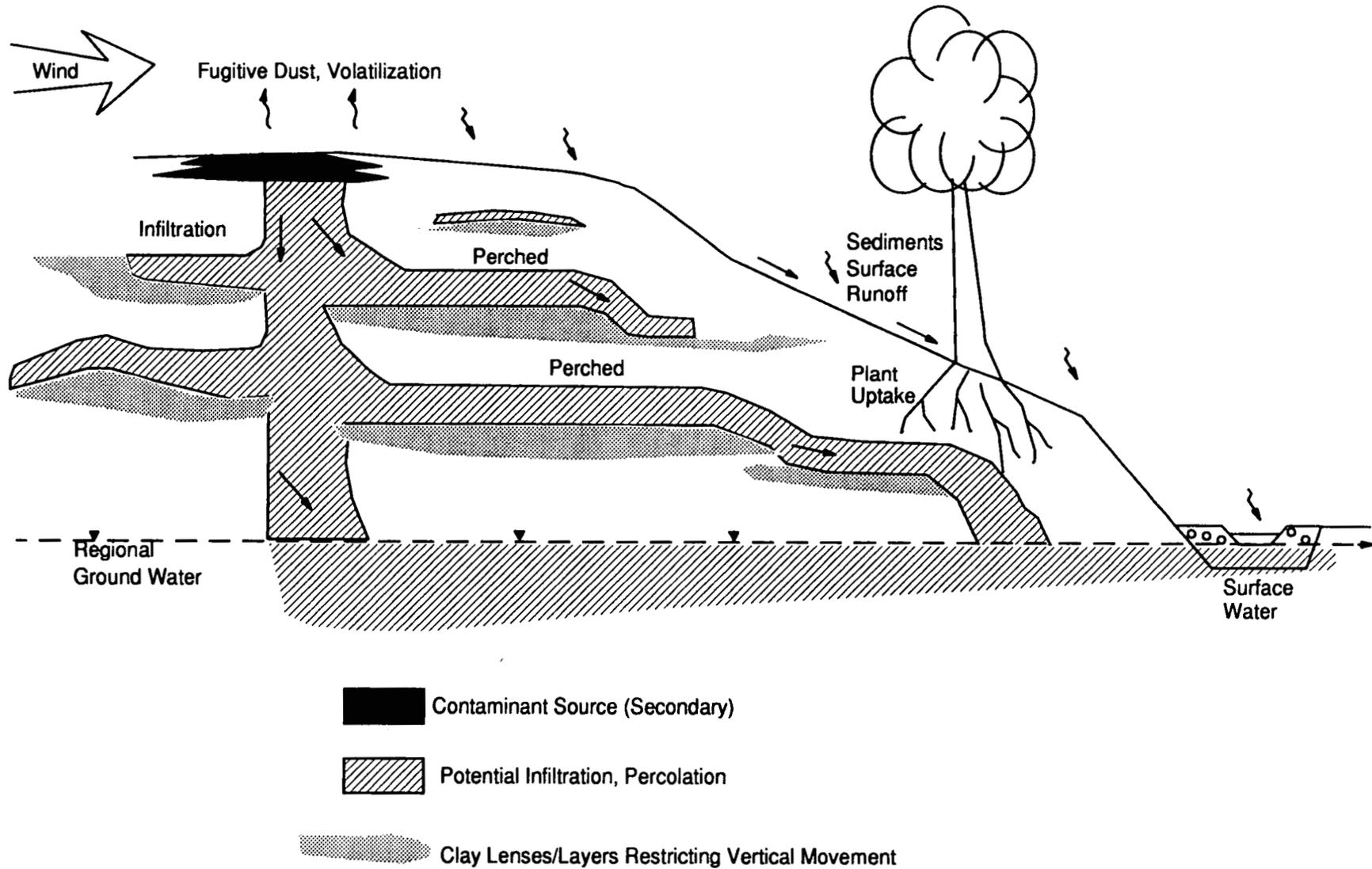


FIGURE 2-30
GROUP I - CONCEPTUAL MODEL

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

BURIED MATERIAL

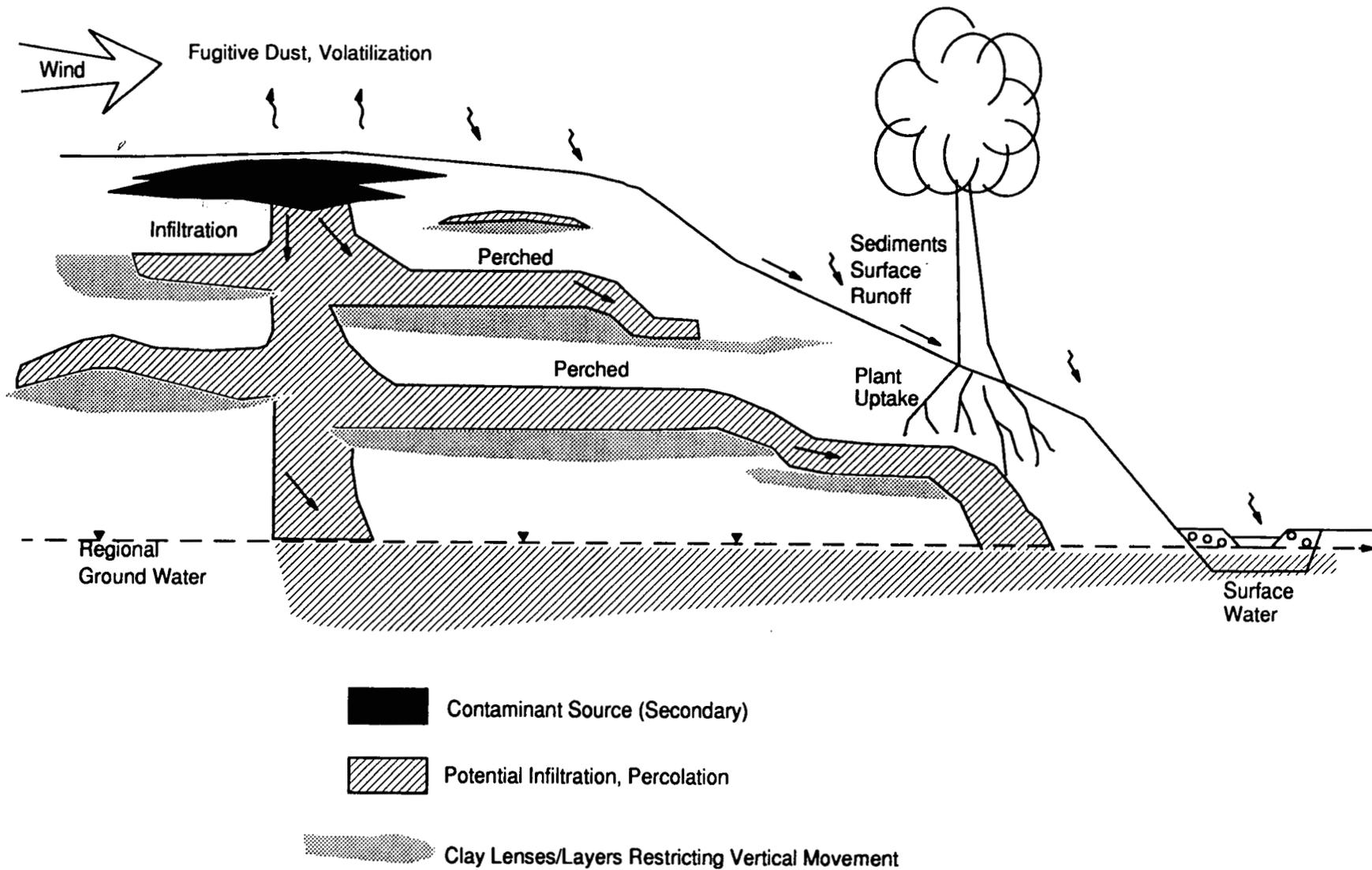
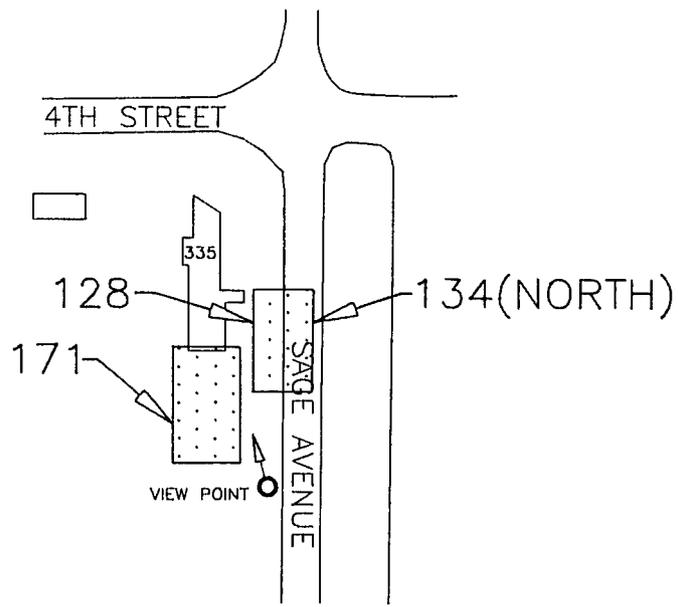


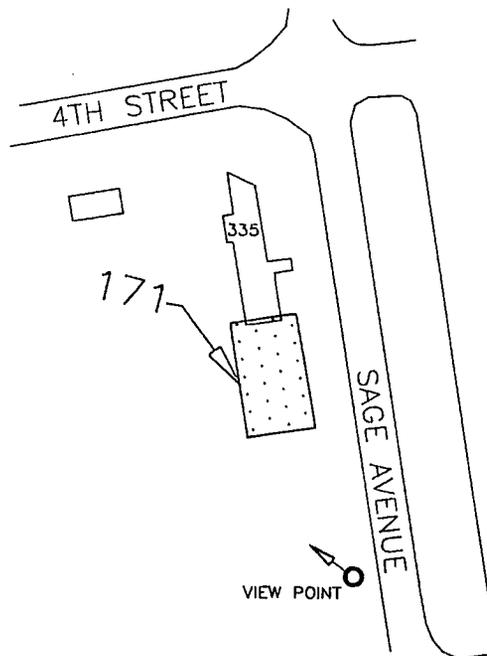
FIGURE 2-31
GROUP II - CONCEPTUAL MODEL

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado



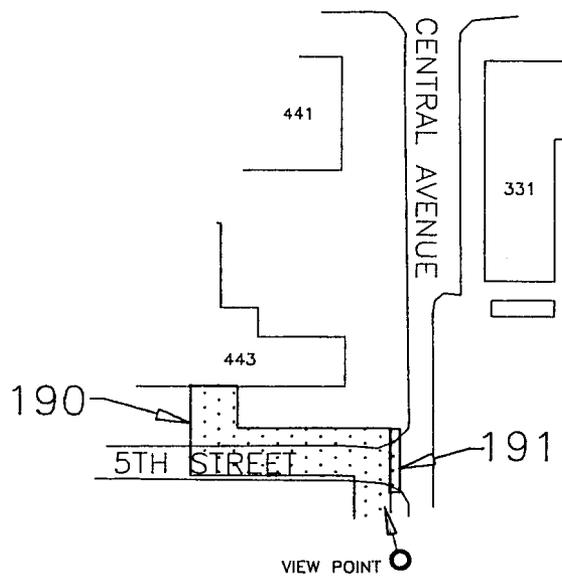
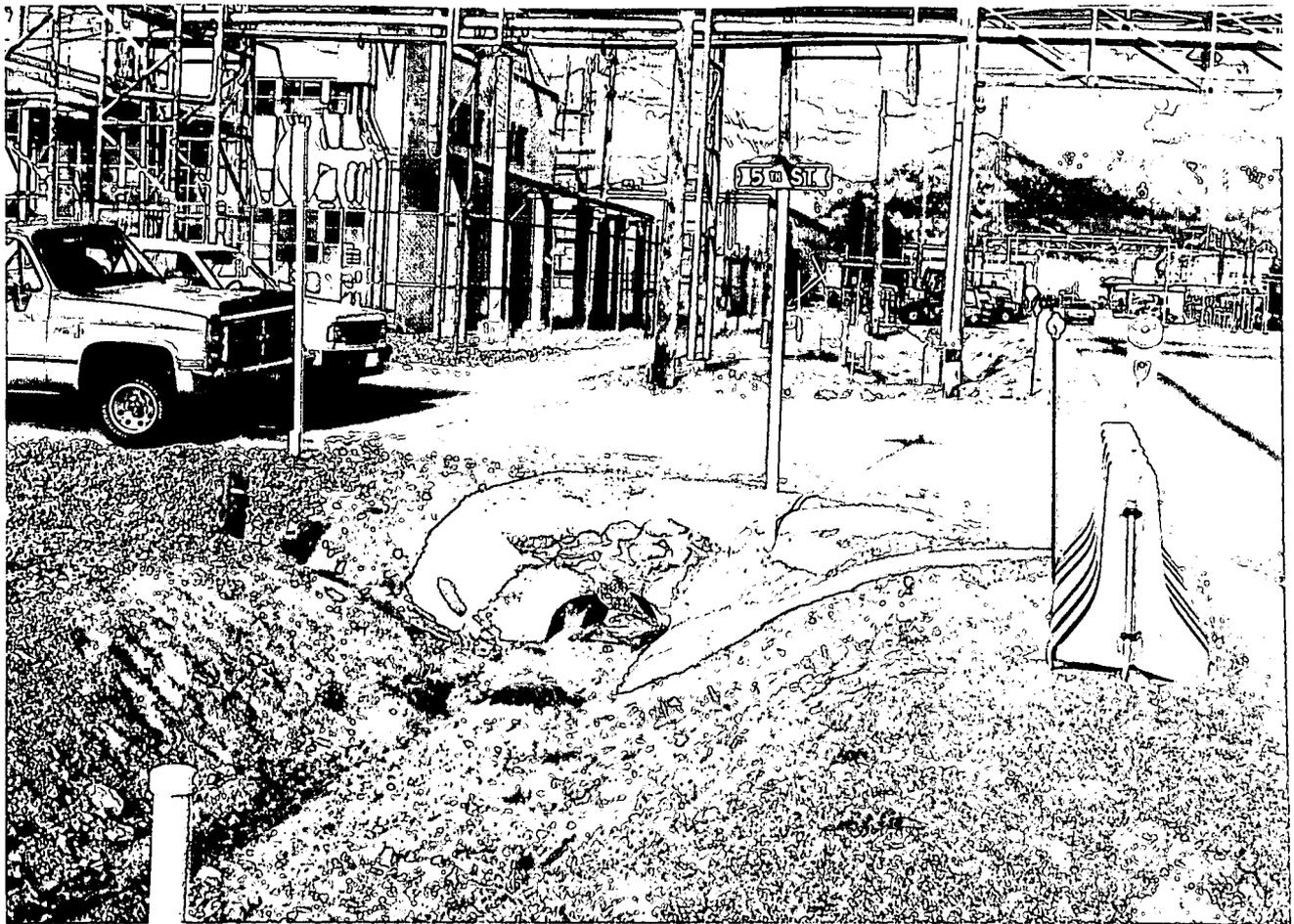
PHOTOGRAPH 1
 IHSSs 128, 134(NORTH), AND 171
 LOOKING WEST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



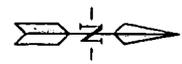
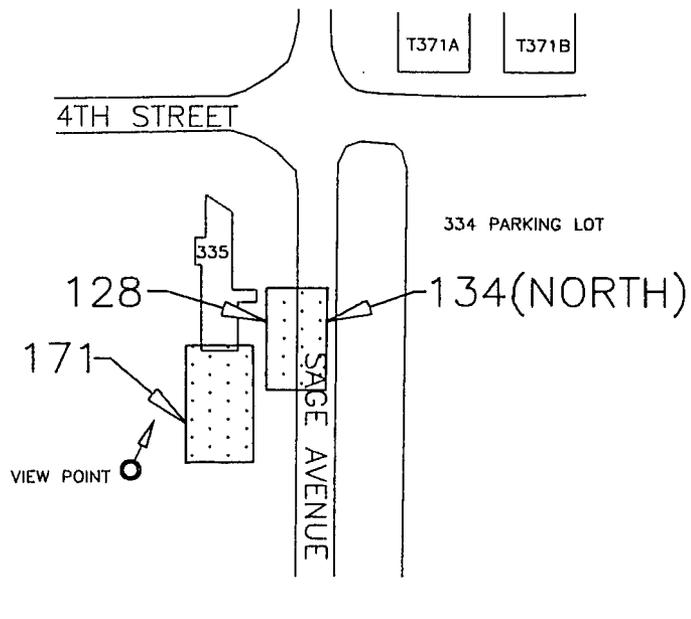
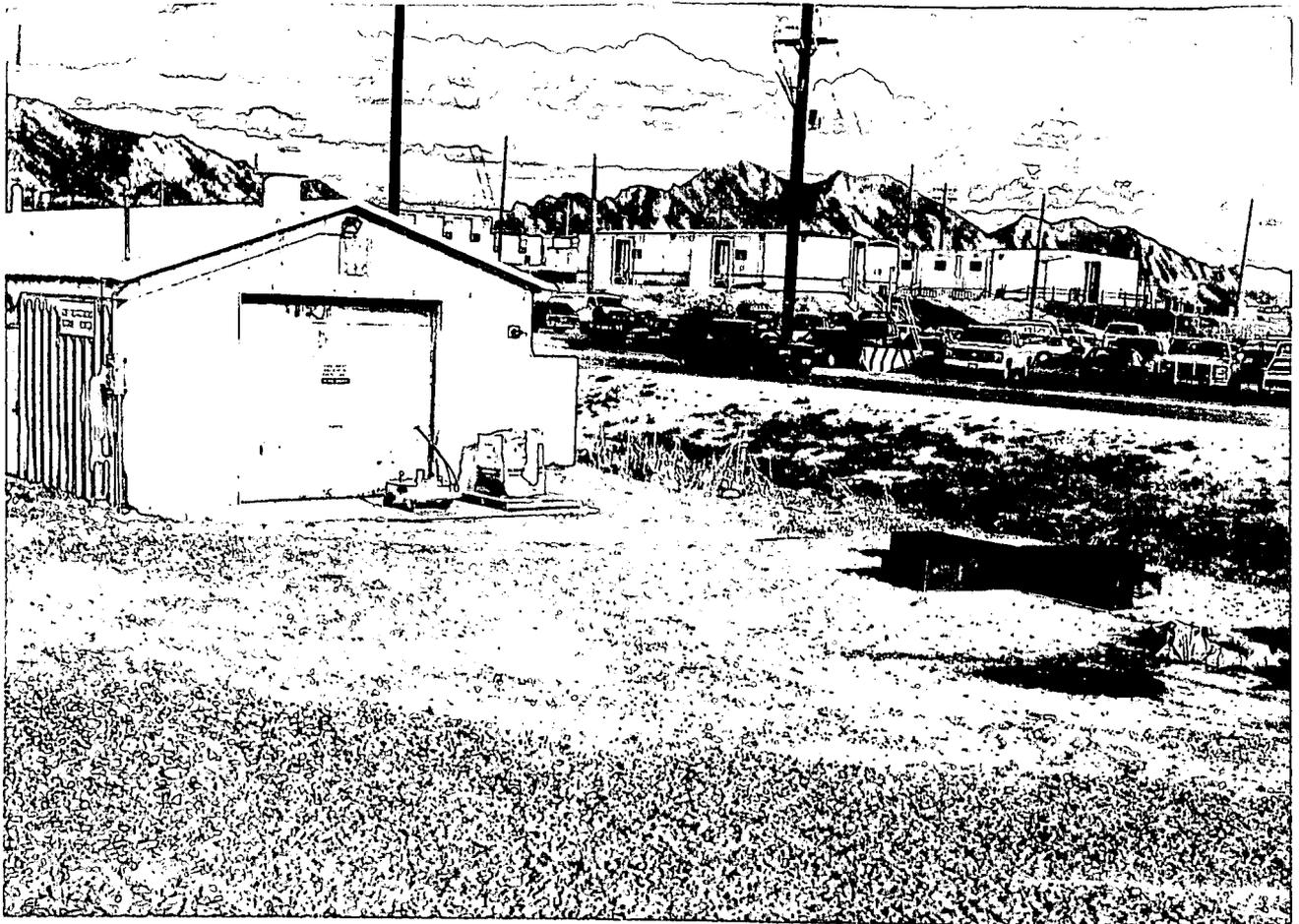
PHOTOGRAPH 2
 IHSS 171
 LOOKING WEST SOUTHWEST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



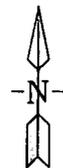
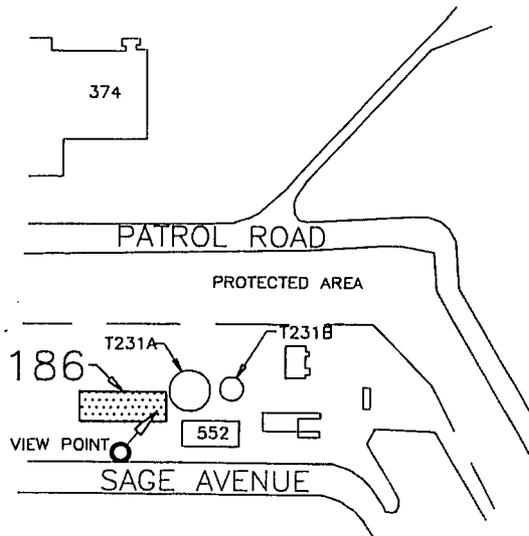
PHOTOGRAPH 3
 IHSSs 191 AND PART OF 190
 LOOKING WEST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



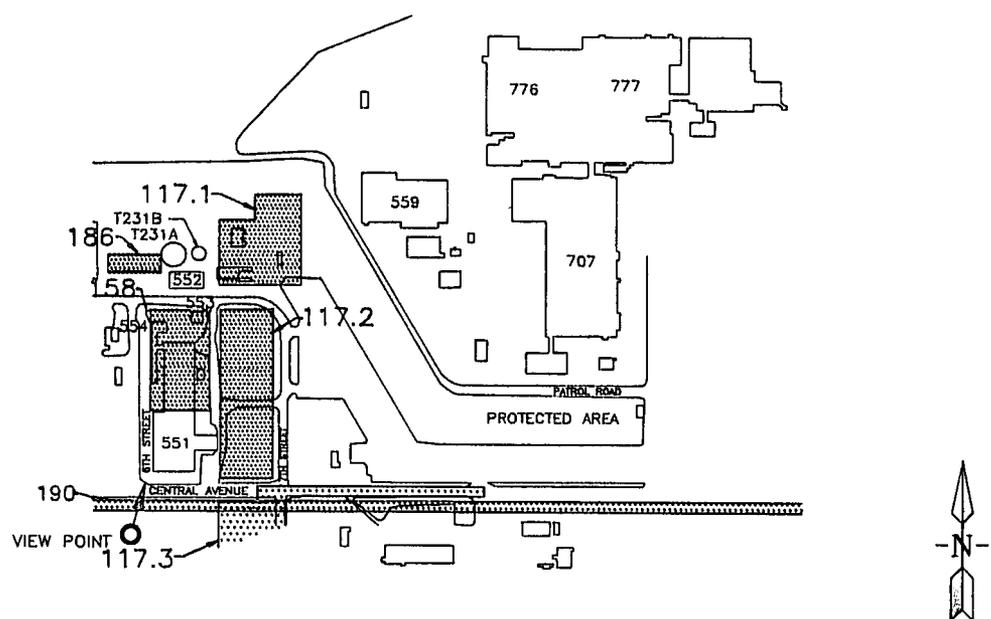
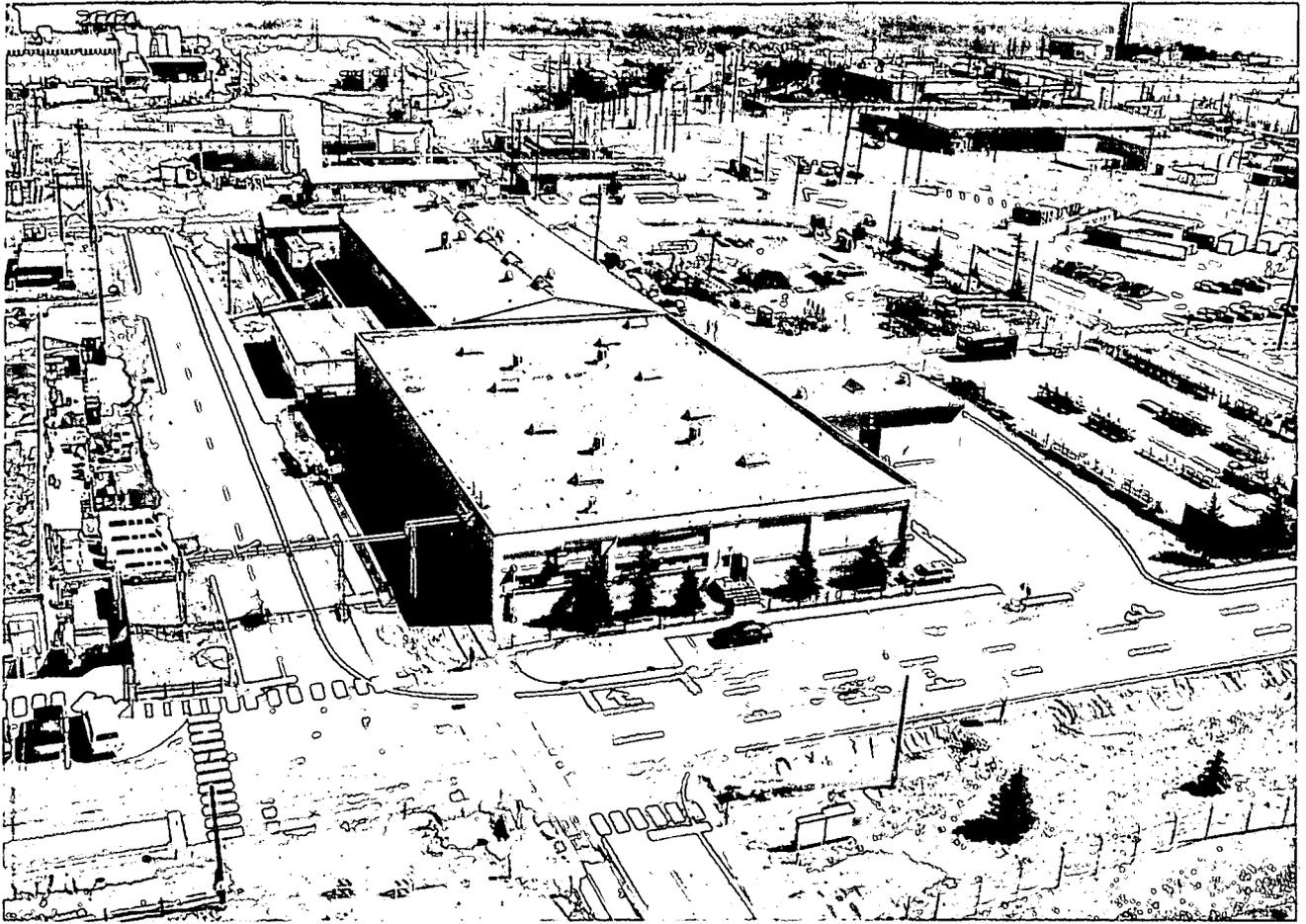
PHOTOGRAPH 4
 IHSS'S 128, 134(NORTH), AND 171
 LOOKING NORTHWEST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



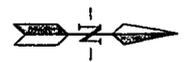
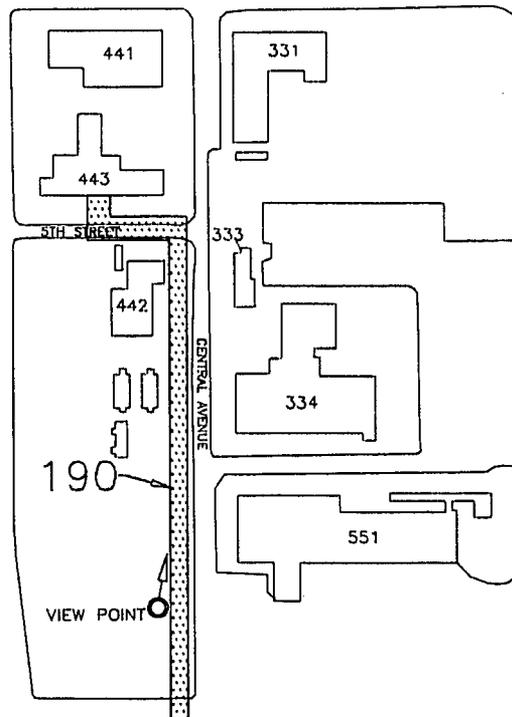
PHOTOGRAPH 5
IHSS 186
LOOKING NORTH NORTHEAST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



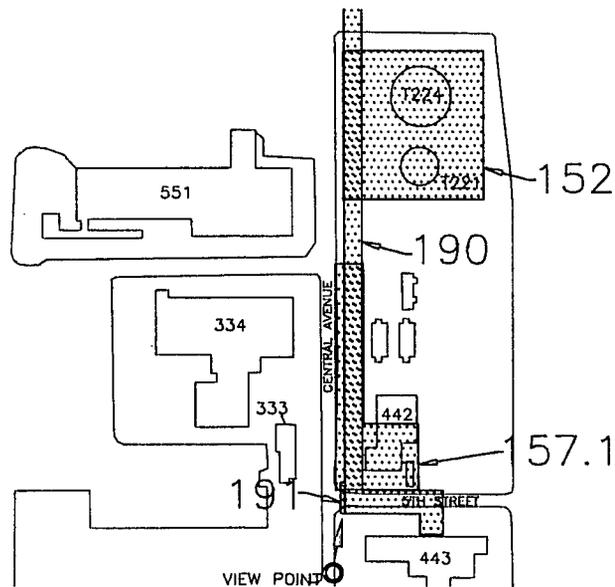
PHOTOGRAPH 6
 IHSSs 117.1, 117.2, 158, 186, AND PARTS OF 117.3 AND 190
 LOOKING NORTH NORTHEAST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



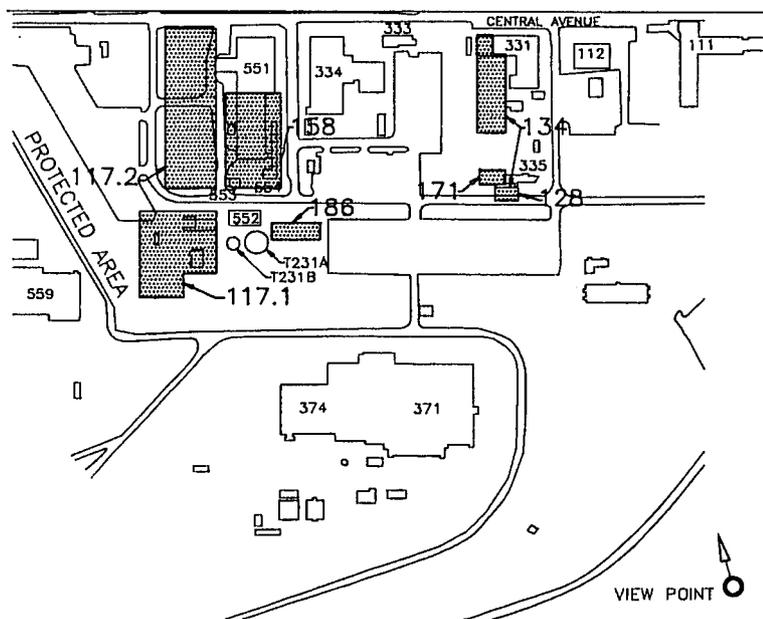
PHOTOGRAPH 7
IHSS 190
LOOKING WEST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



PHOTOGRAPH 8
 IHSSs 152, 157.1, 191, AND PART OF 190
 LOOKING EAST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado

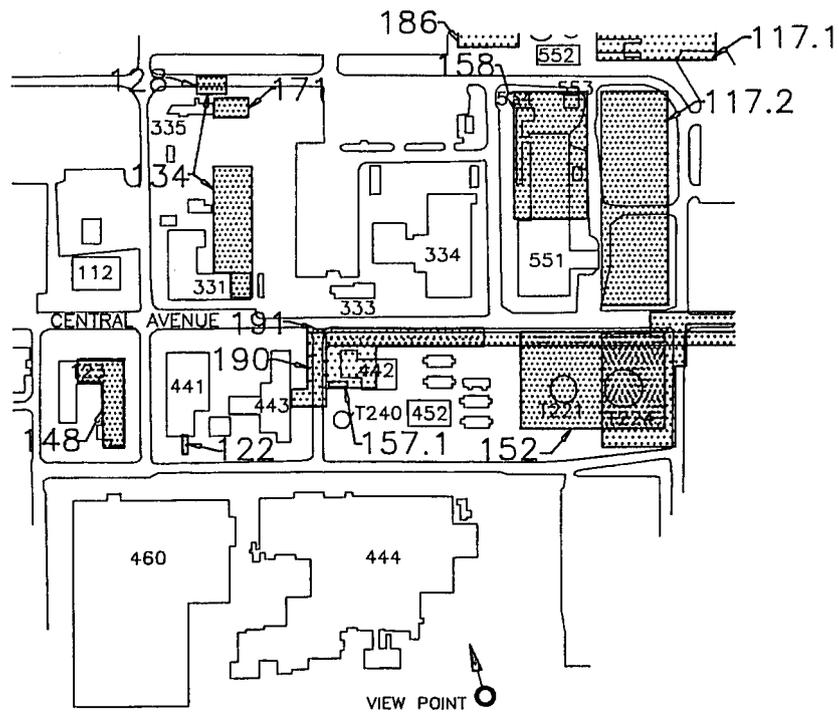
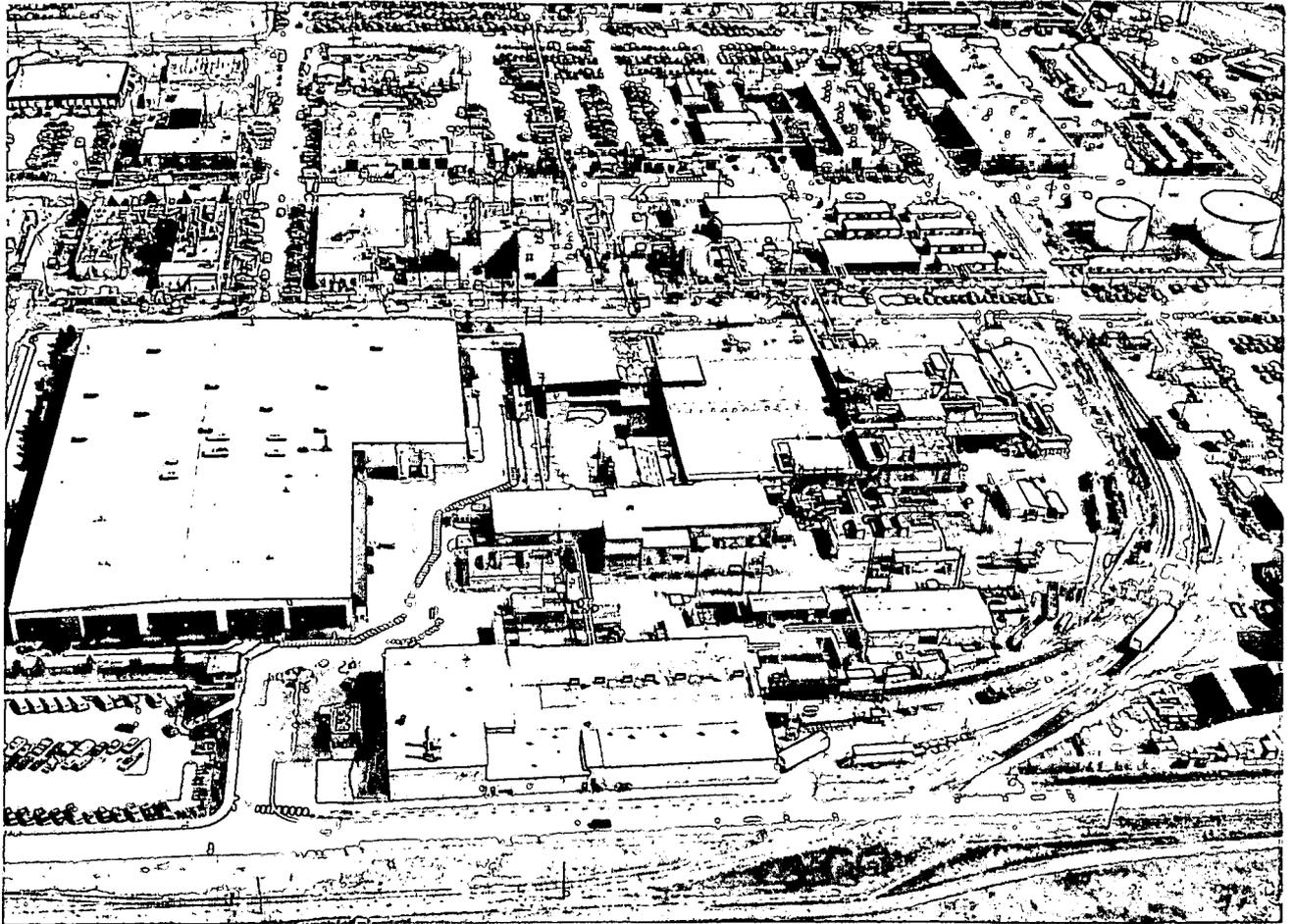


PHOTOGRAPH 9

IHSSs 117.1, 117.2, 128, 134, 158, 171, AND 186
 LOOKING SOUTH

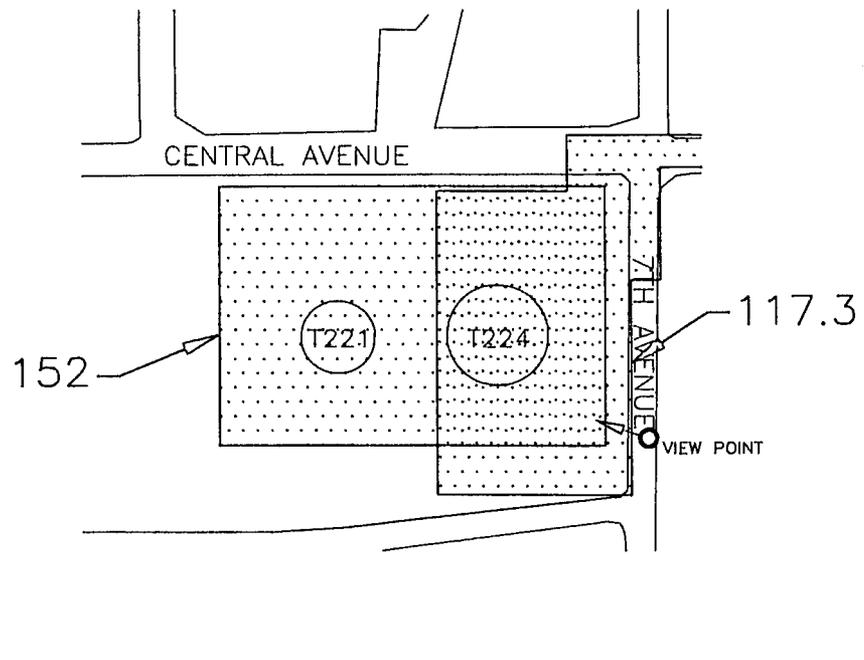
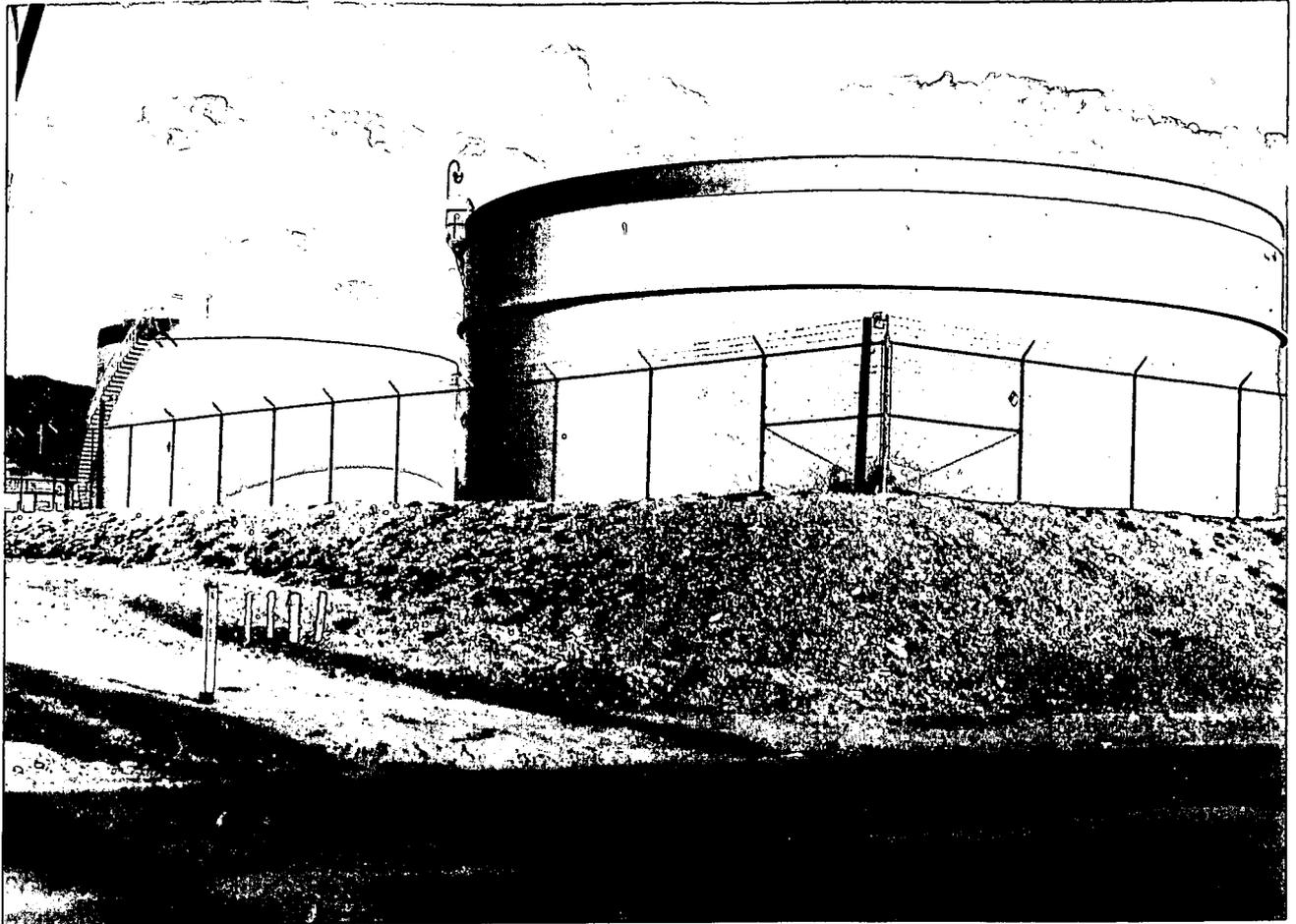
OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN

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



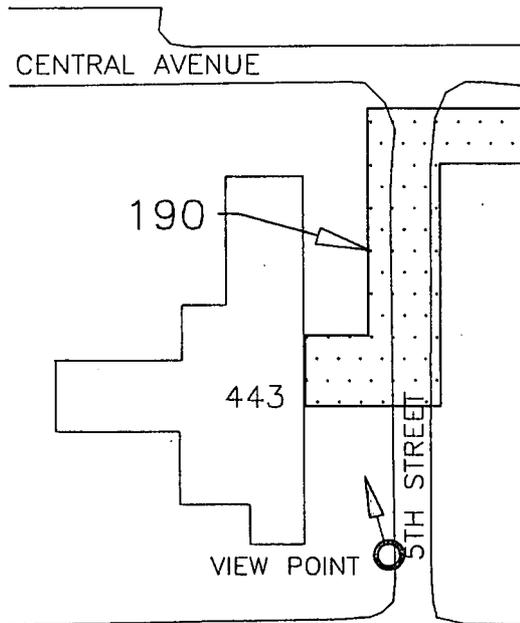
PHOTOGRAPH 10
OU13 IHSSs
LOOKING NORTH

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



PHOTOGRAPH 11
 IHSSs 117.3 AND 152
 LOOKING WEST NORTHWEST

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado



PHOTOGRAPH 12
PART OF IHSS 190
LOOKING NORTH NORTHWEST

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

**ENVIRONMENTAL MANAGEMENT
PROGRAM
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area**

Manual 21100-WP-OU13.1
Section No.: 3.0, REV. 2
Page: 1 of 2
Effective Date: May 11, 1992
Organization: Environmental Management

**TITLE:
Phase I RFI/RI Work Plan for
Operable Unit 13**

Approved By:

3.0 ROCKY FLATS PLANT CHEMICAL SPECIFIC BENCHMARKS

Tables 3.1 through 3.4 provide a preliminary identification of potential chemical-specific Benchmarks for groundwater and surface water at RFP. Chemical specific benchmarks 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. The Benchmarks included in this section are in lieu of ARARS, and were developed for the entire Rocky Flats Plant site and are not specific to OU13. Site specific ARARs will be developed as the initial step of the Corrective Measures Study for OU13. As validated data become available from RFI/RI investigations obtained pursuant to this Work Plan, the Benchmarks will be reevaluated in accordance with Chapter Three, Part 15 of the IAG (DOE, 1991a). The site-wide Benchmarks 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. Cleanup criteria for OU13 will be site specific and shall be based on results of an environmental and human-based Risk Assessment.

Site-wide Benchmarks represented in Tables 3.1 through 3.4 were developed from the following sources:

- Colorado Department of Health (CDH), Water Quality Control Commission (WQCC), groundwater standards;
- Safe Drinking Water Act (SWADA), Maximum Contaminant Levels (MCLs), surface water and groundwater;
- Clean Water Act (CWA), Ambient Water Quality Criteria (AWQC), potentially applicable to surface water and groundwater;

- RCRA, Subpart F, Groundwater Concentration Limits (40 CFR 264.94), groundwater standards; and
- CDH, WQCC proposed statewide and classified groundwater area standards.

In instances where Benchmarks have not been proposed for a particular chemical or for a particular type of investigative method, EG&Gs 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.

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

Parameter	Type (7)	PQL		Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal (b)	CWA AWQC for Protection of		CWA AWQC for Protection of		NRC Effluent Standards Water pCi/L
		MDL							Aquatic Life (c)	Chronic Values	Human Health (d) Water and Fish Ingestion	Fish Consumption Only	
		RPF	CDH											Acute Values
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		a									
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	
Benzene	V	5	1	CV	5		0		5,300		0.66**	40**	
Bromodichloromethane	V	5	1	CV									
Bromoforn	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												
Halo methanes	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		Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goal (c)	SDWA Maximum Contaminant Level Goal (h)	CWA		CWA		NRC Effluent Standards Water pCi/l
		MDL							AWQC for Protection of		AWQC for Protection of		
		RFP	CDH						Aquatic Life (d)	Human Health (e)	Human Health (e)	Fish Consumption Only	
									Acute Value	Chronic Value	Water and Fish Ingestion		

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, bromo dichloromethane, 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 mre/yr.
- (7) type abbreviations are: A=anion; B=bacteria; C=cation; D=dioxin; E=element; I=in diator; PP=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

- (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.

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

Parameter	Type (5)	PQL		Method (6)	Human Health Carcinogens/ Noncarcinogens (2) (3)		Statewide Standards (a)				Basin Standards (b)			
		MDL			Water Supply	Water and Fish	Aquatic Life (8)		Aquatic Life (9)		Agricultural Standard (3)	Domestic Water Supply (4)	Organics (7)	
		RFP	CDH				Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)			Aquatic Life	Water Supply
		Table 1, II, III (1)												
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													
Butyl Benzylphthalate	SV	10	10	CS		3,000								
Chlorinated Ethers	SV													
Chlorinated Naphthalenes	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			a										
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	960	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								
Nitrosodimethylamine	SV		10	b		0.0008								
Nitrosodimethylamine	SV		10	b		0.00069								
Nitrosopyrrolidine	SV		10	b		0.016								
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								

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

Parameter	Type (3)	Statewide Standards (a)										Basin Standards (b)		
		PQL MDL		Method (9)	Human Health Cardiac/pam/ Neurotoxicogens (2) (8)		Aquatic Life (5)		Tables I, II, III (1)				Organics (7)	
		RFP	CDH		Water Supply	Water and Fish	Acute Value	Chronic Value	Aquatic Life		Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
									Acute Value (2)	Chronic Value (2)				

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
- 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 a specific, numeric standard 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
 - (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=BPA; 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--in 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 3.10 (5 CCR 1002-8) 1/15/1974; amended 10/17/1991 (AR AR).
(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 - Basin-wide standards are AR AR.

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

Parameter	Type (5)	POL MDL		Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		POL MDL			Table A,B (1)	Table C Fish & Water Ingestion	Table D Radio- nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
		RFP	CDH					Acute Value	Chronic Value	Womans 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	0.0000022	0.00000013			0.00000013		
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							
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							

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

Parameter	Type (5)	FQL MDL		Method (6)	Tables A,B (1)	Table C Risk & Water Impacts	Table D Radio-nuclide	Screen Segment Table (5)		Table 2 Radionuclides Winnipeg Creek
		RFP	CDH					Acute Value	Chronic Value	
Methoxychlor	P	0.5	0.5	CP	100					
Mirex	P		0.1							
Parathion	P			CP						
PCBs	P	0.5		E	0.005 (6)	0.000079		0.000079		
Simazine	P		5	CP						
Toxaphene	P									
Vapontic 2	P									
Aroclor 1016	PP	0.5		CP						
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						
Americium (pCi/l)	R									
Americium 241 (pCi/l)	R	0.01					30		0.05	0.05
Cesium 134 (pCi/l)	R	1			80		80		80	80
Cesium 137 (pCi/l)	R	1							7	11
Gross Alpha (pCi/l)	R	2							5	19
Gross Beta (pCi/l)	R	4							5	0.05
Plutonium (pCi/l)	R						15			
Plutonium 238+239+240 (pCi/l)	R	0.01					5			
Radium 226+228 (pCi/l)	R	0.5/1.0 (7)								
Strontium 89+90 (pCi/l)	R	1					8			8
Strontium 90 (pCi/l)	R						60			500
Thorium 230+232 (pCi/l)	R						20,000			
Tritium (pCi/l)	R									
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			10
1,2,4,5-Tetrachlorobenzene	SV		10		2 (6)					
1,2,4-Trichlorobenzene	SV	10								
1,2-Dichlorobenzene (Ortho)	SV	10								
1,2-Diphenylhydrazine	SV		1		620					
1,3-Dichlorobenzene (Meta)	SV	10			0.05 (6)					
1,4-Dichlorobenzene (Para)	SV	10			620					
2,4,5-Trichlorophenol	SV	50			75					
2,4,6-Trichlorophenol	SV	10	50		700					
2,4-Dimethylphenol	SV	10	50		2.0 (6)	1.2				
2,4-Dinitrophenol	SV	10	50		21 (6)					
2,4-Dinitrofluorene	SV	10	10							

**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)											
Parameter	Type (5)	FQL MDL		Method (6)	Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio- nucleide	Stream Segment Table (3)		Table 2 Radionuclides	
		RFP	CDH					Acute Value	Chronic Value	Woman Creek	Walnut Creek
Acetone	V	10		CV							
Acrylonitrile	V		5	CV		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						
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										
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							

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

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

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
- 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.

**ENVIRONMENTAL MANAGEMENT
PROGRAM
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area**

Manual 21100-WP-OU13.1
Section No.: 4.0, REV. 2
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Phase I RFI/RI Work Plan for
Operable Unit 13**

Approved By:

4.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION TASKS

4.1 PROJECT PLANNING

Project planning will consist of the activities necessary to initiate the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Individual Hazardous Substance Sites (IHSSs) in the 100 Area. Activities undertaken for this project have included a review of previous investigations, historical aerial photographs, and other historical information. Results of this review are presented in Section 2.0 of this work plan. Prior to field investigations, it is necessary to complete the review of the existing data, including plant records and plans, available aerial photographs, and new data which become available after preparation of this work plan. The IAG also requires the submittal of several existing reports to the regulatory agencies. These reports will be assembled and reviewed during the project planning task.

There are ongoing site studies at RFP of surface water and sediments, groundwater, geology, background geochemistry, and ambient air that may provide data that have bearing on the investigations in the 100 area. These data will be compiled and evaluated during the project planning activities. Data from investigations at overlapping OUs will also be reviewed. If available data from ongoing investigations meet the requirements of the Phase I sampling and analysis plan, the samples proposed in Section 6.0 need not be collected again.

Other project related documents are currently being prepared. The Sampling and Analysis Plan (SAP), which includes the site-wide Quality Assurance Project Plan (QAPjP) and Standard Operating Procedures (SOP) for field activities, is currently being completed by EG&G. The Health and Safety Plan (HSP) is also being completed by EG&G. The Field Sampling Plan (FSP) is included as Section 6.0 of this

document. The Phase I FSP will be revised as necessary based on the findings of the photo and records review.

4.2 COMMUNITY RELATIONS

In accordance with the IAG, dated January 22, 1991, the Communications Department at Rocky Flats is developing a plant-wide Community Relations Plan (CRP) to develop an interactive relationship with the public relating to environmental restoration activities. A Draft Community Relations Survey Plan has been completed and forwarded to the Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the public for review. This plan specifies activities planned to complete the Environmental Restoration (ER) Program CRP, including plans for community interviews. The draft CRP was completed in September and the final CRP in November 1990, in accordance with the IAG schedules. Accordingly, a site-specific CRP is not required for Operable Unit Number 13 (OU13). The ER program community relations activities include participation by plant representatives in informational workshops, meetings of the Rocky Flats Environmental Monitoring Council, briefings of the public on proposed remedial action plans, and meetings to solicit public comment on various ER program plans and actions.

The Communications Department is continuing other public information efforts to keep the public informed on ER activities and other issues related to plant operations. A Speakers Bureau program sends speakers to civic groups and educational organizations, while a public tour program allows the public to visit Rocky Flats. An Outreach Program is also in place in which plant officials visit elected officials, the news media, and business and civic organizations to further discuss issues related to Rocky Flats and ER activities. The Communications Department receives numerous public inquiries which are answered through telephone conversations or by sending written informational materials to the requestor.

4.3 FIELD INVESTIGATION

Phase I field investigations will be conducted at the IHSSs in the 100 Area to collect samples and data concerning the nature and extent of contamination, if any, at each site. The data and sample results will be used to support the Phase I Environmental Evaluation and Phase I Human Health Risk Assessment, as well as meet the objectives and data needs described in Section 5.0 of this work plan. Additional phase(s) of investigation and risk assessment may be required at IHSSs prior to Feasibility Studies.

Three types of activities will be performed during the Phase I field- investigation: screening activities, sampling activities, and monitoring well installation. Screening activities include visual inspections, radiological surveys and soil gas surveys. Sampling activities include surface soil sampling, subsurface sampling using test borings, vadose water sampling, surface water sampling, and sediment sampling. Monitoring wells will be installed and sampled at specified locations and in some test borings.

Thirteen IHSSs have been included in OU13 in the 100 Area. These IHSSs have been grouped into two groups based on the contaminant source type and release mechanism of the sites. Because of the diverse nature of the IHSS groups, the Phase I field investigations for each group will be different. Specific field activities are described in the Phase I FSP in Section 6.0 of this work plan.

4.4 SAMPLE ANALYSIS AND DATA VALIDATION

Samples collected during the Phase I field investigation will be analyzed for the parameters specified in the IAG as described in Section 6.4. Analytical procedures will be completed in accordance with the ER Program QAPjP. Project-specific quality assurance (QA) requirements are included in the Quality Assurance Addendum (QAA), Section 10.0 of this work plan. Section 6.0 of this work plan specifies Phase I analytical requirements, as well as sample containers, preservation and holding times, and field quality control (QC) requirements. Samples collected for this work plan will be analyzed by a Rocky Flats Plant (RFP) contract laboratory.

Phase I data will be reviewed and validated according to the data validation guidelines in the QAPjP and the Data Validation Functional Guidelines. These documents state that the results of data review and validation activities will be documented in data validation reports.

4.5 DATA EVALUATION

Data collected during the Phase I 100 Area RI will be incorporated into the existing database with data from investigations at other OUs. The data will be used to better define site characteristics, source characteristics, the nature and extent of contamination, to support the baseline risk assessment and environmental evaluation, and to evaluate potential remedial alternatives.

4.5.1 Site Characterization

Geologic and hydrogeologic data will be used to develop site maps and cross sections. Geologic data will be used to evaluate the stratigraphy of the alluvium and colluvium at each site and to determine the depth to bedrock and the bedrock type.

Hydrogeologic data will be used to characterize the unconfined aquifer at the sites. These data will include information about the following:

- Hydrostratigraphic characteristics of units present;
- Hydraulic gradients; and
- Water table depth and configuration.

To characterize the general groundwater flow regime within and adjacent to the IHSSs, groundwater flow modeling at an appropriate scale will be conducted. This flow modeling will initially consist of a single modeling project designed to include the IHSSs within OU13 and integrate consistently with site-wide groundwater flow modeling. The initial flow modeling will be used to construct flow paths from the IHSSs and to determine requirements for more detailed flow and transport modeling. Detailed flow and transport modeling will be done at the IHSS level as necessary.

To characterize the general surface water system of OU13, a regional scale surface water flow and transport model will be developed. Where required, IHSS specific flow and transport models will be developed and integrated to the regional scale model.

Data collected during surface water and sediment sampling, including background sampling, will be used to characterize the 100 Area.

4.5.2 Source Characterization

The data collected during the Phase I RI will be evaluated to identify potential sources of contamination at the IHSSs. Potential sources include wastes disposed at the sites and off-site sources located topographically and/or hydraulically upgradient of the sites. Analytical data from soil and sediment

sampling at the sites will be used to characterize the nature, lateral and vertical extent, and volume of source materials, if present.

4.5.3 Nature and Extent of Contamination

Graphical and, where appropriate, statistical methods will be used to identify chemical and radioactive contaminants present in the soil, sediment, surface water, and groundwater and to estimate the concentrations and distributions of the contaminants. Results of sampling will be compared with results of the ongoing background geochemical characterization to assess whether the chemical concentrations are above background levels. Products of this analysis may include isopleth maps, cross sections and profiles, chemical tables, and statistical results.

4.6 PHASE I BASELINE RISK ASSESSMENT

Using existing data and data collected during the tasks described above, a Phase I baseline risk assessment will be prepared for OU13 to evaluate the potential risks to public health and the environment in the absence of remedial action. The Phase I baseline risk assessment will provide the basis for determining whether additional investigations are necessary at the IHSSs and whether remedial actions are necessary.

The risk assessment will be accomplished in five general steps:

- Identification of chemicals of concern;
- Exposure assessment;
- Toxicity assessment;
- Risk characterization; and
- Presentation of uncertainties and limitations of the analysis.

The Phase I risk assessment will address the potential public health and environmental impacts associated with the site under the no-action alternative (no remedial action taken) based on the data available. This assessment will aid in the preliminary screening site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment.

The objectives and description of work for each risk assessment step are described in detail in the Human Health Risk Assessment Plan for OU13, Section 8.0 of this work plan. The Environmental Evaluation Work Plan for OU13 is Section 9.0 of this work plan.

4.7 PRELIMINARY REMEDIAL ACTION ALTERNATIVES

Remedial action alternatives reflect remedial action objectives aimed at protecting human health and the environment and should specify contaminants, exposure routes and receptors, and a preliminary remediation goal (e.g., an acceptable contaminant range).

4.7.1 Surficial Materials, Bedrock, Surface Water and Sediments, and Groundwater

4.7.1.1 Development and Screening of Remedial Alternatives

This section identifies potential technologies applicable to remediation of contaminated soils, bedrock, surface water, surficial materials, and groundwater at OU13. The identified technologies are based on the preliminary site characterization developed in Section 2.0. Identification and screening of technologies and assembling an initial screening of alternatives will be conducted simultaneously with the RFI/RI. However, investigation of this OU is in its early stages; thus, remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives for OU13 will be addressed in the feasibility study (FS).

OU13 is a CERCLA unit and as such the processes employed to develop and evaluate alternatives for OU13 are outlined in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988). As stated in the IAG, general compliance with both RCRA and CERCLA is required for this OU. However, the outline presented in the CERCLA Guidelines provides the greatest detail and ensures compliance with RCRA.

The following steps were used to develop remedial alternatives for the OU13 area:

- Develop remedial action objectives of a general nature appropriate for site-specific, risk-related factors and based on chemical-specific and radionuclide-specific standards when available.

- Develop a list of actions appropriate for the bedrock, surface water, surficial materials, and groundwater at OU13 (such as containment, treatment, and/or removal) that may be implemented to satisfy the objectives defined in the previous step. These actions are generally referred to as "general response actions" in EPA guidelines.
- Identify and screen technology groups for each general response action. General response actions can each be further defined to include groups of technologies by which an action can be accomplished. Screening will eliminate those groups that are not technically feasible at the site.
- Identify and evaluate process options for each technology group to select a process option representing each technology group under consideration. Although specific process options are selected for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group.
- Assemble the selected representative technologies into site closure and corrective action alternatives for the bedrock, surface water, surficial materials and groundwater of the IHSS areas of OU13 that represent a range of treatment and containment combinations, as appropriate.
- Screen the assembled alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the screening evaluation reduces the number of alternatives that will undergo thorough and extensive analyses, alternatives will be evaluated in less detail than subsequent evaluations.

Determining the effectiveness of alternatives involves an evaluation of the protection of human health and the environment achieved by a remedial action during construction and implementation and after the response objectives have been met. Evaluation of short-term effectiveness is based on protection of the community and workers, impacts to the environment, and the time required to meet remedial response objectives. Long-term effectiveness addresses the risk remaining to human health and the environment. It is based on the percentage of permanent destruction, decreased mobility, and/or reduction in volume of toxic compounds achieved after response objectives have been met.

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to the site-specific conditions. Technical feasibility refers to the ability to construct, reliably operate, and comply with action-specific (technology-specific) requirements in order to complete the remedial action. Administrative feasibility refers to the ability to

obtain required permits and approvals; to obtain the necessary services and capacity for treatment, storage, and disposal of hazardous wastes; and to obtain essential equipment and technical expertise.

Cost estimates for screening will be derived from cost curves, generic unit costs, vendor information, conventional cost estimating guides, and prior estimates made for similar sites at RFP, with modifications made for current RFP conditions. Precise estimates are not necessary. However, the cost estimates for comparison and screening will have the same relative accuracy. The cost estimating procedures used during screening are similar to those that will be used during the later detailed alternatives analyses. However, the later detailed analysis will receive more in-depth and detailed estimates for the components of each alternative. The screening cost estimates will include capital, operating, and maintenance costs. The operating and maintenance costs will be calculated for the lifetime of the treatment operations at the site. Present worth cost analysis will be used to make the costs for the various alternatives for the various alternatives comparable.

Alternatives with the most favorable results from the composite evaluation will be retained for further scrutiny during the detailed analysis. Not more than ten alternatives will be retained for detailed analysis (including containment and no action). At that time, it may be determined that additional site-specific information or technology-specific treatability studies are necessary for an objective detailed analysis. It will also be necessary to identify and verify the action-specific applicable or relevant and appropriate requirements (ARARs) for each alternative.

The Phase I RFI/RI Work Plan identifies the appropriate level of alternatives analyses and involves listing general response actions most applicable to the type of site under investigation. General response actions are broadly defined as those that may satisfy the objectives for remediation defined for OU13. Those objectives include the protection of human health and the environment from ingestion, dermal contact or inhalation of contaminants that may be present in the bedrock, wastes, surficial materials, surface water, or groundwater in the OU13 area through remediation. Table 4.1 provides a list and description of general response actions and typical technologies associated with remediating soils, wastes, groundwater, surficial materials, and surface water. Table 4.1 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 the IHSS areas of OU13. Some will be discarded during the screening of alternatives.

The response actions outlined in Table 4.1 must be applied to the potential exposure pathways that will be identified for OU13. The response actions may provide control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that control all pathways.

In general terms, potential human exposure may 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 contact with the released contaminant could be prevented.

While the identification of general response actions is discussed above, the selection of the most appropriate action or combination of actions is not warranted at this time. Site and contaminant data are not sufficient to initiate the screening process. Phase I will generate data necessary to characterize the source and soils and will evaluate the impact of OU13 on surface water, groundwater, air, the environment, and biota in addition to characterizing potential contaminant migration pathways. Data obtained from these investigations will:

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

These data will provide information for the preliminary screening of alternatives and a thorough, comparative evaluation of the technologies with respect to implementability, effectiveness, and cost. This information will allow for informed decisions to be made with respect to the selection of preferred technologies. The Field Sampling and Analysis Plan (FSAP) in Section 6.0 describes the methodology that will be followed to obtain the required information for the Phase I RFNRI characterization.

Detailed Analysis of Remedial Alternatives

The detailed analysis of each alternative will be performed when sufficient data are generated. The detailed analysis and selection of alternatives is not a final decision-making process; rather, it is the process of analyzing and comparing relevant information in order to select a preferred remedial action. In accordance with the NCP, containment technologies will generally be appropriate remedies for wastes that pose a relatively low-level threat or where treatment is impracticable (EPA, 1991). 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 based on the nine evaluation criteria is necessary for the Corrective Measure Study (CMS) and the subsequent Corrective Action Decision (CAD)/Record of Decision (ROD). The nine 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.

These criteria are described in recently revised guidelines provided in the National Contingency Plan (NCP). The first two criteria are considered standards because they must be evaluated before further consideration of the remaining criteria. The next five criteria are considered the balancing items on which the analysis is based. The final two criteria are addressed during the final decision-making process after completion of the CMS/FS.

4.7.2 Air

Atmospheric transport is characterized by short migration times, relatively large areas of exposure, and an inability to mitigate the potential consequences of a contaminant release once it occurs. As such, effective air pathway contaminant control will emphasize source emissions reduction and containment prior to atmospheric release. Conventional technologies that may be employed during OU13 Work Plan implementation to suppress fugitive dust and volatile organic emissions include application of water sprays, surfactants, or dust suppressants and installation of wind-screens or membrane coverings. Such methods will be applied when personnel protection monitoring (as implemented according to the Site-Specific Health and Safety Plan) indicates the need for mitigative action during Work Plan implementation.

4.8 TREATABILITY STUDIES

This task includes efforts to provide technical support in the form of bench-scale treatability tests to the Rocky Flats Plant ER Program in the event that treatability studies are necessary or appropriate to support the OU13 RFI/RI. EG&G has prepared a site-wide Treatability Studies Plan which addresses this Task. The site-wide studies will be utilized as appropriate for OU13.

Treatability studies are conducted primarily to: (1) provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis, and to support the design of a selected remedial alternative; and (2) reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. Treatability study requirements are developed during the development and screening of remedial alternatives and include all available data from the current study as well as prior studies.

Numerous technologies that appear to be potentially applicable for treating OU13 will be screened for treatability testing. The technologies selected for screening will be limited to those already commercially established or which have demonstrated potential for processing spent solvents, radionuclides, oils, and similar contaminants. Additionally, the technologies considered will be required to be readily implementable (i.e., standard design package units available) within a short time frame. Innovative and alternative technologies not meeting the above requirements will not be considered.

Depending on the hydraulic properties of the unconfined aquifer considered for remediation, it may be feasible to collect groundwater for treatment above ground. In that case, the following technologies have been identified for potential testing:

Chemical Oxidation of Organics - Chemical oxidation is used to degrade hazardous organic materials to less toxic compounds. Oxidation systems, particularly those using ultraviolet (UV) light, ozone, and hydrogen peroxide, are powerful tools for treating a wide variety of common organic environmental contaminants. Disadvantages are similar to those for inorganic oxidation reduction: potential nontarget organics and inorganics can produce undesirable side products and increase oxidant requirements.

Granular Activated Carbon (GAC) Adsorption of Organics - GAC adsorption is the most fully developed and widely used technology for treating groundwater contaminated with organics. It is effective for the removal of a wide range of organics from aqueous waste streams. Bench-scale testing consists of running a series of descriptive tests to determine isotherms for the groundwater contaminants. GAC is typically regenerated with a thermal process, and the regeneration process can be performed at either off-site or on-site facilities.

Reverse Osmosis - Reverse osmosis processes involve the use of semipermeable membranes. By applying water pressure greater than the osmotic pressure to one side of the membrane, water is passed through the membrane while particulate, salts, and high molecular weight organics are retained. However, the retained, highly concentrated solution (retentate) contains dissolved salts as well as the target contaminants, and requires further treatment or disposal.

Air Stripping - Air stripping is a proven technology for removal of volatile and semivolatile contaminants from water. This process involves the transfer of contaminants from a contaminated liquid phase to a vapor phase by passing the two countercurrent streams through a packed tower. Air emission treatment is generally required, with vapor phase activated-carbon systems being the most commonly used process for this purpose, though other alternatives, such as oxidation and incineration, exist. The vapor phase treatment unit is generally costly.

Distillation - Distillation is a process that involves separating compounds by means of their boiling point characteristics. The primary use of distillation is for reclaiming spent solvents from industrial processes, and it is generally applicable only to rather concentrated solutions. The process can be used to separate various volatile compounds or to separate mixtures of organics into light and heavy fractions. The light fraction can usually be recycled or used as a boiler feed, while the heavy fraction requires further treatment.

Biological Reactors - Biological reactors utilize microorganisms to remove organic contaminants from the water. Most organic contaminants can be biologically degraded by introducing the appropriate microorganisms. High concentrations of some organics and the presence of metals may prove toxic to the organisms, however, and pretreatment may be required. Several types of aerobic reactors exist, including activated sludge systems, trickling filters, rotating biological contactors, and immobilized cell reactors. In general, these methods generate large amounts of sludge, requiring disposal.

Sorption of Radionuclides - Sorption of inorganics, metals, and radionuclides is a standard technique for removal and concentration of these contaminants from wastewater. Common and proven sorption processes include ion exchange and GAC, while less-proven techniques involve the use of activated alumina, bone char, and proprietary sorption media. The sorption media are generally chemically regenerated, which results in a concentrated side stream requiring further treatment or disposal. Ion exchange and GAC sorbents are addressed separately elsewhere in this subsection, while the use of activated alumina and bone char are discussed below.

Activated alumina is a porous form of aluminum oxide with a large surface area. For removal of aqueous contaminants, activated alumina is typically used in a column similar to that for ion exchange. It has been proven successful in the removal of arsenic and fluoride from groundwater. More recently, activated alumina has shown promise in absorbing plutonium from a low-level wastewater effluent at the Hanford Site. In the same study, plutonium adsorption on bone char was the most rapid and gave the highest decontamination factors. Waste-stream specific laboratory testing would provide valuable information on the suitability of these sorbents for low-level radionuclide removal.

Ion Exchange of Radionuclides - Ion exchange processes are used for a wide range of water treatment application, including commonly recognized systems such as demineralizers and water softeners. The goal of an ion exchange system is to remove undesirable ions of a certain type(s) from a solution and replace them with more acceptable ions. Radionuclides are commonly removed from waste streams at nuclear facilities using ion exchange.

Ion exchange resins, particularly anion exchange resins, have been used to recover uranium from mine run-off water for many years. Extensive studies on the laboratory scale report removal of uranium from natural waters as high as 99 percent. A small full-scale ion exchange system was capable of removing uranium from drinking water supplies to as low as g/L. Ion exchange resins are typically rechargeable; however, the resins used in radioactive applications are generally only used once and are then disposed of as solid waste.

In cases where collection of groundwater is not feasible or practical, the following technologies have been identified for potential testing:

In Situ Biological Treatment - Depending on the effective porosity of the soils, in situ biological treatment may be feasible. In situ biological treatment of groundwater involves the stimulation of biological growth in the contaminated zone in order to reduce the contaminant concentrations. Microorganisms that can use some or all of the contaminants as substrates will normally exist in a contaminated environment. The microorganisms are stimulated to increase their biological growth and consumption of contaminants through addition of essential nutrients. Aerobic treatment systems also require the introduction of oxygen. In situ treatment is dependent on geological and hydrological conditions. The process is relatively inexpensive.

Vacuum Extraction - Volatile contaminants can be removed from soil using vacuum extraction, which is an in situ treatment technology that involves the air stripping of contaminants by inducing a vapor flow through the soil. Since this technology involves the transfer of contaminants to the vapor, air emission treatment is generally required. The efficiency of the process is highly dependent on geologic conditions, and would tend to be ineffective in low-permeability materials.

In cases where contaminants are entrained in soils, the soil (such as surface soil) is accessible, and the contamination is of limited areal extent, the following technologies have been identified for potential testing:

Solidification/Stabilization - Solidification is a process in which contaminants are mechanically bound to solidification agents, reducing their mobility. This produces a solid matrix of waste with high structural integrity. Stabilization usually involves the addition of a chemical reagent to react with the contaminant, producing a less mobile or less toxic compound. Solidification and stabilization are frequently used together and are a well-established method for reducing the mobility and toxicity of hazardous wastes. This process generates large volumes of solidified materials requiring disposal.

Vitrification - The vitrification process involves heating the waste matrix to a very high temperature and either combining the matrix with molten glass or heating the matrix until it melts. Once cooled, the molten mass solidifies into a stable, noncrystalline solid resistant to leaching of inorganic, metal, and radionuclide contaminants. Organic components are destroyed by pyrolysis. The process can be conducted either in situ or off site; however, the process is generally expensive.

Physical Separation - Soil contaminants are often found to be associated with a particular size fraction of soils, most often fine particles. In these cases, fractionation of the soil based on particle size can be an effective means of reducing the volume of the material that requires further treatment. The processes used for soil size fractionation include screening, classification, flotation, and gravity concentration.

Soil Washing - Soil washing is based on the principle of contaminant removal from soil by washing with two liquid solutions. Washing agents include water, acids, solvents, surfactants, and chelators. With the selection of appropriate washing solutions, soil washing technology can potentially be used to remove organics, inorganics, metals, and radionuclides. The wash solution containing the contaminants will require treatment and/or disposal.

4.9 REMEDIAL INVESTIGATION REPORT

An RI report will be prepared summarizing the data obtained during the Phase I field work and data collected from previous and ongoing investigations. This report will:

- Describe in detail the field activities that serve as a basis for the RI report. This will include any deviations from the work plan that occurred during implementation of the field investigation.
- Discuss site physical conditions. This discussion will include surface features, meteorology, surface water hydrology, surficial and subsurface geology, groundwater hydrology, demography and land use, and ecology.
- Present a Preliminary Site Characterization based on all RFI/RI activities at OU13 and characterize the nature and extent of contamination. The media to be addressed will include contaminant sources, soils, sediments, groundwater, surface water, air, and biota.
- Discuss contaminant fate and transport. This discussion will include potential migration routes, contaminant persistence, chemical attenuation processes and potential receptors.
- Present a baseline risk assessment. The risk assessment will include human health and environmental evaluations.
- Present a summary of the findings and conclusions.
- Identify data gaps and work to be performed for the Phase 11 investigation.

TABLE 4.1

**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 onsite contact.
Access and Use Restrictions.	Permanent prevention of entry into contaminated area of site. Control of land use.	Site security, fencing, deed use restrictions, and warning signs.	Could control onsite exposure and reduce potential for offsite exposure. Site security fence and some 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, groundwater containment barriers, soil stabilization, and 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.	Groundwater pumping, leachate collection, and liquid removal from surface impoundments.	Applicable to leachate removal prior to in situ treatment or waste removal. Applicable removal of contaminated groundwater and bulk liquids (for example, from buried drums).
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of drums, soils, sediments, wastes, and 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 4.1 (Continued)

General Response Actions

Typical Associated Technologies and Evaluation

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
In Situ Treatment	Application of technologies in situ to change the in-place physical or chemical characteristics of contaminated material.	In situ vitrification and bioremediation.	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 definition 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 landfills and repositories.	With source removal, could be used to control all pathways. With removal of contaminated transport media, 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 groundwater sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.

**ENVIRONMENTAL MANAGEMENT
PROGRAM**
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area

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Phase I RFI/RI Work Plan for
Operable Unit 13

Approved By:

5.0 DATA QUALITY OBJECTIVES AND DATA NEEDS

5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are established to define data needs for each of the RFI/RI tasks, coordinate collection activities to support those needs, and to ensure the quality and quantity of resultant data. Collectively the data are used to make decisions regarding the risks the site poses to human health and the environment and to make decisions regarding which remedial measures are appropriate to mitigate the risks. DQOs are developed interactively with ongoing RFI/RI activities. The DQO development process is flexible, iterative, and dependant upon evaluation of existing data, and data that become available as a result of RFI/RI activities. Three stages are used in the development of DQOs, and each of the stages is outlined below (EPA, 1987).

Stage 1 - Identify Decision Types

- Identify and involve data users;
- Evaluate available data;
- Develop a conceptual model of the study site; and
- Specify RFI/RI objectives, and anticipate the decisions necessary to achieve the objectives.

Stage 2 - Identify Data Uses and Needs

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

Stage 3 - Design Data Collection Program

- Assemble data collection components; and
- Develop data collection documentation.

The DQO elements are continually revised and reevaluated on the basis of new data developed during each phase of the RFI/RI. As the environmental characteristics and the nature of contamination of the study area become better understood, additional data requirements will become apparent and both the DQOs and the Field Sampling and Analysis Plan (FSAP) may evolve in response to these requirements. The following discussion addresses each of the DQO elements.

5.1.1 Stage 1 Identification of Decision Types

5.1.1.1 Identification of Data Users

The following is a list of agencies and organizations that are the principal decision makers and end-users of data that will be generated during the OU13 Phase I RFI/RI (EG&G, 1991i).

United States Environmental Protection Agency, Region VIII, Waste Management Division Director, Federal Facilities Branch Chief, and the Rocky Flats Remedial Project Manager.

State of Colorado Department of Health, Hazardous Materials and Waste Management Division Director, Hazardous Waste Section Leader, Hazardous Waste Facilities Unit Leader, and the Monitoring and Enforcement Unit Leader.

United States Department of Energy, Office of Environmental Restoration and Waste Management, Secretary of Energy, and the Acting Assistant Secretary for Environmental Restoration and Waste Management.

United States Department of Energy Rocky, Flats Office Manager, Assistant Manager for Environmental Management, and the Acting Environmental Restoration Division Director.

EG&G Rocky Flats Plant, Environmental Management Department, Associate General Manager for Environmental Restoration and Waste Management, Environmental Management Department Director, Environmental Management Department Division Managers, and matrix project personnel from other Rocky Flats Plant or external EG&G organizations.

EG&G Rocky Flats Plant technical specialists and subcontractors responsible for supervising, coordinating and performing Environmental Restoration activities (EG&G, 1991i).

5.1.1.2 Evaluation of Available Data

Existing data are described in Section 2 of this document. Soils and geologic data collection activities in the vicinity of OU13 have been primarily directed toward defining the RFP environmental setting. Much of the data were developed as a result of the RFP Geological Characterization including chemical data used to characterize the types and sources of contamination present in the soils and groundwater. Chemical data continue to be collected from monitoring well 4486 as part of the overall RFP characterization monitoring program. The available soils and geology data were not developed for the specific purpose of characterizing OU13.

Existing ambient air monitoring programs characterize the RFP site on an area-wide basis for plutonium, and americium. This data is not specific to any of the OU13 IHSS sources, but provides a baseline for the RFP and is collected according to air sampling procedures specified in EMD Operating Procedures Manual No. 5-21000-OPS-AP, Volume VI, Air.

Surface water data (VOCs, metals, water quality, and radiochemistry) for OU13 are available from seven sampling stations (SED118, SW018, SW019, SW020, SW022, SW023, and SW093). Four of the stations (SW019, SW020, SW022, and SW023) are located within OU13; however, only SW019 is in a location that receives runoff from OU13. The seven other surface water sampling stations receive runoff from other OUs.

Data for air quality, surface water, groundwater, soils, and geology are being validated in accordance with sections 3.4 and 3.7 of the QAPjP for data validation guidelines and data usability criteria respectively. Some of the data are validated and accepted, some are validated with qualifications, some have been rejected, and some have yet to go through the validation process. Appendices D, E, and F list the available analytical data and identify which samples have been validated. A summary evaluation of the data available for each IHSS located in OU13 is given below.

North Chemical Storage Site (IHSS 117.1). This site was used to store non-radioactive construction debris, waste metal, and scrap metal. Existing data for this site are available from piezometers and groundwater monitor wells P114789, P214689, P115589, and P218089. The available data characterize the site's soils and geology.

Middle Chemical Storage Site (IHSS 117.2). This site was used as a non-radioactive chemical storage facility. Existing soils and geologic data for this are limited to piezometers located in the vicinity of the site. These piezometers are P115589, P213689, and P214089.

South Chemical Storage Site (IHSS 117.3). This site was used as a storage area for pallets cargo containers and new drums, and in one instance it is believed the site was used for the storage of a contaminated glovebox. Existing data for this site characterize soils geology and groundwater in the vicinity. These data are available from piezometers and monitor wells P313489, P418289, 6186. A radiometric survey for gross contamination was conducted for this area.

Oil Burn Pit Number 1 Waste Leak (IHSS 128). Approximately 200 gallons of radioactively contaminated waste oil were burned in an open pit in 1956. Data for soils and geology are available from piezometer P114889. Air monitoring data collected at the time the oil was burned may also be available.

Lithium Metal Destruction Site (IHSS 134). This area contains the reaction products from oxidation of magnesium and lithium metal coated with machine oils that may have contained perchloroethylene. Existing data for soils and geology are available from piezometers P114889 and P115489.

Waste Spills (IHSS 148). The soils of this site have reportedly been contaminated by spills of nitrates and possibly of unknown radioactive compounds. Existing data for this site is limited to a radiometric survey for gross contamination and surface water sampling station SW019.

Fuel Oil Tank (IHSS 152). This facility consists of an 800,000-gallon storage tank that is presently in operation, surrounded by an earthen dike, and containing No. 6 fuel oil. Approximately 700 gallons of fuel oil was spilled, cleaned up, and recycled in 1971. A similar spill of 400 gallons occurred in 1979. Existing data for this site is limited to a radiometric survey that indicated low levels of radioactivity were present.

North Area Radioactive Site (IHSS 157.1). This site is contaminated with unknown volumes of depleted uranium and beryllium. Existing data for this site include groundwater data from

monitor well 4486, soil samples taken in the year 1953, and a radiometric survey for gross contamination.

Building 551 Radioactive Site (IHSS 158). This site was used as loading area and as a temporary holding area for items contaminated with low levels of uranium. Existing data for this site include soils and geology data from piezometers P115589, and P214689.

Waste Peroxide Drum Burial (IHSS 169). This site is the reported location of a buried single 55-gallon drum of hydrogen peroxide. The date of burial is not known, and no existing sources of data are believed to be available. This incident is probably the same incident described as IHSS 191.

Solvent Burning Ground (IHSS 171). This site was used for training fire-fighting personnel and may be contaminated with waste oil and gasoline. Existing data characterizing this site's soils and geology are available from piezometer P114889.

Valve Vault (IHSS 186). This was the site of a process waste line leak. Unknown volumes of liquid waste carrying radioactive constituents and other unknown chemicals leaked into the soil at this location. Existing data for soils and geology are available from piezometer P114789.

Caustic Leak (IHSS 190). This was the site of two leaks of sodium hydroxide from an above-ground storage tank. One of the leaks resulted in a release to the environment, and the other did not. There are no known sources of soils, geology, or groundwater data for this site. Surface water data is available from sampling station SW019.

Hydrogen Peroxide Spill (IHSS 191). This was the site of a release of hydrogen peroxide from a 55-gallon drum. There do not appear to be any sources of data for this site.

5.1.1.3 Site Conceptual Model

Conceptual models of IHSSs in OU13 have been developed and are presented in Section 3.1 of this document. The models include a description of potential sources of contamination, release mechanisms, transport media, exposure routes, and potential receptors. The conceptual models were developed by organizing the IHSSs into two logical groups based upon the secondary source type, potential exposure routes and transport mechanisms. The two groups and the IHSSs that compose each group are listed below. IHSSs 128 and 148 are listed in both groups because they each exhibit characteristics of both groups.

- Releases originating above ground and affecting surficial materials:
117.1, 117.2, 117.3, 128, 134, 148, 152, 157.1, 158, 171, 190, and 191.
- Releases originating and affecting transport media below the ground surface:
128, 148, 169, and 186.

The conceptual models will be an aid in identifying exposure pathways and to evaluate the potential risks to human health and the environment posed by the contamination present in OU13.

5.1.1.4 Data Objectives and Decisions

The DQO process requires that specific data objectives be defined; formulation of the objectives leads to the identification of data needs. The data objectives for the OU13 RFI/RI Work Plan are summarized in Table 5.1. Data needs are expected to evolve based upon new information generated as the Work Plan is implemented.

5.1.2 Stage 2 - Identify Data Uses and Needs

5.1.2.1 Identify Data Uses

The principal uses of RFI/RI data have been defined in Data Quality Objectives for Remedial Response Activities and are listed below (EPA, 1987).

- **Site Characterization** - data are used to determine the nature and extent of contamination at a site;
- **Health and Safety** - data are used to establish the level of protection needed for onsite workers and to determine if there is imminent danger to the surrounding population;
- **Risk Assessment** - data are used to evaluate the threat posed by the site to public health and the environment;
- **Evaluation of Alternatives** - data are used to evaluate which remedial technologies may be appropriate;
- **Engineering Design of Alternatives** - data are used in the remedial design process to evaluate the performance of various remedial technologies;
- **Monitoring During Remedial Action** - after remedial actions are implemented, data are used to assess their effectiveness; and
- **Correlation of Environmental Contamination to Responsible Party(s)** - data are used to link wastes detected in the environment to wastes known to be onsite.

Data uses specific to RFI/RI Phase I sampling and analysis activities for OU13 are listed in Table 5.2.

5.1.2.2 Identify Data Types

Data types required for the OU13 RFI/RI are: air quality, soil engineering/geotechnical, soil-gas, soil chemistry, aquifer parameters, and groundwater chemistry. Table 5.2 provides additional information on the types of data that will be collected.

5.1.2.3 Identify Data Quality Needs

The level of data quality required for OU13 RFI/RI activities is based upon the following factors: appropriate analytical levels, potential contaminants that may be present, level of concern and required detection limit. Each of these factors is discussed below.

Appropriate analytical levels for RFI/RI work are listed below (EPA, 1987).

- **Level I** Field portable instruments. Results are typically not compound-specific or quantitative. This analytical level is appropriate for providing real-time health and safety data and as a screening tool to indicate potentially contaminated areas.
- **Level II** Mobile laboratories and field gas chromatograph/mass spectrometer (GC/MS) units. Results may be compound-specific and quantitative depending on instrument calibration, reference standards, equipment condition, and operator capability. Real-time data may be available, or results may be produced in several hours. This analytical level is appropriate during the site characterization, evaluation of remedial alternatives, engineering design, and during site monitoring.
- **Level III** Offsite analytical laboratory. Results generally have a greater degree of analytical precision than Level II. Data may be available in 24 hours or in several days to weeks. Level III is an appropriate level for some phases of site characterization, evaluation of remedial alternatives, engineering design, responsible party determination, and during site monitoring. Level III may be appropriate for risk assessment depending on the outcome of RFP policy decisions.
- **Level IV** EPA Contract Laboratory Program. The analytical precision is similar to that of Level III, but stringent quality assurance and quality control protocol are formally documented. Laboratory turn-around time for reporting analytical results are similar to those described for Level III.
- **Level V** Offsite analytical laboratory using non-standard methods. Analytical method development or modification is required, and analytical precision and reporting schedules may vary according to the method.

Analytical Levels I, II, IV and V will be used during implementation of the OU13 RFI/RI. The analytical methods that will be used are those specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B.

Potential contaminants have been identified based upon their toxicity, persistence in the environment, and frequency of occurrence. The potential contaminants present are listed in Table 5.3, but the list is expected to evolve as additional data become available.

Levels of concern are based upon available health standards and are expressed as contaminant-specific concentration ranges that serve as guidelines for selecting analytical methods, detection limits and in determining the boundaries of field investigations.

Detection limit requirements take into account the levels of concern, RFP chemical specific Benchmarks in lieu of Applicable or Relevant and Appropriate Requirements (ARARs), and DQOs specified in the RFP Site-Wide Quality Assistance Project Plan (EG&G, 1991i). Site specific ARARs will be developed as the initial step in the OU13 corrective measures study. Detection limits are listed in Table 5.4.

5.1.2.4 Identify Data Quantity Needs

Data quantity needs are based primarily on a review of the available environmental data and on an assessment of additional data required to adequately characterize the site and the nature of contamination at OU13. The rationale for sampling quantities is described in the FSAP presented in Section 6 of this Work Plan. The FSAP recommends a three stage approach to data collection and the number and location of sampling sites is expected to evolve based upon review of data generated during implementation of this Work Plan. Field sampling density will be based upon methodologies and statistical guidance contained in DQOs for Remedial Response Activities (EPA, 1987) and site specific information available from the Historical Release Report and developed as a result of preparing this Work Plan.

5.1.2.5 Evaluate Sampling/Analysis Options

RFI/RI data collection and analysis for OU13 will utilize a graduated approach in which analytical Level I and Level II field screening techniques will be used to focus subsequent data collection and analysis for analytical Levels IV and V. The sampling/analysis options selected are based upon their ability to obtain data that is consistent with known site conditions.

Field screening techniques will be used whenever possible to reduce waste generated during sample collection, minimize delays that can result when more exacting analytical methods are used, and to minimize worker exposure. Analytical Level I and Level II field screening will assess both radiochemical and organic chemical contamination during stage one of the FSAP. Radiological surveys using a High Purity Germanium detector (HPGe) will be conducted to identify areas of radiochemical contamination that may require further investigation. Field methods for use of the HPGe are presently being prepared and a standard operating procedure will be incorporated in the Environmental Management Radiological Guidelines Manual (RFP-EMD, 1991a). Soil-gas surveys utilizing a portable GC will be used to identify areas of organic chemical contamination and to direct further sampling efforts. Data collection procedures will be those specified in Environmental Management Division Manual 5-21000, Volume III, Geotechnical (RFP-EMD, 1992a). Photoionization detectors will be employed for health and safety purposes.

Surface scrape samples will be collected during stage two of the FSAP at IHSSs that show indications of contamination based upon the results of the radiation survey and soil gas survey. Soil samples that are collected from locations covered by asphalt may exhibit concentrations of TCL semi-volatiles and TAL metals that are related to the asphalt rather than an IHSS contamination source. To define the extent of apparent contamination attributable to the asphalt, a sample will be collected from the side of the opening created when the asphalt plug was removed in preparation for the soil gas and radiation surveys. The asphalt sample will be analyzed for TCL volatiles and TAL metals. A scrape sample will be collected at a depth of

approximately four inches below the base material that underlies the asphalt pavement. Surface scrape samples will be analyzed for TCL semi-volatile compounds, TAL metals, plutonium 239 and 240, americium 241, uranium 238, uranium 235, uranium 233/234, tritium, strontium 89/90, strontium 90, cesium 137, radium 226, radium 228, gross alpha, and gross beta. Analytical methods will conform to those referenced in the GRRASP: these methods meet the criteria for analytical Level IV through V. Field data collection will be in accordance with Environmental Management Division Manual 5-21000, Volume III, Geotechnical, (RFP-EMD, 1992a).

Soil samples will be collected from boreholes during stage two of the FSAP to assess contaminant types and distribution. A minimum of one randomly located boring will be drilled in every IHSS. Two additional boreholes may be drilled if the results of the radiation survey or soil gas survey indicate contamination. Samples will be analyzed for TCL volatile compounds, TCL semi-volatile compounds, TAL metals, plutonium 239 and 240, americium 241, uranium 238, uranium 235, uranium 233/234, tritium, strontium 89/90, strontium 90, cesium 137, radium 226 radium 228, gross alpha, and gross beta. Analytical Level IV will be used for the volatile, semi-volatile and metals analyses. Analytical Level V will be used for the radiochemical analyses. Field data collection will be in accordance with Environmental Management Division Manual 5-21000, Volume III, Geotechnical, (RFP-EMD, 1992b).

Alluvial groundwater samples will be collected from all existing piezometers and monitor wells in and immediately surrounding OU13 during stage one of the FSAP. During stage two of the FSAP, alluvial groundwater samples will be collected at the time boreholes are drilled using the Hydropunch® method or equivalent. If contamination is confirmed by the soil or groundwater samples, one monitoring well will be located upgradient of the affected IHSS and one downgradient monitoring well will be located downgradient of the affected IHSS. Samples will be analyzed for TCL volatiles, TCL semi-volatiles, TAL metals, plutonium 239 and 240, americium 241, uranium 238, uranium 235, uranium 233/234, tritium, strontium 89/90, strontium 90, cesium 137, radium 226 radium 228, gross alpha and gross beta. Quarterly groundwater data collection from monitoring wells will be conducted as Part of the RFP site-wide monitoring

program. Analytical Level IV (CLP protocol) and Level V (for radiochemicals) will be used for groundwater sample analysis. Groundwater sampling and measurement of field parameters will be conducted in accordance with procedures specified in the FSAP.

All data collection field records will be handled in accordance with the quality control procedures specified in Environmental Management Division Manual 521000, Volume I, Field Operations (RFP-EMD, 1992c).

5.1.2.6 Review of PARCC Parameter Information

PARCC parameters (precision, accuracy, representativeness completeness, and comparability) for analytical Levels I, II, IV and V are discussed below. Precision, accuracy and completeness goals are specified in the Quality Assurance addendum for this Work Plan.

Precision is a quantitative measure of data quality that defines the reproducibility or degree of agreement among replicate measurements of a single analyte. The closer the numerical values of the measurements are to each other, the more precise the measurements. One of methods used to estimate the precision of a method is the standard error of the estimates for the least square regression line of "measured" versus "target" concentrations (EG&G, 1991i). The primary role of this application is to characterize the precision of any analysis method under specified conditions. This allows comparison of different results produced by the same method. Analytical precision for a single analyte may be expressed as percentage of the difference between results of duplicate samples and matrix spike duplicates for a given analyte. Precision will be determined from the results of duplicate and matrix spike duplicate analyses (EG&G 1991i).

During the collection of data using field methods or instrumentation, precision is checked by reporting several measurements taken at one location and comparing the results. Precision will be reported as the relative percent difference for two results and as the standard deviation for

three or more results. Sample collection precision shall be measured in the laboratory with the analysis of field replicates and laboratory duplicates (EG&G, 1991i). Analytical precision will be achieved by adhering to the analytical methods contained in the GRRASP. Sampling precision will be achieved by conformance the procedures specified in the Environmental Management Division's Operating Procedure manuals referenced above.

Accuracy can be expressed in terms of completeness and bias. Accuracy is a quantitative measure of data quality that refers to the degree of difference between measured or calculated values and the true value. The closer to the true value, the more accurate the measurement. One of the measures of analytical accuracy is expressed as a percent recovery of a spike or tracer which has been added to the environmental sample at a known concentration before analysis (EG&G, 1991i). While it is not feasible to totally eliminate sources of error that may reduce accuracy, the OU13 Work Plan attempts to minimize error by using standardized analytical methods and field procedures.

Representativeness is a qualitative parameter that expresses the degree to which sample data accurately represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition (EG&G, 1991i). Representative data will be obtained by using both biased and unbiased methods of selecting sample locations. Biased methods will employ existing data in areas known to be contaminated to determine the degree of contamination. Unbiased methods such as grid sampling will be used to determine both the nature and extent of contamination. Field work will be conducted according to standard operating procedures, further aiding the collection of representative data.

Completeness is a quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from a measurement system. The objectives of the field sampling program are to obtain samples for all analyses required at each individual site, to provide sufficient sample material to complete those analyses, and to produce QC samples that represent

all possible contamination situations such as potential contamination during sample collection, transportation, or storage (EG&G, 1991i).

Comparability is a qualitative parameter describing the confidence with which one data set may be compared to another (EPA, 1987). The standard laboratory methods of the GRRASP and standard operating procedures for conducting field work will allow for one to one comparability of OU13 RFI/RI data to other work conducted in conformance with those same standards.

5.1.3 Stage 3 - Design Data Collection Program

Stage three of the DQO process compiles the various elements of Stages one and two into a cohesive data collection program for the OU13 RFI/RI. To this end, a Field Sampling and Analysis Plan and Quality Assurance/Quality Control Plan have been developed and are included as Sections 6 and 10, respectively, of this Work Plan. The results of the DQO process have been distilled into a detailed list (Table 6.1) of the number and type of samples to be collected, their location, and analytical methods.

Table 5.1
Data Objectives and Decisions

OBJECTIVE	RFI/RI ACTIVITY	DECISIONS
Evaluate the potential presence or absence of contaminants in the site's air, surface water, soils, subsoils, and groundwater.	Review site historical records and available contaminant source and distribution data.	Determine the applicable regulatory framework in conformance with the IAG.
Determine the demographic setting of the site and establish the site's relationship with surrounding population centers.	Collect qualitative and quantitative information describing the demographic setting, community interest groups, and their attitudes toward the site.	Determine what level of community relations involvement is appropriate in the early stages of the RFI/RI process, and how will this involvement be incorporated into other ongoing or planned community relations efforts.
Characterize the environmental setting of the site and define the mechanisms for contaminant transport.	Collect environmental samples (air, surface water, soils, subsoils, and groundwater), perform analyses, and conduct field tests to quantify and describe the physical nature of the site and to define the mechanisms governing contaminant transport.	Adjust the level of detail necessary to adequately describe the site as investigative activities progress.
Define contaminant concentrations and the extent of contamination.	Analyze sample data to define concentration gradients.	Prioritize contamination sources and transport mechanisms for future studies.
Assess the risks the site poses to human health and the environment.	Compare contamination data to existing health standards and perform a risk assessment.	Prioritize sources that may pose a threat to human health and the environment. Assess what level of community relations is appropriate.
Identify applicable remedial alternatives based upon the physical properties of the contaminants, the media in which they occur, and the migration and exposure pathways.	Review literature on available remedial technologies and their application. Use RFI/RI data to select technology that is compatible with the site risk assessment requirements.	Determine what resources can be shared between similar remedial actions at other OUs.

Table 5.2

Data Uses, Data Needs and Analytical/Field Quality

DATA USE	DATA TYPE	ANALYTICAL LEVEL	QA/QC METHODS
<p>Site Characterization</p> <p>Risk Assessment</p> <p>Evaluation of Remedial Alternatives</p> <p>Engineering Design Alternatives</p> <p>Monitoring During Remedial Action</p> <p>Correlation of Contamination to Responsible Party(s)</p>	<p>Groundwater samples are needed to determine concentrations of TCL volatiles, TCL semi-volatiles, TAL metals and radiochemicals.</p>	<p>Level IV, EPA CLP Protocol and Level V GRRASP protocol.</p>	<p>Duplicates, will be collected from wells that produce enough water to collect the required suites of analytes without dewatering. Matrix spikes and laboratory QA/QC will be in accordance with CLP protocol and GRRASP protocol.</p>
<p>Site Characterization</p>	<p>Real time soil gas surveys are needed to identify areas contaminated with organic chemicals. Surveys will be conducted using sampling grids.</p>	<p>Level II, field portable GC/MS equipment.</p>	<p>GC field calibration after every 10 sample analysis. Field duplicates for every 10 samples. Method blanks for each operating day.</p>
<p>Site Characterization</p> <p>Health and Safety</p> <p>Risk Assessment</p> <p>Evaluation of Remedial Alternatives</p> <p>Engineering Design Alternatives</p>	<p>Soil samples from boreholes are needed to determine the concentration and distribution of TCL volatiles, TCL semi-volatiles, TAL metals and radiochemicals in the alluvium.</p>	<p>Level IV, EPA CLP protocol and Level V GRRASP protocol.</p>	<p>Duplicates for every 10 samples. Method blanks for each suite of samples sent offsite for analysis. Laboratory QA/QC will be in accordance with CLP protocol and GRRASP protocol.</p>

TABLE 5.2 (Continued)
DATA USES, DATA NEEDS AND ANALYTICAL/FIELD QUALITY

DATA USE	DATA TYPE	ANALYTICAL LEVEL	QA/QC METHODS
Site Characterization Health and Safety Risk Assessment	Surface scrape samples are needed to identify areas exhibiting radiological contamination.	Level IV, EPA CLP protocol and GRRASP protocol.	Duplicates for every 10 samples. Method blanks for each suite of samples sent for analysis. Laboratory QA/QC will be in accordance with the GRRASP.
Site Characterization Health and Safety	Radiological surveys are needed to identify areas with elevated activity levels.	Level I, field portable detectors.	Performance testing as specified by EG&G radiation instrumentation.

**TABLE 5.3
POTENTIAL CONTAMINANTS
PRESENT IN OU13**

IHSS NUMBER	POTENTIAL CONTAMINANTS PRESENT
117.1	plutonium 239/240, strontium 89/90, radium 226, uranium 233/234, uranium 238, arsenic, benzene, carbon disulfide, ethylbenzene, toluene, xylene, and acetone
117.2	plutonium 239/240, strontium 89/90, radium 226, uranium 233/234, uranium 238, tritium, arsenic, lead, mercury, 1,1,1 - trichloroethane, methylene chloride, 2 butanone, xylenes, and acetone. arsenic, lead, mercury
117.3	plutonium 239/240, strontium 89/90, radium 226, uranium 233/234, uranium 238, lead, 1,2 - dichloroethene, chlorobenzene, tetrachloroethene, trichloroethene, and vinyl chloride
128	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, strontium 89/90, tritium, arsenic, lead, carbon disulfide, methylene chloride, tetrachloroethene, acetone and toluene
134	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, strontium 89/90, tritium, arsenic, lead, lithium, carbon disulfide, methylene chloride, tetrachloroethene, acetone, toluene and total petroleum hydrocarbons
148	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, strontium 89/90, tritium and nitrate
152	total petroleum hydrocarbons
157.1	uranium 233/234, uranium 235, uranium 238 and beryllium

Compiled from historical accounts of spills and from groundwater data from wells and piezometers located in the vicinity of OU13.

**TABLE 5.3
POTENTIAL CONTAMINANTS
PRESENT IN OU13**

158	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, strontium 89/90, arsenic, cadmium, benzene, carbon disulfide, toluene, xylene, acetone, methylene chloride, ethylbenzene, 1,1,1 - trichloroethane, 1,1,2,2 tetrachloroethane, 1,2, dichloroethene, 1 - dichloroethene
171	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, arsenic, carbon disulfide, methylene chloride, and acetone
186	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, strontium 89/90, arsenic, nickel, benzene, carbon disulfide, ethylbenzene, toluene, and xylene
190	sodium hydroxide
191	hydrogen peroxide

Compiled from historical accounts of spills and from groundwater data from wells and piezometers located in the vicinity of OU13.

Table 5.4
ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS
FOR SAMPLING ACTIVITIES AT OU13

TARGET COMPOUND LIST VOLATILES		
	WATER LIMITS <u>(ug/L)</u>	SOIL LIMITS <u>ug/Kg</u>
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
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	1	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-1,2-Dichloropropene	5	5
Bromoform	5	5
4-Methyl-2-pentanone	10	10
2-Hexanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
1,1,2,2-Tetrachloroethane	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Xylenes (total)	5	5

EPA Contract Laboratory Methods For TCL Volatiles Will Be Used Unless Noted Otherwise.

Table 5.4 (continued)
ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS
FOR SAMPLING ACTIVITIES AT OU13

TARGET COMPOUND LIST SEMIVOLATILES		
	WATER LIMITS <u>(ug/L)</u>	SOIL LIMITS <u>ug/Kg</u>
Phenol	10	330
bis(2-Chloroethyl) ether	10	330
2-Chlorophenol	10	330
1-3-Dichlorobenzene	10	330
1-4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1-2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl) ether	10	330
4-Methylphenol	10	330
N-Nitroso-Dipropylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis (2-Chloroethoxy) methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphtalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330

EPA Contract Laboratory Methods For TCL Semivolatiles Will Be Used Unless Noted Otherwise.

Table 5.4 (continued)
 ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS
 FOR SAMPLING ACTIVITIES AT OU13

TARGET COMPOUND LIST SEMIVOLATILES (CONTINUED)		
	WATER LIMITS <u>(ug/L)</u>	SOIL LIMITS <u>ug/Kg</u>
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenol Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine (1)	10	330
4-Bromophenyl-Phenyl ether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Flouranthene	10	330
Pyrene	10	330
Butyl Benzlyphthalate	10	330
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis-(2-ethylhexyl)phthalate	10	330
Di-n-octyl Phthalate	10	330
Benzo(b)flouranthene	10	330
Benzo(k)flouranthene	10	330
Benzo(a)pyrene	10	330
Indeno (1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

EPA Contract Laboratory Methods For TCL Semivolatiles Will Be Used Unless Noted Otherwise.

Table 5.4 (continued)
**ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS
 FOR SAMPLING ACTIVITIES AT OU13**

TARGET ANALYTE LIST METALS		
	<u>WATER LIMITS</u> (ug/L)	<u>SOIL LIMITS</u> ug/Kg
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1
Cadmium	5	1
Calcium	5000	2000
Chromium	10	2
Cobalt	50	10
Copper	25	5
Cyanide	5	10
Iron	100	20
Lead	3	1
Magnesium	5000	2000
Manganese	15	3
Mercury	.2	.2
Nickel	40	8
Potassium	5000	2000
Selenium	5	1
Silver	10	2
Sodium	10	2
Thallium	10	2
Vanadium	50	10
Zinc	20	4

EPA Contract Laboratory Methods For TAL Metals Will Be Used Unless Noted Otherwise.

Table 5.4 (continued)
 ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS
 FOR SAMPLING ACTIVITIES AT OU13

OTHER CHEMICAL COMPOUNDS		
RADIONUCLIDES	<u>WATER LIMITS</u> pCi/L	<u>SOIL LIMITS</u> pCi/g
Gross Alpha	2	4
Gross Beta	4	10
Uranium 233/234	.6	.3
Uranium 235,238	.6	.3
Americium 241	.01	.02
Plutonium 239/240	.01	.03
Tritium	400	400
ANIONS		
Nitrate	1 mg/L EPA 353.2	5 mg/Kg EPA 353.2
Sulfate	5 mg/L EPA 375.4	10 mg/Kg EPA 375.3
Chloride	5 mg/L EPA 325.2	5 mg/Kg EPA 325.2
Fluoride	5 mg/L EPA 340.2	5 mg/Kg EPA 340.2
pH*	*	*
Specific Conductance*	*	*
Temperature*	*	*

Laboratory Methods for Radionuclides Are Identified In Part B Of The GRRASP And In The Quality Assurance Addendum For This Work Plan.

* Field Methods OPS-GW.05 (EG&G, 1991c).

**ENVIRONMENTAL MANAGEMENT
PROGRAM
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area**

**Manual 21100-WP-OUI3.1
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Organization: Environmental Management**

**TITLE:
Phase I RFI/RI Work Plan for
Operable Unit 13**

Approved By:

6.0 FIELD SAMPLING AND ANALYSIS PLAN

The purpose of this section of the work plan is to develop a Field Sampling and Analysis Plan (FSAP) that will address the data needs of the Phase I RFI/RI and describe the work required to fulfill the data quality objectives.

The objective of this FSAP is to provide environmental measurement data of sufficient detail and quality to meet the intended use of the data. The data generated through implementation of this FSAP will be used to:

- Establish the presence or absence of contaminants;
- Characterize the environmental setting of each IHSS;
- Characterize the nature and extent of contamination;
- Assess fate and transport of contaminants;
- Assess risk to human health and environment; and
- Identify applicable remedial alternatives

6.1 BACKGROUND AND SAMPLING RATIONALE

6.1.1 Background

Available information regarding potential contamination associated with OU13 includes limited IHSS site histories, stratigraphic well logs, water level data, and analytical data for groundwater, surface water, and borehole samples collected within and surrounding OU13. This information is described in detail in Section 2.0 of this work plan.

As stated in Section 2.0, the available data are not of a sufficient quantity or quality to allow a determination of the nature and extent of contamination attributable to each IHSS. The data indicate the potential for contamination to be present at several IHSSs. The existing data are currently being validated to the extent possible. The use of these data in making RFI/RI decisions will be continually evaluated as the validation process continues.

6.1.2 Sampling Rationale

The rationale for Phase I sampling activities is based on a staged approach. Stage 1 will address the presence of contamination and will involve primarily screening-level surveys. Stage 2 will confirm the results of Stage 1 and verify the presence of contamination in the vadose zone and groundwater. Stage 3, if necessary, will address the potential migration of contaminants from each IHSS. Figures 6-1A through 6-1C present sampling decision trees for each IHSS identifying investigation stages, types of sampling, and sampling decisions.

Because the existing data do not provide evidence of contamination at the OU13 IHSSs, Stage 1 sampling activities are designed to detect contamination at each IHSS primarily using screening-level surveys. These surveys will provide a preliminary assessment of the nature of contamination present. These surveys will provide information on a real-time basis that is needed

for planning more detailed investigations of each IHSS. The types of activities to be conducted during Stage 1 include:

- Surface radiation surveys;
- Soil-gas surveys; and
- Groundwater sampling from existing wells and piezometers.

The rationale for sampling groundwater from the existing wells and piezometers in the vicinity of OU13 is based on the fact that the current quality of the groundwater beneath the OU is not known. Groundwater quality data is available for only one well located within OU13. Sampling of the existing wells and piezometers provides a cost-effective means for better assessing groundwater conditions within the OU. The data obtained from this activity will also enable a more complete evaluation of the analytical data that currently exists for the wells and piezometers in and around OU13.

Stage 2 sampling will be used to confirm the results of the Stage 1 surveys and to more intensively study those sites where contamination was found to be present in Stage 1. At those sites where no contamination was indicated by Stage 1 activities, Stage 2 sampling will be performed to confirm the absence of contamination. Activities to be conducted under Stage 2 include:

- Surface scrape sampling at borehole locations;
- Borehole sampling; and
- Sampling of groundwater using the Hydropunch®, or equivalent, technology at borehole locations.

Upon completion of Stage 2, all data collected during Stages 1 and 2 will be fully evaluated to determine if further investigation of each IHSS is required. The results of Stages 1 and 2 and recommendations for further investigation will be summarized in a brief technical memorandum.

Stage 3 will attempt to assess the migration of contamination from IHSSs determined to be sources of contamination in Stages 1 and 2. It is currently anticipated that two alluvial groundwater monitoring wells, one located upgradient and one located downgradient of these IHSSs, will be required to assess contaminant migration. To the extent possible, existing wells and piezometers will be used. Based on the proximity of several IHSSs to one another, it is also anticipated that some wells may be used to assess contamination attributable to more than one IHSS.

More extensive methods of sampling may be required on a case by case basis. It may be possible to employ the Hydropunch®, or equivalent, technology to outline the extent of the contaminant plumes in the subsurface. It may also be necessary to evaluate possible hydraulic connection between the Rocky Flats Alluvium and the Arapahoe Formation if the borings installed during Stage 2 indicate that the No. 1 sandstone subcrop beneath the alluvium near a particular IHSS(s). If the results of Stages 1 and 2 indicate the need for sampling other environmental media, such as surface water and sediments, these investigations will be implemented during Stage 3. The need for such investigations will be established in the technical memorandum submitted at the completion of Stage 2.

6.1.3 Analytical Rationale

The potential contaminants present for each IHSS in OU13 are listed in Table 5.3. These contaminants were identified through a review of the information provided in Section 2.0 and together with the analytes specified by the IAG provide the basis for the analytical parameters for this investigation. However, the operational histories and release histories are not clearly defined for many of the IHSSs, and the available analytical data indicate the presence of contaminants in or near some IHSSs not known to have been released in these IHSSs. Therefore, it is necessary to utilize a more comprehensive list of analytes. The specific analytes that will be used for each stage of the Phase I RFI/RI are presented in Table 6.1 (also see Table 5.4).

Analytical results from the sampling may dictate future analytical parameters. Utilization of the parameters listed in Table 6.1 may be modified as appropriate based on additional data compilation to provide maximum potential for identifying all possible contaminants present in OU13. Analytes for later stages will be selected based on concentration levels exceeding values identified by the Background Geochemical Characterization Report and updates to that report. Decisions regarding analytical parameter selection will be documented by submitting technical memoranda.

6.1.4 Relevant Studies of Other OUs

Current and planned investigations at other OUs may provide data relevant to the Phase I investigation of OU13. Although areas of overlap with other OUs do not imply a reduction in scope of the Phase I investigation of OU13, such overlaps will be examined to prevent duplication of effort. Provided that the specified objectives of the OU13 Phase I RFI/RI are achieved, data from studies of other OUs shall be utilized to supplement or replace activities in OU13. These determinations will be made on a case-by-case basis. Decisions regarding use of data from studies of other OUs will be documented by submitting technical memoranda.

6.2 SAMPLING PROGRAM

The Phase I RFI/RI investigation activities at OU13 are discussed below. The sampling programs for each IHSS are shown in Figures 6-1A to 6-1C and are described in detail in the following subsections. The sampling activities for each IHSS are summarized in Table 6.1. This table also specifies the sampling methods and SOPs to be used, sample frequencies, and sample analytes. Appendix F contains utility drawings that are referred to in the IHSS-specific discussions below.

As described in Section 2.2, it is likely that there would be no detectable impacts to environmental media as a result of the releases known to have occurred in IHSSs 190 and 191. Therefore, no further investigation of IHSSs 190 and 191 is necessary.

6.2.1 Stage 1 Investigation

Stage 1 sampling efforts include surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers. Figures 6-2 and 6-3 show those IHSSs where surface radiation and soil gas surveys are to be performed and the initial grid spacings to be used for these surveys. Figure 6-4 illustrates the locations of the existing wells and piezometers to be sampled during Stage 1 and provides an indication of which IHSSs the groundwater data collected will be applicable to. Subsections 6.2.1.1 to 6.2.1.11 define the details of the Stage 1 sampling program for each IHSS.

The initial grid spacings specified for each IHSS will allow the performance of both the radiation surveys and the soil gas surveys on the same grid. The grid spacing specified for radiation surveys is typically one-half that specified for soil gas surveys. The specified grid spacings take into account the expected resolution of the survey techniques, the size of each IHSS, and potential access problems. The grid for each IHSS will be adjusted as necessary due to access restrictions and then topographically surveyed. The surface radiation and soil gas surveys will be performed up to the foundations of buildings where IHSSs may extend beneath the building. In areas where surfacing such as asphalt is present, a 4 to 8 inch diameter access hole will be cut through the surfacing to enable the performance of these surveys. After the data generated by these surveys have been evaluated and borehole locations selected for the Stage 2 investigation (see Section 6.2.2), the access holes at those locations where boreholes will not be drilled will be patched with the proper material. The following subsections provide a preliminary definition of the area to be surveyed for each IHSS. These areas are likely to change based on access problems posed by utilities.

Surface radiation surveys will be conducted using a High Purity Germanium (HPGe) detector. As indicated in Table 6.1, an SOP for conducting such surveys with the HPGe is under development by EG&G. In general, these surveys will be conducted on the grid specified below and in Table 6.1 for each IHSS. If elevated activity levels are measured at any location, the grid

spacing will be tightened to 2 feet, as logistically possible, to attempt to isolate the contamination detected. As defined by SOP FO.16 Field Radiological Measurements, elevated activity will be reflected by readings exceeding 250 counts per minute (cpm).

The specific analytes for soil gas surveys of each IHSS are defined in the following subsections and summarized in Table 6.1. All soil gas analyses will be performed using a field gas chromatograph. The existing groundwater monitoring wells and piezometers identified in Figure 6-4 will be sampled once for the analytes specified in Table 6.1.

6.2.1.1 North Chemical Storage Site (IHSS 117.1)

Stage 1 sampling efforts for IHSS 117.1 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1A and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 20 feet and 40 feet, respectively (Figures 6-2 and 6-3). Due to access and security restrictions, the surface radiation and soil gas surveys will not be performed within that section of the IHSS which is believed to extend into the Protected Area. The portion of this IHSS that is paved will require access holes to be cut through the pavement prior to initiating these surveys. In addition, the presence of stored scrap metal, trailers, a transformer, a valve vault, and several small buildings may require that the grids for these surveys be adjusted (see drawing C4 in Appendix F and Photographs 6 and 9 in Section 2.0).

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

1,1,1-trichloroethane	perchloroethene	benzene	carbon tetrachloride
dichloromethane	carbon disulfide	acetone	toluene
total xylenes	trichloroethene	ethylbenzene	

This list of compounds is based upon the requirements stated in the IAG and on historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing piezometers P214689 and P115589 will provide data which may be useful in assessing potential contamination associated with IHSS 117.1 (Figure 6-4). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.1.

6.2.1.2 Middle Chemical Storage Site (IHSS 117.2)

Stage 1 sampling efforts for IHSS 117.2 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1A and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 20 feet and 40 feet, respectively (Figures 6-2 and 6-3). The entire area of IHSS 117.2 is paved, requiring access holes be cut through the pavement prior to performing these surveys. In addition, the presence of a numerous items that are stored in this IHSS and of a large storage tent will require that the survey grids be adjusted to account for these items (see Photographs 6 and 9 in Section 2.0).

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

1,1,1-trichloroethane	perchloroethene	benzene	carbon tetrachloride
dichloromethane	ethylbenzene	toluene	2-butanone
total xylenes	trichloroethene	acetone	

This list of compounds is based upon the requirements stated in the IAG and on historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing piezometers P214689, P115589, P115689, and P215789 will provide data which may be useful in assessing potential contamination associated with IHSS 117.2 (Figure 6-4). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.1.

6.2.1.3 South Chemical Storage Site (IHSS 117.3)

Stage 1 sampling efforts for IHSS 117.3 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figures 6-1A and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 20 feet and 40 feet, respectively (Figures 6-2 and 6-3). These surveys will be conducted over the entire area of the IHSS to the extent possible. The presence of Tank 224 and equipment associated with that tank will prevent the performance of these surveys over a portion of the IHSS within the berm for that tank (see drawing E4 in Appendix F and Photograph 11 in Section 2.0). Due to the fact that the area within this berm was disturbed considerably during the construction of the tank it is not likely that contamination attributable to this IHSS would be detectable within the bermed area.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

1,1,1-trichloroethane	perchloroethene	benzene	carbon tetrachloride
dichloromethane	trichloroethene		

This list of compounds is based upon the requirements stated in the IAG and on historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing well P418289 and piezometer P414189 will provide data which may be useful in assessing potential contamination associated with IHSS

117.3 (Figure 6-4). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.1.

6.2.1.4 Oil Burn Pit No. 1 (IHSS 128)

Stage 1 sampling efforts for IHSS 128 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1B and Table 6.1). These activities will also provide data required for the evaluation of the portion of IHSS 134 that occurs in this location (see Section 6.2.1.5). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 10 feet and 20 feet, respectively (Figures 6-2 and 6-3). It is believed that these sites are located beneath the current location of Sage Avenue (see Photographs 1 and 4 in Section 2.0). At this time it is anticipated that these surveys can be conducted between Sage Avenue and the drainage ditch to the south and the parking lot to the north. One sampling location will also be established on Sage Avenue near the center of these IHSSs. This sampling location will require that an access hole be cut through the pavement on Sage Avenue. It is estimated that approximately 10 feet of artificial fill was placed over these IHSSs during the construction of Sage Avenue. Therefore, a boring drilled to a depth of approximately 15 feet will be required for the placement of a soil gas probe beneath Sage Avenue.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

benzene toluene xylene carbon disulfide
acetone

This list of compounds is based upon the requirements stated in the IAG and on historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing piezometers P114989, P114889, and P114789 will provide data which may be useful in assessing potential contamination associated with IHSS 128 and the northern portion of IHSS 134 (Figure 6-4). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.1.

6.2.1.5 Lithium Metal Destruction Site (IHSS 134)

As discussed in Subsection 6.2.1.4, the northern portion of IHSS 134 will be investigated with IHSS 128. Stage 1 sampling efforts for the southern portion of IHSS 134 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1A and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 20 feet and 40 feet, respectively (Figures 6-2 and 6-3). These surveys will be conducted, as possible, from the eastern addition of Building 331 north to IHSS 171 near Building 335 and from Building 331 east to the 334 parking area (see drawing D3 in Appendix F and Photograph 9 in Section 2.0). It is likely that the surveys of this IHSS will be performed in conjunction with the surveys of IHSS 171 (see Section 6.2.1.10). Those portions of this area that are paved will require that access holes be cut through the pavement prior to initiating these surveys.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

benzene	toluene	xylene	carbon disulfide
acetone			

This list of compounds is based upon the requirements stated in the IAG and on historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing piezometer P115489 will provide data which may be useful in assessing potential contamination associated with the southern portion of IHSS 134

(Figure 6-4). Groundwater samples from this piezometer will be analyzed for the constituents indicated in Table 6.1.

6.2.1.6 Waste Spills (IHSS 148)

Stage 1 sampling efforts for IHSS 148 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1B and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 10 feet and 20 feet, respectively (Figures 6-2 and 6-3). It is believed that the releases that may have occurred within this IHSS were beneath Building 123. The surface radiation and soil gas surveys will be performed around the perimeter of this building to the extent possible. The surveys will be performed between Building 123 and Fourth Street to the east, Central Avenue to the north, and Third Street to the west. The southern side of Building 123 will be surveyed within an area extending from the building to approximately 20 feet south of the eastern wing of the building. This area includes the alcove between the wings of the building (see drawing E2 in Appendix F and Photograph 10 in Section 2.0). Much of this area is paved and will require that access holes be cut through the pavement prior to initiating these surveys.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

1,1,1-trichloroethane	perchloroethene	trichloroethene	chloroform
1,1-dichloroethane	acetone		

This list of compounds is based upon historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing well 4486 and piezometers P415989, P416189, P115589, and P115689 will provide data which may be useful in assessing potential

contamination associated with IHSS 148 (Figure 6-4). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.1.

6.2.1.7 Fuel Oil Tank (IHSS 152)

Stage 1 sampling efforts for IHSS 152 will consist of a soil gas survey and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1C and Table 6.1). The Stage 1 soil gas survey for this IHSS will be performed on a grid spacing of 20 feet (Figure 6-3). This grid spacing will be adjusted as field conditions indicate. This survey will be conducted over the entire area of the IHSS to the extent possible. The presence of Tank 221 and equipment associated with the tank may prevent the performance of this survey over a portion of the IHSS within the berm for that tank (see drawing E3 in Appendix F and Photograph 11 in Section 2.0). The survey will be performed over an area bounded by Central Avenue on the north, Sixth Street on the west, the berm between Tank 221 and Tank 224 on the east, and the berm for Tank 221 on the south. IHSS 117.3 is located immediately to the east of this IHSS and it is likely that the soil gas surveys for both IHSSs will be performed at the same time.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

benzene	toluene	total xylenes
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This list of compounds is based upon the requirements stated in the IAG. No historical data was obtained during the preparation of this work plan to indicate that a more extensive suite of parameters is required at this IHSS.

Analyses of groundwater samples from existing well P418289 and piezometer P414189 will provide data which may be useful in assessing potential contamination associated with IHSS 152 (Figure 6-4). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.1.

6.2.1.8 North Area Radioactive Site (IHSS 157.1)

Stage 1 sampling efforts for IHSS 157.1 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1B and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 10 feet and 20 feet, respectively (Figures 6-2 and 6-3). The surface radiation and soil gas surveys will be performed around the perimeter of Building 442 to the extent possible. These surveys will be conducted in an area between the building and Central Avenue on the north, the sidewalk to the east, Fifth Street to the west, and extending approximately 40 feet to the south of the building in the area of 42 Drive (see Figure E3 in Appendix F and Photographs 8 and 10 in Section 2.0). Much of this area is paved and will require that access holes be cut through the pavement prior to initiating these surveys.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

1,1,1-trichloroethane	perchloroethene	trichloroethene	chloroform
1,1-dichloroethane	acetone		

This list of compounds is based upon historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing well 4486 and piezometers P115589 and P115689 will provide data which may be useful in assessing potential contamination associated with IHSS 157.1 (Figure 6-4). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.1.

6.2.1.9 Building 551 Radioactive Site (IHSS 158)

Stage 1 sampling efforts for IHSS 158 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1B and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 10 feet and 20 feet, respectively (Figures 6-2 and 6-3). Much of this IHSS is located beneath the northern addition of Building 551. These surveys will be conducted around the perimeter of the building to the extent possible. The area to be surveyed will consist approximately of the area outside of the foundation of Building 551 from the junction between the original building and the northern addition north to Sage Avenue and from Sixth Avenue on the west side of the building to approximately 60 feet east of the building (see Photograph 6 in Section 2.0). Much of the area north and east of the building is paved and will require holes cut through the pavement prior to initiating these surveys. In addition, the presence of several trailers and loading docks on the western side of the building will necessitate that the survey grids be adjusted to maximize the coverage of the surveys in those areas.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

1,1,1-trichloroethane	perchloroethene	acetone	trichloroethene
1,1-dichloroethene	1,2-dichloroethene	toluene	benzene
carbon tetrachloride	1,1,2-tetrachloroethane		

This list of compounds is based upon the requirements stated in the IAG and on historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing piezometers P115589, P115689, P214689, and P215789 will provide data which may be useful in assessing potential contamination associated

with IHSS 158 (Figure 6-4). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.1.

6.2.1.10 Solvent Burning Ground (IHSS 171)

Stage 1 sampling efforts for IHSS 171 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1B and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 10 feet and 20 feet, respectively (Figures 6-2 and 6-3). The area to be surveyed will extend from Building 335 east to the driveway to Building 331 and from Sage Avenue south approximately 100 feet to the base of a small slope (see Photographs 1 and 2). The surface of this area has not been paved and should not pose significant problems to the performance of the surveys with the exception of minor adjustments in grid spacing that may be required near the sump and drainage ditch east and north of Building 335.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

1,2-dichloroethane	perchloroethene	trichloroethene	chloroform
carbon tetrachloride	carbon disulfide	methylene chloride	acetone

This list of compounds is based upon the requirements stated in the IAG and on historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing piezometers P114989, P114889, and P114789 will provide data which may be useful in assessing potential contamination associated with IHSS 171 (Figure 6-4). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.1.

6.2.1.11 Valve Vault (IHSS 186)

Stage 1 sampling efforts for IHSS 186 will consist of surface radiation and soil gas surveys and sampling of existing groundwater monitoring wells and piezometers (Figure 6-1B and Table 6.1). The Stage 1 surface radiation and soil gas surveys for this IHSS will be performed on initial grid spacings of 10 feet and 20 feet, respectively (Figures 6-2 and 6-3). The area to be surveyed will extend from the drainage west of valve vault 12 to the retaining wall around Tanks 231A and 231B and from where the drainage enters the Protected Area north of the valve vault to approximately 20 feet south of the valve vault (see Photograph 5 in Section 2.0). The area to be surveyed is unpaved and should not pose significant problems to the performance of these surveys with the exception of adjustments in grid spacing to account for the valve vault, Building 231, and utilities in the area.

The soil gas survey will analyze for the following compounds and will note any other compounds detected but which were not calibrated for:

benzene	carbon disulfide	ethylbenzene	toluene
total xylenes	acetone		

This list of compounds is based upon historical data obtained during the preparation of this work plan.

Analyses of groundwater samples from existing piezometers P114789 and P214689 will provide data which may be useful in assessing potential contamination associated with IHSS 186 (Figure 6-4). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.1.

6.2.2 Stage 2 Investigation

Upon completion of Stage 1, the Stage 2 investigation will be initiated to confirm the results of Stage 1 and to further define any contamination detected during Stage 1. Stage 2 will consist of the drilling of boreholes at locations indicated by Stage 1 sampling. As indicated in Figures 6-1A to 6-1C, Stage 2 will involve the drilling of one to three boreholes within most IHSSs. For those IHSSs where no contamination was detected by Stage 1 activities, one borehole will be drilled to confirm the nonpresence of contamination. This borehole will be located at one of the surface radiation and soil gas survey sampling points. For those IHSSs where contamination is detected by the Stage 1 surveys, an additional borehole will be drilled at the location of the highest level of contamination detected by each survey. The number of boreholes drilled will depend on whether the location of the highest level of contamination detected by the radiation survey and that detected by the soil gas survey coincide. Therefore, a maximum of three boreholes may be drilled at each IHSS.

All boreholes will be drilled to a depth of three feet into weathered bedrock. If the weathered bedrock encountered in any borehole is sandstone, the borehole will be drilled through the sandstone to at least three feet into the next bedrock horizon. Figure 6-5 graphically illustrates the samples that will be taken from each borehole as described in the following paragraphs.

Surface scrape samples will be taken at the location of each borehole prior to initiating drilling. These samples will be analyzed for TCL semivolatiles, radionuclides, and TAL metals (Table 6.1). At locations that are paved, instead of collecting a surface scrape, a sample of native material will be taken approximately 4 inches below any base material that underlies the asphalt. This sample will be analyzed for the same constituents as surface scrapes. A sample of asphalt will also be taken from the edge of the access hole and analyzed for TCL semivolatiles and TAL metals.

In each borehole, discrete samples will be taken at 4-foot intervals during drilling for analysis of TCL volatiles and semi-volatiles. Samples for TCL volatile and semi-volatile analyses will also be taken at the water table and at the alluvium-bedrock contact. Composite samples will be collected in each borehole from every 6-foot interval for analysis of TAL metals and radionuclides. All geologic materials will be continuously logged during drilling and 5 samples of alluvium and 5 samples of bedrock will be taken from boreholes throughout OU13 for physical analyses (Section 6.3.2 and Table 6.1). All sampling activities will be conducted in accordance with EG&G SOPs (Table 6.1).

Where boreholes are being drilled at the location of the highest level of contamination detected in the Stage 1 surveys, groundwater samples will be collected from the borehole using the Hydropunch®, or equivalent, technology. An SOP for the Hydropunch®, or equivalent, technology will be developed as part of the Field Implementation Plan. The Hydropunch® will be lowered inside the hollow stem auger and then pushed or driven to a depth of at least 5 feet below the water table, if possible. Water samples collected will be analyzed for TCL volatiles and semi-volatiles, TAL metals, radionuclides, and anions (Table 6.1). Field measurements of pH, temperature, and specific conductance will also be performed.

Upon completion of borehole sampling activities, all boreholes will be plugged and abandoned in accordance with EG&G SOPs (Table 6.1). All access holes cut into pavement will be patched with the proper material.

Due to access problems at certain IHSSs, it may not be possible to install boreholes in the locations indicated by the Stage 1 activities. Under these circumstances alternate locations for the boreholes will be evaluated based upon the results of Stage 1. For example, based upon the present location of fuel oil Tanks 221 and 224 within bermed areas in IHSSs 152 and 117.3, respectively, it is unlikely that boreholes can be drilled inside of the berms for these tanks. If contamination is detected during Stage 1 activities at these IHSSs, boreholes will be drilled

outside of the bermed areas in those locations where the greatest potential exists for detecting such contamination.

Upon the completion of Stage 2, the results of Stages 1 and 2 will be fully evaluated to determine if further investigation of each IHSS is necessary. If the data collected do not indicate that contamination exists at a particular IHSS, no further investigation of that IHSS will be necessary. If the borehole and groundwater data collected indicate that contamination exists at an IHSS, then the Stage 3 investigation of that IHSS will be initiated. The results of Stages 1 and 2 and recommendations for further investigation will be documented in a brief technical memorandum. This technical memorandum will summarize the results collected and will outline the scope of the Stage 3 investigation, if necessary, for each IHSS, particularly if Stage 3 will require activities that are not described in this work plan.

6.2.3 Stage 3 Investigation

The focus of the Stage 3 investigation will be to attempt to determine migration of contamination detected during Stages 1 and 2. The scope of the Stage 3 investigation is largely dependent upon the results of the Stage 1 and Stage 2 investigations. The number, location, and types of sampling points required cannot be precisely defined until Stages 1 and 2 have been completed and the data collected fully evaluated. The exact sampling locations will be determined on a case-by-case basis, taking into account the following factors:

- Environmental fate and transport of the specific contaminants;
- Contaminant concentrations;
- Expected depth to water table and bedrock;
- Nature of alluvium;
- Presence of any subcropping sandstone units in the bedrock; and
- Other pertinent data.

For scoping purposes, it is assumed that two alluvial groundwater monitoring wells will be required to be installed at each IHSS determined to be a source of contamination in Stages 1 and 2. One well upgradient and one well downgradient of these IHSSs will be installed. Whenever possible, existing wells and piezometers will be used for the Stage 3 investigation. Figure 6-6 provides preliminary locations of new wells to be installed and identifies those existing wells or piezometers that may be used during Stage 3. These locations will likely change based on the results of the Stage 1 and Stage 2 investigations and due to access problems. Based on the preliminary well locations identified in Figure 6-6, it is estimated that a maximum of 17 new wells will be installed during Stage 3. It is also estimated that a maximum of 10 existing wells and piezometers will be sampled during Stage 3.

During the drilling of new wells, borehole samples will be collected for analysis. The intervals sampled and the analytes for each sample will be the same as those defined above for Stage 2 (Table 6.1). If the Stage 1 and Stage 2 investigations indicate that a less extensive list of analytes will be required at any location, the analytes for samples obtained at that location will be specified in the technical memorandum submitted at the completion of Stage 2.

Groundwater samples will be collected from each well and analyzed for the list of constituents identified in Table 6.1. As with borehole samples, if a less extensive suite of analytes is required the analytes for groundwater samples will be specified in the technical memorandum submitted at the completion of Stage 2. Samples will be collected from each new well immediately upon

completion. Samples from existing wells and piezometers will be collected once at the time the Stage 3 investigation is initiated. Subsequent groundwater sampling will be performed as part of the site-wide monitoring program and will be arranged for by EG&G.

6.3 SAMPLE ANALYSIS

6.3.1 Soil Gas Analysis

Soil gas samples will be analyzed for the parameters specified for each IHSS in Subsections 6.2.1.1 to 6.2.1.11. The analytical methods and SOPs applicable to the analysis of soil gas samples are specified in Table 6.1. Detection limits for these analyses are specified in Table 5.4.

6.3.2 Borehole Samples

6.3.2.1 Chemical Analysis

Borehole samples will be collected for chemical analysis from surficial materials and weathered bedrock, as discussed in Subsections 6.2.2 and 6.2.3. Subsection 6.2.2 and Table 6.1 designate borehole samples for analysis and provide the chemical parameters that the samples will be analyzed for. The detection limits for these analyses are specified in Table 5.4.

6.3.2.2 Physical Analysis

Physical analysis of five samples of alluvium and five samples of bedrock from random boreholes throughout OU13 will be performed. Physical analysis on alluvium and bedrock samples will consist of classification (ASTM [American Society for Testing and Materials] D2488), moisture content (ASTM D2216), and dry density for intact samples (ASTM D2216). Laboratory classification tests will consist of grain size distribution (ASTM D422) (including hydrometer analysis) and Atterberg limits (ASTM D4318). A grain size analysis will also be

performed on surface scrapes to determine the amount of material that is less than 10 micrometers in diameter.

6.3.3 Groundwater Samples

Groundwater samples will be collected from existing wells and piezometers identified in Subsections 6.2.1.1 to 6.2.1.11 and from new and existing wells and piezometers as identified in Subsection 6.2.3. Samples will be measured in the field for pH, specific conductance, and temperature in accordance with the procedure specified in Table 6.1. Table 6.1 lists the analytical parameters for groundwater samples for the Stage 1 investigation. Subsequent sampling during Stage 3 may require analyses of a less extensive suite of analytes as specified in Subsection 6.2.3. Metals analyses will be performed for both total and dissolved metals. Laboratory analyses for dissolved metals will be performed on samples filtered in the field using a 0.45 μm cellulose acetate filter prior to sample preservation.

6.3.4 Sample Containers and Preservation

The type of analysis and media to be sampled dictates the sample container volume and material requirements, preservation techniques, and holding times. Information relating to sample containers and preservatives is provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples. The parameters specific to OU13 with the corresponding containers, preservative, and holding time are listed in Table 6.2.

6.3.5 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 describing container labeling, decontamination,

field packaging, chain of custody records, field data documentation, packaging and shipping is provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples.

Field data and reporting requirements are discussed in detail in SOP FO.14 Field Data Management. In general the following procedures must be followed:

- Collection of data on pre-printed forms;
- Preliminary verification of the data;
- Technical verification by a qualified verifier;
- Data input into the Rocky Flats Environmental Data System (RFEDS);
- Verification of input;
- Archive and filing of data;
- Security of database and computers;
- Documentation of implementation of the referenced SOP; and
- Use of data management forms.

6.3.6 Sample Designation

The Rocky Flats Environmental Data System (RFEDS) requires all sample designations to be consistent. Each sample designation will contain a nine-character sample number consisting of a two-letter prefix that relates to the type of sample collected (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 quality control samples. Using this system, 99,999 unique sample numbers are available for each sample media per contractor. Boring numbers will be developed independently of the sample number for a given boring, however, the boring number and sample number are linked so that data for

particular samples can be related to the boring from which the sample was taken. These sample numbering procedures are consistent with the RFP sitewide QAPjP.

6.4 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the EMD 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 6.3.

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 placed 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 distilled water, preserved according to the preservation requirements (Subsection 6.3.4), will be prepared by the sampling team and will be used to provide any indication of any contamination introduced during field preparation. As indicated in Table 6.3, these QC samples are applicable only to samples requiring chemical preservation.

Equipment (rinsate) blanks will be collected from final decontamination rinsate 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 rinsate is collected and placed in the appropriate sample containers. Equipment blanks are applicable to all analyses for water and soil samples and for organics analysis of soil gas samples, as indicated in Table 6.3. Equipment blanks for soil gas

sampling will consist of blanks taken and analyzed to check background contamination in the sampling system and cartridges (see SOP FO.09).

Trip blanks consisting of ASTM Type II laboratory reagent water will be prepared by the laboratory technician and will accompany each shipment of samples for VOC analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of VOCs or any problems associated with sample shipment, handling, or storage. Trip blanks for soil gas analysis will consist of an unused sample cartridge transported into the field with the sampling equipment. The trip blank cartridge will be handled in the same manner as a sample, but a sample will not be collected through this cartridge.

TABLE 6.1 (Sheet 1 of 7)
SUMMARY OF PHASE I RFI/RI INVESTIGATION ACTIVITIES AT OU13

ACTIVITY	SAMPLING METHOD AND FREQUENCY	STANDARD OPERATING PROCEDURES (SOPs) ¹	ANALYTES ²
STAGE 1 INVESTIGATION - IHSS 117.1			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 20-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 40-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - 1,1,1-trichloroethane; perchloroethene; benzene; carbon tetrachloride; dichloromethane; carbon disulfide; acetone; toluene; total xylenes; trichloroethene; ethylbenzene
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometers P115589 and P214689	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance
STAGE 1 INVESTIGATION - IHSS 117.2			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 20-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 40-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - 1,1,1-trichloroethane; perchloroethene; benzene; carbon tetrachloride; 2-butanone; dichloromethane; acetone; toluene; total xylenes; trichloroethene; ethylbenzene
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometers P115589, P115689, P214689, and P215789	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance

TABLE 6.1 (Sheet 2 of 7)
SUMMARY OF PHASE I RFI/RI INVESTIGATION ACTIVITIES AT OU13

ACTIVITY	SAMPLING METHOD AND FREQUENCY	STANDARD OPERATING PROCEDURES (SOPs) ¹	ANALYTES ²
STAGE I INVESTIGATION - IHSS 117.3			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 20-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 40-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - 1,1,1-trichloroethane; perchloroethene; benzene; carbon tetrachloride; dichloromethane; trichloroethene
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from well P418289 and piezometer P414189	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance

TABLE 6.1 (Sheet 3 of 7)
SUMMARY OF PHASE I RFI/RI INVESTIGATION ACTIVITIES AT OU13

ACTIVITY	SAMPLING METHOD AND FREQUENCY	STANDARD OPERATING PROCEDURES (SOPs) ¹	ANALYTES ²
STAGE 1 INVESTIGATION - IHSS 128 AND IHSS 134 (NORTH)			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 10-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 20-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - benzene; toluene; total xylenes; carbon disulfide; acetone
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometers P114789, P114889, and P114989	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance
STAGE 1 INVESTIGATION - IHSS 134 (SOUTH)			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 20-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 40-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - benzene; toluene; total xylenes; carbon disulfide; acetone
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometer P115489	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance

TABLE 6.1 (Sheet 4 of 7)
 SUMMARY OF PHASE I RFI/RI INVESTIGATION ACTIVITIES AT OU13

ACTIVITY	SAMPLING METHOD AND FREQUENCY	STANDARD OPERATING PROCEDURES (SOPs) ¹	ANALYTES ²
STAGE I INVESTIGATION - IHSS 148			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 10-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 20-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - 1,1,1-trichloroethane; perchloroethene; acetone; trichloroethene; chloroform; 1,1-dichloroethane
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from well 4486 and piezometers P115589, P115689, P415989, and P416189	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance
STAGE I INVESTIGATION - IHSS 152			
Soil gas survey	Perform soil gas survey on 20-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - benzene; toluene; total xylenes
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from well P418289 and piezometer P414189	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance

TABLE 6.1 (Sheet 5 of 7)
SUMMARY OF PHASE I RFI/RI INVESTIGATION ACTIVITIES AT OU13

ACTIVITY	SAMPLING METHOD AND FREQUENCY	STANDARD OPERATING PROCEDURES (SOPs) ¹	ANALYTES ²
STAGE 1 INVESTIGATION - IHSS 157.1			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 10-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 20-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - 1,1,1-trichloroethane; perchloroethene; benzene; carbon tetrachloride; acetone; toluene; trichloroethene; 1,1-dichloroethene; 1,2-dichloroethene; 1,1,2 tetrachloroethane
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometers P115589, P115689, P214689, and P215789	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance
STAGE 1 INVESTIGATION - IHSS 158			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 10-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 20-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - 1,1,1-trichloroethane; perchloroethene; acetone; trichloroethene; 1,1-dichloroethene; 1,2-dichloroethene; toluene; benzene; carbon tetrachloride; 1,1,2-tetrachloroethane
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometers P115589, P115689, P214689, and P215789	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance

TABLE 6.1 (Sheet 6 of 7)
SUMMARY OF PHASE I RFI/RI INVESTIGATION ACTIVITIES AT OU13

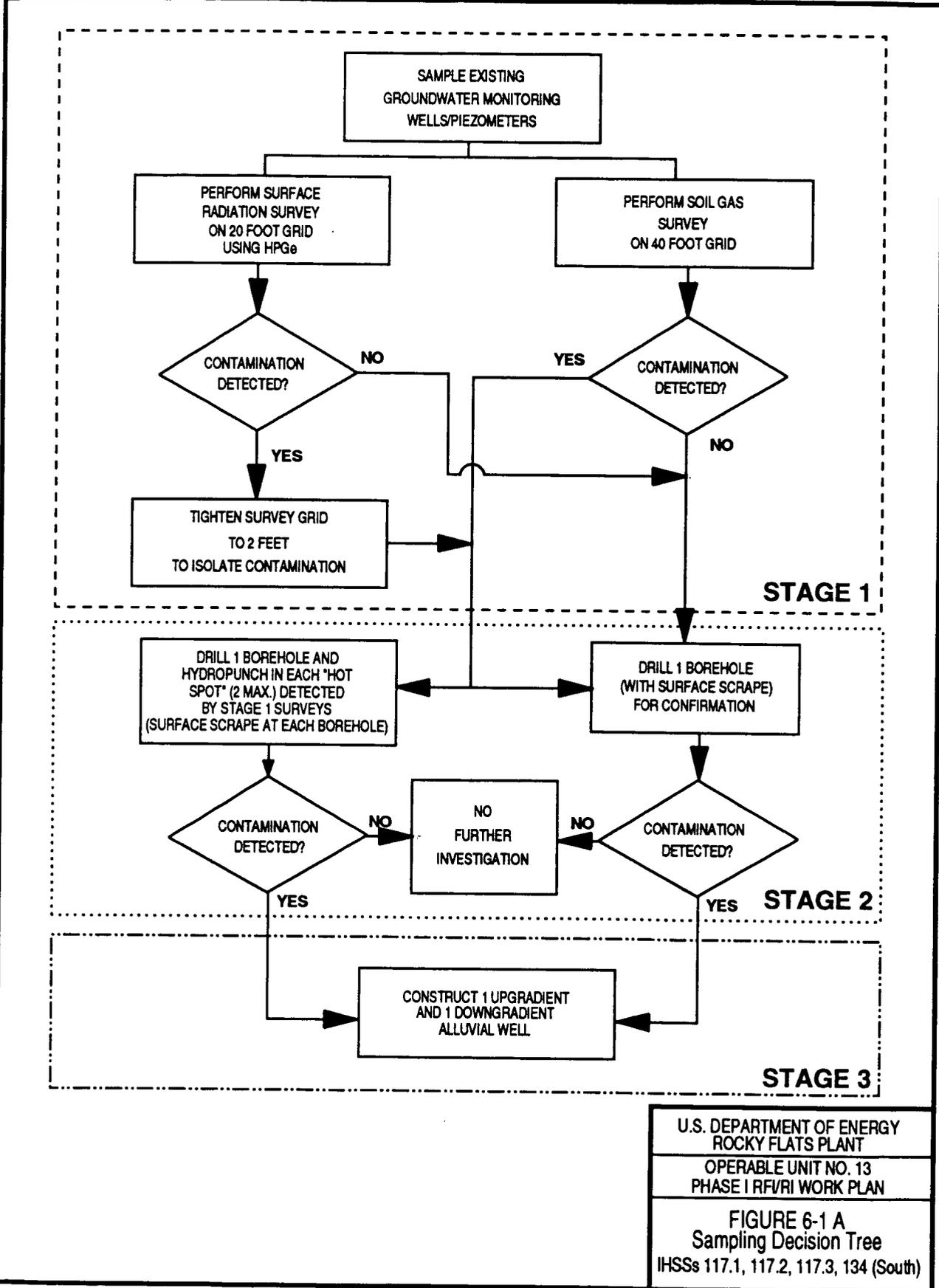
ACTIVITY	SAMPLING METHOD AND FREQUENCY	STANDARD OPERATING PROCEDURES (SOPs) ¹	ANALYTES ²
STAGE 1 INVESTIGATION - IHSS 171			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 10-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 20-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - 1,2-dichloroethane; perchloroethene; trichloroethene; chloroform; carbon tetrachloride; carbon disulfide; methylene chloride; acetone
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometers P114789, P114889, and P114989	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance
STAGE 1 INVESTIGATION - IHSS 106			
Surface radiation survey	Perform surface radiation survey using HPGe detector on 10-foot grid tightened to 2 feet if elevated activity is detected.	SOP for HPGe surveys is under development by EG&G, FO.11, FO.14, FO.16, GT.17	Qualitative radionuclides
Soil gas survey	Perform soil gas survey on 20-foot grid.	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19	Field GC calibrated for - benzene; carbon disulfide; ethylbenzene; toluene; total xylenes; acetone
Groundwater sampling from existing wells and piezometers	Collect groundwater samples once from piezometers P114789 and P214689	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance

TABLE 6.1 (Sheet 7 of 7)
SUMMARY OF PHASE I RFI/RI INVESTIGATION ACTIVITIES AT OU13

ACTIVITY	SAMPLING METHOD AND FREQUENCY	STANDARD OPERATING PROCEDURES (SOPs) ¹	ANALYTES ²
STAGE 2 INVESTIGATION - ALL IHSSs			
Borehole soil sampling	Drill 1 to 3 boreholes depending upon results of Stage 1 surveys. The following samples to be taken: 1. Surface scrapes at each borehole location using CDH method (also, asphalt samples at locations that are paved). 2. Discrete samples at 4-foot intervals and at water table and alluvium-bedrock contact. 3. 6-foot composite samples. Continuously log geologic materials.	FO.01, FO.03, FO.04, FO.08, FO.09, FO.10, FO.11, FO.12, FO.13, FO.14, FO.16, FO.18, FO.19, GT.01, GT.02, GT.03, GT.05, GT.08, GT.17	1. TCL Semivolatiles, Radionuclides, and TAL metals (TCL semivolatiles and TAL for asphalt samples) 2. TCL volatiles and semivolatiles 3. Radionuclides and TAL metals
Groundwater sampling from boreholes	Collect groundwater samples using the Hydropunch®, or equivalent, technology from boreholes drilled into "hotspots" detected by Stage 1 surveys.	SOP for Hydropunch® to be provided in Field Implementation Plan, FO.03, FO.04, FO.07, FO.09, FO.13, FO.14, FO.15, FO.18	TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance
STAGE 3 INVESTIGATION - ALL IHSSs (IF NECESSARY)			
Install and sample alluvial groundwater monitoring wells	Drill 1 upgradient and 1 downgradient alluvial monitoring well (use existing wells or piezometers when possible). Collect borehole samples at frequencies defined above for Stage 2. Collect groundwater samples once from each well.	FO.01, FO.03, FO.04, FO.05, FO.07, FO.08, FO.09, FO.10, FO.11, FO.12, FO.13, FO.14, FO.15, FO.16, FO.18, FO.19, GT.01, GT.02, GT.03, GT.05, GT.06, GT.08, GT.11, GT.17, GW.01, GW.02, GW.05, GW.06	Borehole samples - see Stage 2 above. Groundwater samples - TCL volatiles and semivolatiles; TAL metals; radionuclides; anions; pH; temperature; specific conductance

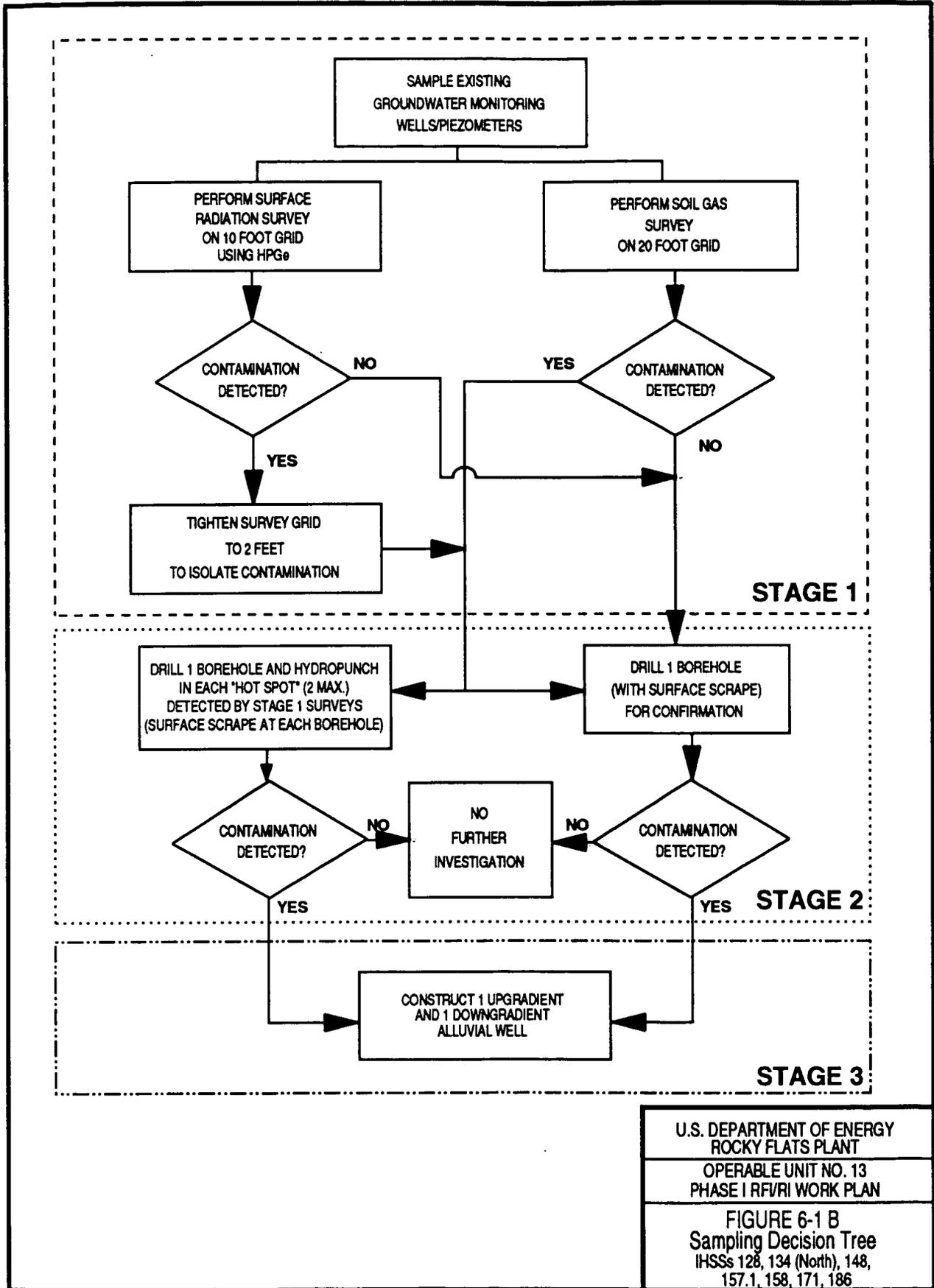
¹ A list of all SOPs referenced is included in the Attachment to this table.

² Analytical detection limits and analytical methods are specified in Table 5.4.



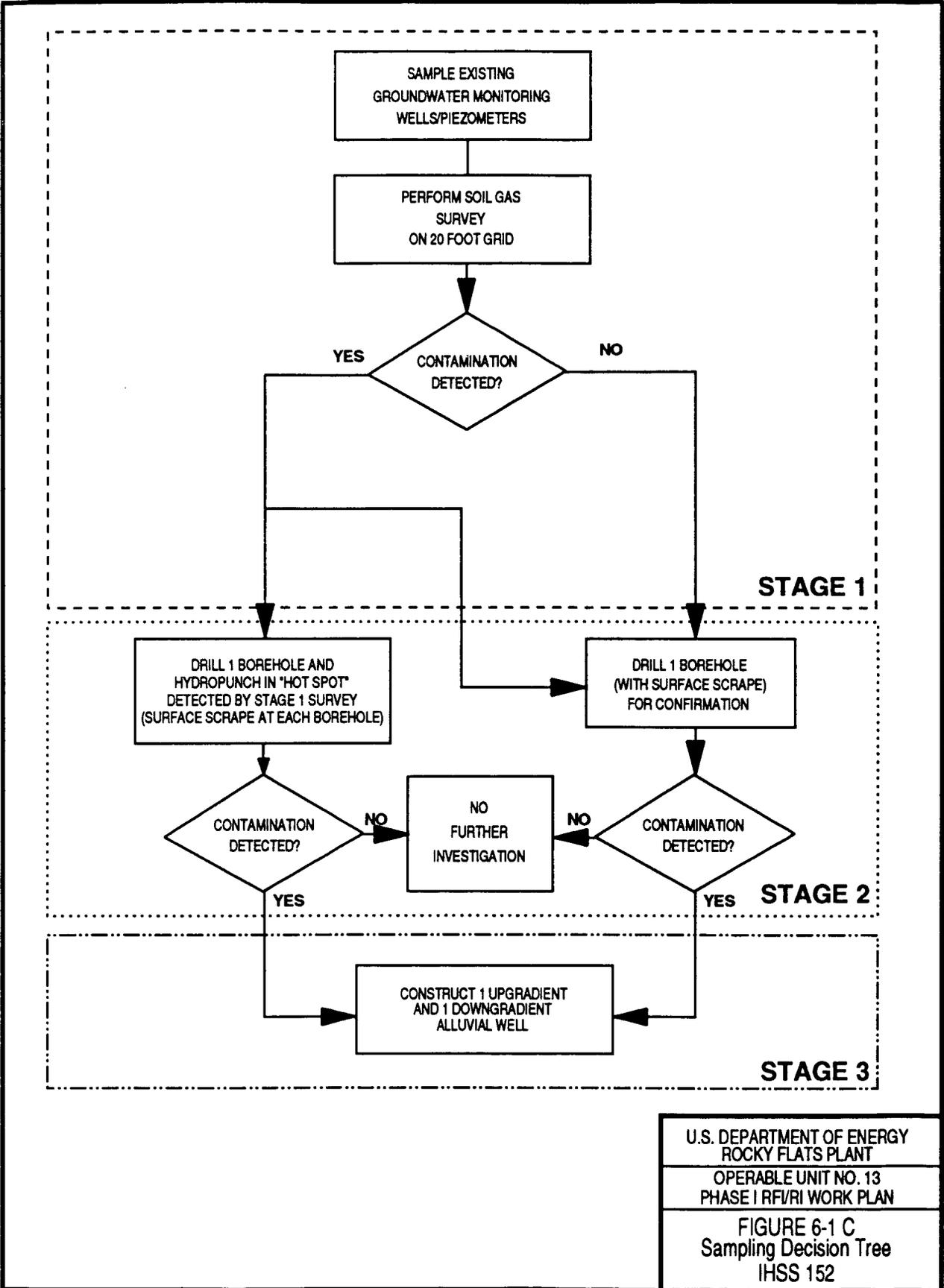
U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 OPERABLE UNIT NO. 13
 PHASE I RF/RI WORK PLAN

FIGURE 6-1 A
 Sampling Decision Tree
 IHSSs 117.1, 117.2, 117.3, 134 (South)



U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 OPERABLE UNIT NO. 13
 PHASE I RFVRI WORK PLAN

FIGURE 6-1 B
 Sampling Decision Tree
 IHSSs 128, 134 (North), 148,
 157.1, 158, 171, 186



U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT
OPERABLE UNIT NO. 13 PHASE I RF/RI WORK PLAN
FIGURE 6-1 C Sampling Decision Tree IHSS 152

**ENVIRONMENTAL MANAGEMENT
PROGRAM**
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area

Manual 21100-WP-OU13.1
Section No.: 7.0, REV. 2
Page: 1 of 1
Effective Date: May 11, 1992
Organization: Environmental Management

TITLE:
Phase I RFI/RI Work Plan for
Operable Unit 13

Approved By:

7.0 TASKS AND SCHEDULING

The preliminary schedule for conducting the OU13 Phase I RFI/RI is summarized in Figure 7-1. The preliminary schedule includes the milestones established in the IAG and includes contingencies for regulatory review of a brief Technical Memorandum to be prepared after stage two of the FSAP. The schedule does not address issues related to obtaining contractual authorization to proceed. Laboratory turn-around time for reporting analytical results is assumed to take 21 days; data validation is assumed to require an additional 30 days, and both have been factored into the preliminary schedule. Approximately two years will elapse from the time the Work Plan is implemented until the final RFI/RI Phase I report is issued.

Several key elements of the Work Plan overlap chronologically. This reflects both the flexibility designed into the Work Plan and the need to implement the Work Plan on an aggressive schedule.

Data validation will begin approximately one month after the site characterization task begins in anticipation that sufficient data will be generated from this stage of the RFI/RI until its completion. It will therefore be necessary to utilize a full-time data validation staff. Implementing data validation concurrent with site characterization will assist in the refinement of data collection procedures and in completing RFI/RI activities within the timeframe established in the IAG.

OU13 RFR/1 Schedule Includes Time for Regulatory Review of a Brief Technical Memoranda Between Stages 2 and 3 of the FSAP.

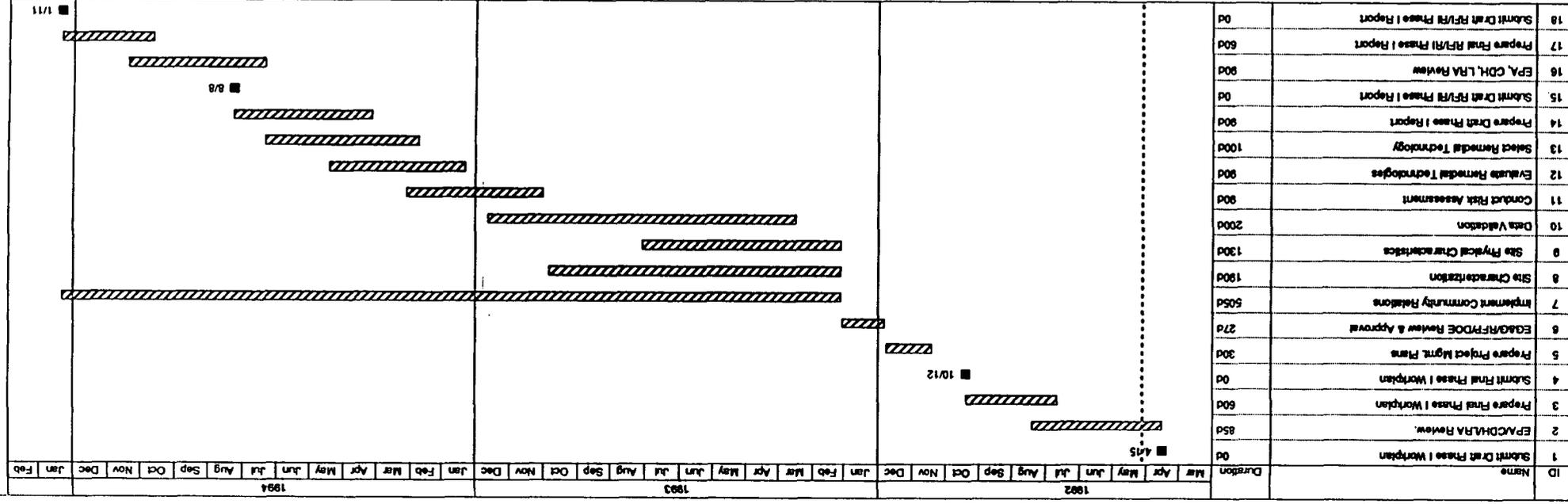


FIGURE 7-1

Critical
 Noncritical
 Progress
 Milestone

**ENVIRONMENTAL MANAGEMENT
PROGRAM**
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area

Manual 21100-WP-OU13.1
Section No.: 8.0, REV. 2
Page: 1 of 16
Effective Date: May 11, 1992
Organization: Environmental Management

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Phase I RFI/RI Work Plan for
Operable Unit 13

Approved By:

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, including the following:

- Contaminant description;
- Exposure assessment;
- Toxicity assessment;
- Risk characterization; and
- Uncertainty analysis.

These components correspond to the four components within IAG required in Section VII.D.I for contaminant identification, exposure assessment, toxicity assessment, and risk characterization. The uncertainty analysis is an additional requirement of the risk assessment procedures for assessing the level of confidence in risk estimates (EPA, 1989b).

Figure 8-1 illustrates the basic Human Health Risk Assessment process and components. The objective of this assessment is to identify and estimate potential human health risks resulting from exposure to

contaminants present in various environmental media within OU13. 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 the 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 OU13 and, if so, what associated cleanup levels will be necessary to protect human health. Clean-up 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, 1989b), including Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03 Human Health Evaluation, Supplemental Guidance: "Standard Default Exposure Factors";
- 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, 1988b);
- Procedures established by the ICRP and adopted by EPA in Federal Guidance Report No. 11 (EPA, 1988);
- 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

In the OU13 there presently exists a total of 13 IHSSs. Historical quantitative data is nonexistent for these areas and only qualitative historical data is available (Appendix A).

Contaminants identified in the draft HRR at the OU13 IHSSs and UBC include enriched and depleted uranium, plutonium, beryllium, chlorinated hydrocarbon solvents, chromates, nitric and sulfuric acids, carbon tetrachloride, and fuel oil. These compounds may occur in the groundwater, soils, ambient air, surface water, and sediments of OU13.

A comprehensive assessment of all contaminants of concern (COCs) and of the exposure pathways will be performed during OU13 RFI/RI activities. This assessment will conclude with a Technical Memorandum on exposure scenarios and a Technical Memorandum on computer modeling. These Technical Memoranda will be reviewed and approved by EPA and CDH.

Data needs and DQOs are presented in Section 5.0 of this work plan. Section 6.0 of this work plan describes how the data needs identified will be collected. The data needs and FSAP address the objectives described in Section 5.0 and include characterizing the nature and extent of contamination and the data collection necessary to assess the complete potential exposure pathways. The data to be collected and its use in the Human Health Risk Assessment include the following media sampling:

- **Soils:** Data characterizing vertical depth contaminant concentrations in OU13 will be used to support discussions of contaminant fate and transport and, ultimately, the exposure assessment.
- **Surficial Soils:** Surface soil data will be used to estimate exposure and risk through ingestion and, if necessary, estimate windborne particulate concentrations for subsequent inhalation exposures.
- **Surface Water and Sediments:** Data characterizing contaminants in surface water 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 and confined 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.

A comprehensive quantitative assessment of all contaminants of concern and potential exposure pathways will be performed as part of the RFI/RI. The remainder of this section generally describes the individual Human Health Risk Assessment components as they relate to the overall risk assessment.

8.2 CONTAMINANTS OF CONCERN

The objective of this section is to describe the procedures to identify source-related contaminants present at OU13 at concentrations that could be of concern to human health. The contaminant description component and identification of COCs of the Human Health Risk Assessment summarizes historical and RFI/RI data collected at OU13, evaluates historical and RFI/RI data relative to performing the Human Health Risk Assessment, and uses 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 by using EPA's Guidance for Data Useability in Risk Assessment (EPA, 1990). The following data usability criteria may be applicable:

- 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 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 excluded from the Human Health Risk Assessment. 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 RFP-related contaminants present at OU13 in concentrations high enough that may be of concern relative to human health considerations. The HRR identified uranium, plutonium, beryllium, chlorinated solvents, acids, and fuel oil within OU13. 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

A flowchart (Figure 8-2) to be used in screening COCs has been developed from the discussion in the Risk Assessment Guidance for Superfund (RAGs) sections 5.8, 5.9, and 10.4 (EPA, 1989b). In general, each box contains a screening criteria which may be answered "yes" or "no". By proceeding through the

flow chart, contaminants will be eliminated based on detection frequency, concentration, carcinogenicity, and whether or not they are associated with an anomaly, or are an essential human nutrient. Analytical results from OU13 field sampling will be analyzed in order to retain those contaminants which are most likely to contribute significantly to human health risks.

The screening process begins with analytical results from the site-specific chemical analysis list set forth in this work plan. The data will first be evaluated to determine if the detection frequency is greater than 5 percent. Contaminants with a detection frequency less than or equal to 5 percent will be screened to determine if they were detected in hot spots. Contaminants with low detection frequency that were not detected in hot spots will be deleted from further consideration. Contaminants with a detection frequency greater than 5 percent will be retained for further screening.

Remaining contaminants will be screened to determine if the concentration is statistically different from background. Those contaminants which are not detected at concentrations statically elevated above background will be considered for elimination, but will be further screened to determine if they are associated with hot spots. If they are not statistically elevated above background or associated with hot spots, they will be eliminated.

The next step in the screening process is to determine if the contaminant is considered a carcinogen. As indicated in Figure 8-2, EPA guidance will be employed to identify contaminants that are classified as Group A, B, or C carcinogens. This screening step does not eliminate a contaminant from further consideration. Instead, it automatically identifies carcinogens for inclusion in the risk assessment, even if detected at low concentrations.

Non-carcinogens retained for further screening will be checked to determine if mean concentrations are greater than one-tenth the value of identified health protective criteria (e.g., reference dose based criteria, drinking water standards, etc). Contaminants with mean concentrations greater than one-tenth/environmental criteria will be retained in the screening process. If the mean concentration is less than one-tenth health protective criteria, the contaminant is reviewed for mobility, persistence, or significant decay products. Mobility may be evaluated according to criteria such as high volatility, high solubility, and low organic carbon partition coefficient (K_{oc}), and persistence may be evaluated according to criteria such as half-life and bioaccumulation. Contaminants that are not highly mobile, persistent, or

possess significant decay products, and are not associated with hot spots will be eliminated. Contaminants determined to be highly mobile or persistent may be retained for further screening.

The final 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, 1989b). Consequently, contaminants that meet the essential nutrient criteria will not be considered further.

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.a, a technical memorandum which includes a listing of the hazardous substances present within OU13 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 OU13.

8.3 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to determine how exposures to site contaminants could occur, and to estimate the extent of exposure if it occurs. 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 based on source and release, exposure point and exposure route;
- Identification of potentially exposed populations and the dynamics of their exposure; 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 OU13 (Figures 2-30 and 2-31) 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 site worker exposure to the selected contaminants must be determined. Intakes of exposed workers 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 exposures 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 (RMaxE) concentrations. RMaxE concentrations are represented by the 95th percent confidence limit on average concentration.

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 groundwater and subsequent transport, soil entrainment and downwind deposition, or surface runoff that transports surface soil 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.

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.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 assumption made and the data used will be included.

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 (the Reasonable Minimum Exposure, RMinE); and the 95 percent upper confidence limit (the Reasonable Maxim Exposure, RMaxE) 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 RMinE, RMaxE, 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, 1989c) 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) and cancer slope factors, both 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.

Following 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.

Toxicity values for substances identified in OU13 which lack EPA toxicity values can be developed using toxicological and epidemiological studies. It is not expected that toxicity values will be developed. A technical memorandum will be submitted to EPA and the State of Colorado for their review and approval listing the 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 site-related contaminants identified in OU13. 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. These could include, but may be limited to, the following:

- Not all constituents at the site have critical toxicity values (such as cancer slope factors or reference doses);
- 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 effect; 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 exposure; 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 OU13 site. Potential carcinogenic and noncarcinogen 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, 1989c).

Noncancer risk 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 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 target-tissues and like impacts to provide a hazard index; if the index exceeds one, there is a potential for health risk.

The potential for carcinogenic effect 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 radiological risks from exposure for up to four pathways: inhalation, ingestion, air immersion, and external irradiations. Calculations will be performed according to guidance provided by the EPA (1989c). The sum of 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 RMinE and RMaxE 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.

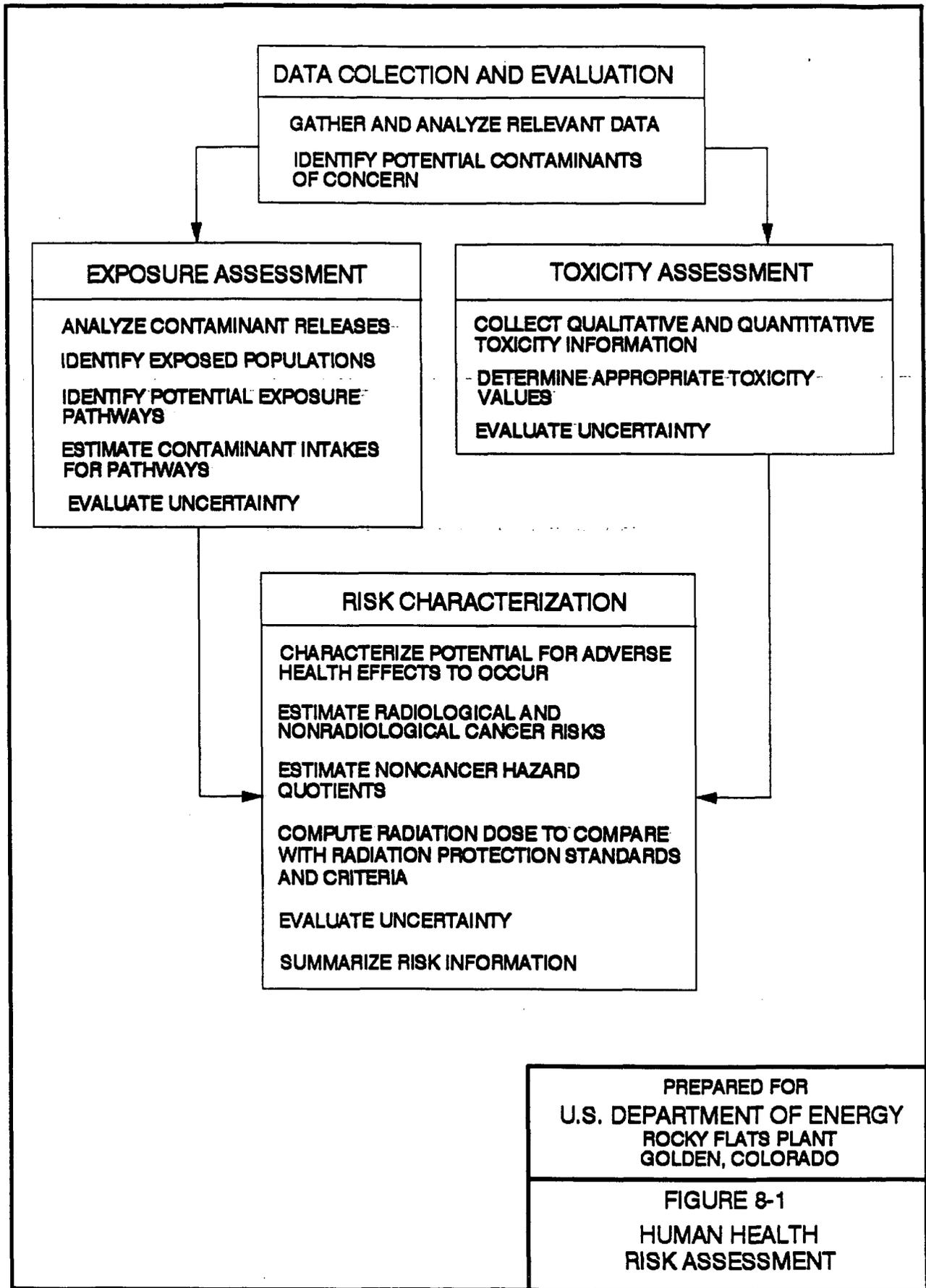
Not all contaminants identified at OU13 will have toxicity values, thereby limiting the ability to develop quantitative estimates of risk. Where adequate toxicity values cannot be identified, potential risks associated with exposure to those constituents will be dealt with qualitatively.

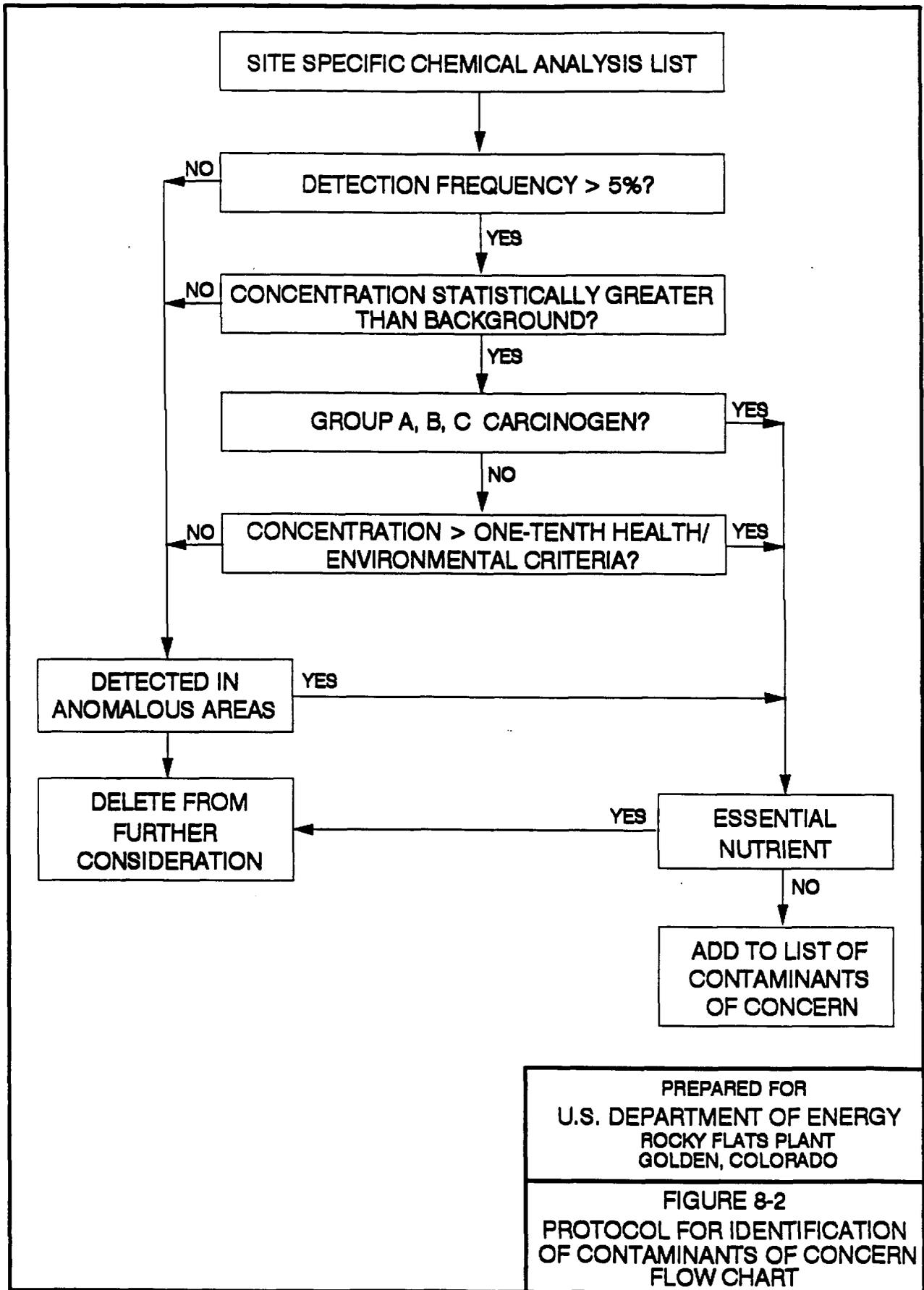
8.6 UNCERTAINTIES, LIMITATIONS, AND ASSUMPTIONS

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 Bayesian 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 8-2
PROTOCOL FOR IDENTIFICATION
OF CONTAMINANTS OF CONCERN
FLOW CHART

**ENVIRONMENTAL MANAGEMENT
PROGRAM**
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area

Manual 21100-WP-OU13.1
Section No.: 9.0, REV. 2
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9.0 ENVIRONMENTAL EVALUATION

9.1 INTRODUCTION

OU13 lies predominantly within the production area at the RFP site. However, the eastern boundaries of OU13 provide a potential contaminant migration corridor between the production area and surrounding buffer-zone. The zone within the production area has been developed to such an extent that there are little if any viable ecosystems or natural habitats presently existing. There are insufficient ecosystems, components, or functions existing on OU13 to require a comprehensive ecological risk assessment. The eastern portion of OU13 which allows potential biotic and abiotic migration of contaminants into the buffer zone is overlapped with other plant site OUs, and is contained substantially within the OU9 preliminary study area. OU9, the Original Process Waste Lines network that extends throughout much of the production area, will address all habitat description necessary within the industrial 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 OU13 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 through migration of contaminants offsite.

Areas of concern in OU13 which bridge the boundary between the RFP site buffer-zone and the production area are fully incorporated within OU6. These sections of OU13 are the portions of

South Walnut Creek south of the STP (Sewage Treatment Plant) and just upstream of the B-series ponds. Coordination of OU13 EE requirements with the OU9 and OU6 Environmental Evaluations is mandated by the overlapping study areas. Habitat and biological surveys proposed for OU9 and OU6 will cover the entire OU13 study area, and the results will apply to OU13. Following is a brief description of the study components presently proposed for OU9 and OU6, and how these studies will relate to OU13. These sections are based on a preliminary draft of a technical memorandum for a revision to the EE proposed for OU9 (EG&G, 1992d).

9.2 BIOLOGICAL AND HABITAT SITE CHARACTERIZATION

Biota and habitat surveys proposed for OU9 and OU6 will be adequate for the biological and habitat characterization of OU13 and will not be duplicated or repeated. These surveys will provide the following information applicable to OU13:

- Comprehensive survey and mapping of types and extent of habitats, particularly habitats that could support species of special concern such as migratory birds;
- Presence and/or use of habitats of raptors and migratory birds, including waterfowl and passerine species;
- Presence or absence of threatened and endangered species, or species of special concern; and
- Data on small mammals or bird population dynamics, if present.

This characterization will include a literature review, expert consultation, and field surveys for vegetation, species of special concern, small mammals, and birds. Soil series will not be mapped because of the heavily disturbed nature of the soil surface within OU13. This information, will be included in the three following reports:

- Habitat survey report for compliance with acts for protection of migratory birds;
- Biological survey report for compliance with acts protecting species of special concern; and

- A technical memorandum reporting results of small mammals and bird surveys.

9.3 ECOTOXICOLOGICAL INVESTIGATIONS

Ecotoxicological investigations will be conducted if the following conditions are present on OU13:

- 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 OU13 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 OU13.

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.

The procedures for conducting this type of investigation for the industrial area are presently under development for OU9, and would be adapted, if needed, for the much smaller and highly disturbed study area in OU13. Procedures and results from the OU6 EE would be used as needed for investigation of the eastern portion of OU13 incorporating habitat in and around South Walnut Creek, upstream of the B-series ponds.

This information would be used to assess the ecological risk posed by contaminant migration by contaminated target taxa. Information on contaminant migration by target taxa to other OUs will be provided to those OU managers for use in conducting their EEs for identifying ecological risks. This would be a quantitative estimate with the appropriate uncertainty analysis for model assumptions and estimates of parameters. This information would also be coordinated with contaminant migration by physical or abiotic media developed during the site characterization and transport models.

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10.0 QUALITY ASSURANCE ADDENDUM

This section consists of the Quality Assurance Addendum (QAA) for Phase I investigations at Operable Unit No. 13 (OU13), which supplements the "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP). This QAA establishes the site-specific Quality Assurance (QA) controls applicable to the investigation activities described in the OU13 Work Plan (OU13 WP).

OU13 is one of 16 operable units (OUs) identified for investigations under the Rocky Flats Plant (RFP) Interagency Agreement (IAG). OU13 contains 15 individual hazardous substance sites (IHSSs), which are described in Section 2.1 of the OU13 WP. Section 2.2 describes the nature and extent of contamination at the IHSSs within OU13. The OU13 WP was prepared in accordance with EPA/530/SW-89-031, "RCRA Facility Investigation (RFI) Guidance" (May 1989), EPA/540/8-89/004, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (October 1988), and the IAG.

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).

Contractors will be tasked by EG&G Rocky Flats to implement the field activities outlined in the OUI3 WP. 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 EPA/QAMS-005/80, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans." The 18-element format of NQA-1 was selected as the basis for both the QAPjP and subsequent QAAs 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 OU13 Phase I activities, unless specified otherwise in this QAA. Where site-wide actions are applicable to OU13 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 OU13 Phase I RFI/RI activities that may not have been addressed on a site-wide basis in the QAPjP. Many of the QA requirements specific to OU13 are addressed within other sections of this 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 Operating Procedures (OPS) that are applicable to OU13 investigations are specified within the respective procedures. The EMD OPS (which may also be referred to as EM Standard Operating Procedures [SOPs] in the QAPjP and the OU13 WP) that are applicable to Phase I activities at OU13 are identified in Table 10.1.

10.2.2 Quality Assurance Reports to Management

A QA summary report will 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 will include a summary of field operation and laboratory inspections, surveillance, and audits and a report on data verification/validation results.

10.3 DESIGN CONTROL AND CONTROL OF SCIENTIFIC INVESTIGATIONS

10.3.1 Design Control

The OU13 WP describes the investigation activities that will be implemented during the Phase I characterization of the OU13 IHSSs. The 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 OU13 WP is considered the investigation control plan for the OU13 Phase I RFI/RI activities.

10.3.2 Data Quality Objectives

The development of Data Quality Objectives (DQOs) for the OU13 Phase I investigations was presented in Section 5.0. The DQOs for OU13 were established in accordance with 3-stage process described in EPA OSWER Directive 9355.0-7B, Data Quality Objectives for Remedial Response Activities, and Appendix A of the QAPjP.

Identification of data quality needs includes defining investigation objectives and identifying data uses and the types of data that need to be collected. Specific Phase 1 investigation objectives, data uses, data types, and data quality objectives (DQOS) for OU13 were defined in Section 5.0. Other factors that are necessary in identifying data quality needs include selecting appropriate analytical levels, contaminants of concern, levels of concern, required detection limits, and critical samples. The identification and selection of these factors were also established in Section 5.0.

Data quality is typically measured in terms of precision, accuracy, representativeness, comparability, and completeness (also referred to as PARCC parameters). Precision, accuracy, and completeness are quantitative measures of data quality, while representativeness and comparability are qualitative statements that express the degree to which sample data represent actual conditions and describe the confidence of one data set to another. These parameters are defined in Appendix A of the QAPjP. PARCC parameters will be determined for OUI3 Phase I measurement data, as described previously in Section 5.0. PARCC parameter goals, that are established prior to initiating investigations, assist decision makers to determine if DQOs for measurement data have been met.

The specific goals for precision and accuracy for the potential contaminants present that were identified in Table 5.3 are presented in Table 10.2. The goals for precision and accuracy presented in Table 10.2 are based primarily on historical measures of precision and accuracy for the specified methods of analysis. The specific methods of analysis were selected based on the analytical level of measurement data established in Section 5.0. The goal for completeness is 100

percent with a minimum acceptable completeness of 90 percent for laboratory measurement data and 80 percent for field measurements.

Based on the data quality needs identified for OU13 Phase I investigations, the sampling and analytical options were evaluated. The sampling methods selected for OU13 Phase I investigations are listed in Table 6.1. The specific field analytical methods and the Standard EPA and EPA CLP laboratory methods are identified in Table 10.2.

10.3.3 Sampling Locations and Sampling Procedures

The sampling plan for OU13 was described in Section 6.0. Sampling activities will be staged, with the initial stages providing information that will be used to direct and refine sampling methods and sampling locations in subsequent stages. The rationale for this stage approached was presented in Section 6.1. The field sampling plan for OU13 was summarized in Table 6.1.

The operating procedures that are applicable to OU13 Phase I field activities and the particular activities to which they are applicable were listed in Tables 6.1 and 10.1.

10.3.4 Analytical Procedures

The analytical requirements for the OU13 Phase I RFI/RI was discussed in Section 6.3. The analytes of interest and the specified detection limits for radiation surveys, surface scrape radiochemistry, soil gas sampling, subsurface (borehole) soil sampling, shallow soil sampling, and alluvial groundwater sampling for each IHSS were identified in Tables 5.4 and 6.1. 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 potential contaminant present identified in Table 5.3 are referenced in Tables 5.4 and 10.2.

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 OPS-FO.03, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, boring, well installation, sample collection, etc. shall be decontaminated as specified in OPS-FO.04, Heavy Equipment Decontamination.

10.3.6 Air Quality

Air monitoring will 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 OUI3 RFI/RI activities comply with the RFP Interim Plan for Prevention of Contaminant Dispersion. Air monitoring will be conducted according to OPS-FO.01, 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 OU13 were addressed in Section 6.4 and are identified in Table 6.3. A specific sampling schedule will be prepared by the sampling subcontractor for approval by the EG&G Laboratory Analysis Task Leader (Figure 10-1) prior to sampling.

10.3.7.1 Objectives for Field QC Samples

Equipment rinsate blanks are considered acceptable (with no need for data qualification) if the concentration of analytes of interest is less than three times the required detection limit for each analyte as specified in Table 4.4. Equipment rinsate blanks may only be analyzed if

contaminants of concern are detected above background in samples. Field duplicate samples shall agree within 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples.

Trip blanks and field preservation blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits presented in Table 4.4. The Laboratory Analysis Task Leader is responsible for verifying these criteria and is also responsible for checking to see if they are met and for qualifying measurement data.

10.3.7.2 Laboratory QC

Laboratory QC procedures are used to provide measures of internal consistency for analyses and storage of samples. The laboratory contractor will submit written SOPs to the Laboratory Analysis Task Leader for approval. The interlaboratory SOPs shall be consistent with or equivalent to EPA-CLP QC 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 III.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
- 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 will 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 will be forwarded to the Laboratory Analysis Task Leader or validation contractor for review and verification.

10.3.8 Quality Assurance Monitoring

To assure the overall quality of the RFI/RI activities discussed in the OU13 WP, field inspections will 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. Audit and surveillance intervals will be based on the schedule contained in Section 7.0. At a minimum, each of the field sampling activities described in Sections 6.2 will 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 will 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 (i.e., comparison of reduced data to DQOs, where appropriate). 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 subsection 3.3.7 of Section 3.0 of the QAPjP.

10.3.9.4 Data Reporting

Depending on the data validation process, data are 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 subsection 3.3.7 of Section 3.0 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 OU13 WP describes the activities to be performed. The OU13 WP will be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined in Section 5.0 of the QAPjP.

EMD OPS 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 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). Any changes, revisions, additions,

or deletions to the OU13 WP will be presented in either DCNs or Technical Memoranda. DCNs and Technical Memoranda will be reviewed and approved by the same organizations that reviewed and approved the original OU13 WP.

10.6 DOCUMENT CONTROL

The following documents will be controlled in accordance with Section 6.0 of the QAPjP:

- Phase I RFI/RI Work Plan for the 100 Area, Operable Unit No. 13
- Rocky Flats Plant Site-Wide 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 Site-Wide QAPjP for Operable Unit No. 13, 100 Area, Phase I RFI/RI Activities
- EMD Operating Procedures and EM Radiological Guidelines (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 OU13 Phase I RFI/RI activities will be selected and evaluated as outlined in Section 7.0 of the QAPjP. This includes pre-award evaluation/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 for investigations at OU13 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 were presented in Table 6.2.

10.8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with Section 8.0 of the QAPjP and OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Samples shall have unique identification that traces the sample to the source(s) 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 will be maintained through the application of OPS-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 analysis, and entering 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., groundwater 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 are not applicable to any of the RFI/RI investigations described in the OU13 WP.

10.12 CONTROL OF MEASURING AND TEST EQUIPMENT (M&TE)

10.12.1 Field Equipment

Specific conductivity, temperature, and pH of groundwater samples shall be measured in the field. Field measurements will be taken and the instruments calibrated as specified in OPS-GW.05, Field Measurements for Groundwater Field 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
- pH: HACH One pH Meter (this meter may also be used for temperature measurements)

In addition to the field measurements for water quality, field measurements for radiation and soil gas will also be made. The following instruments will be used for these measurements.

- Radiological field readings for field survey grid locations will be measured with a High Purity Germanium (HPGe) detector. An SOP for the performance of surveys with the HPGe are under development by EG&G.

- Field readings for soil gas will be taken using a field gas chromatograph. These analyses will be performed in accordance with OPS-GT.09, Soil Gas Sampling and Field Analysis, and OPS-GT.19, Field Gas Chromatographs.

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
- 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 will 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 OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Maximum sample holding times, sample preservative, sample volumes, and sample containers were specified in Table 6.2. Those requirements are generally consistent with the sample holding time, preservative, and sample container requirements specified in Table 8-1 of Section 8.0 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 groundwater monitoring wells shall be maintained by the Field Activities Task Leader, which will 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 will 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 will be controlled in accordance with OPS-FO.02, Field Document Control. QA records to be generated during OUI3 RFI/RI activities include, but are not limited to:

- Field Logs and Data Record Forms (e.g., sample collection notebooks/logs for groundwater, sediment, 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
- Inspection Records

10.18 QUALITY VERIFICATION

The requirements for the verification of quality shall be implemented as specified in Section No. 18 of the QAPJP. EG&G will conduct audits of the laboratory contractor as specified in the GRRASP, Parts A and B. The EMD GAPM 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 will be monitored by the surveillance program are as follows:

- Borings and well installations (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 OU13 activities, and monthly thereafter)
- 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 OU13 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 will 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 OU13 WP activities. Operating procedures applicable to the use of the database storing environmental data can be found in OPS-FO.14, Field Data Management.

TABLE 10.1
EMD Operating Procedures and Field Activities
for Which They are Applicable

Former SOP Reference Numbers	EMAD OPS Reference Numbers	Standard Operating Procedures	Field Radiation Surveys	Well Drilling Completion, Development	Ground-Water Sampling	Soil Gas Surveys	Surface Soil and Soil Scrape Sampling	Subsurface Soil Sampling
1.1	FO.01	Wind Blown Contaminant Dispersion Control					●	
1.2	FO.02	Field Document Control	●	●	●	●	●	●
1.3	FO.03	General Equipment Decontamination	●	●	●	●	●	●
1.4	FO.04	Heavy Equipment Decontamination		●	●		●	●
1.5	FO.05	Handling of Purge and Development Water		●	●			
1.6	FO.06	Handling of Personal Protective Equipment	●	●	●	●	●	●
1.7	FO.07	Handling of Decontamination Water & Wash Water	●	●	●	●	●	●
1.8	FO.08	Handling of Drilling Fluids & Cuttings		●				●
1.9	FO.09	Handling of Residual Samples					●	●
1.10	FO.10	Receiving, Labeling, and Handling Waste Containers		●	●			●
1.11	FO.11	Field Communications	●	●	●	●	●	●
1.12	FO.12	Decontamination Facility Operations	●	●	●	●	●	●
1.13	FO.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples			●	●	●	●
1.14	FO.14	Field Data Management	●	●	●	●	●	●
1.15	FO.15	Use of PIDs and FIDs		X	X	X	X	X
1.16	FO.16	Field Radiological Measurements a) Walk-Over Surveys	●	X	X	X	X	X
New	FO.18	Environmental Sample Radioactivity Content Screening			●		●	●
2.1	GW.01	Water Level Measurements in Wells and Piezometers		●	●			
2.2	GW.02	Well Development		●				
2.5	GW.03	Measurements for Groundwater Field Parameters			●			
2.6	GW.04	Groundwater Sampling			●			

X-As required by H&S plan.

TABLE 10.1 (Continued)
EMD Operating Procedures and Field Activities
for Which They are Applicable

Former SOP Reference Numbers	EMAD OPS Reference Numbers	Standard Operating Procedures	Field Radiation Surveys	Well Drilling Completion, Development	Ground-Water Sampling	Soil Gas Surveys	Surface Soil and Soil Scrape Sampling	Subsurface Soil Sampling
3.1	GT.01	Logging Alluvial and Bedrock Material		●				●
3.2	GT.02	Drilling and Sampling Using Hollow-Stem Auger Techniques		●				●
3.3	GT.03	Isolating Bedrock from the Alluvium with Surface Casing		●				●
3.5	GT.05	Plugging and Abandonment of Boreholes		●				●
3.6	GT.06	Monitoring Well and Piezometer Installation		●				
3.8	GT.08	Surface Soil Sampling					●	
3.9	GT.09	Soil Gas Sampling and Field Analysis						
3.10	GT.10	Borehole Clearing		●				●
New	GT.15	Geophysical Borehole Logging		●				●
New	GT.17	Land Surveying		●				●
New	GT.19	Field Gas Chromatographs				●		
New	GT.22	BAT In-Situ Sampler (Proposed)			●			
EMRG OPS Reference No.								
1.1		Gamma Radiation Surveys	●					
1.2		Beta Radiation Surveys	●					
3.2		Survey Requirements for Conditional and Unrestricted Use	●					

**TABLE 10.2
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES**

Analyte	Method	Required Detection Limits				Precision Objective	Accuracy Objective
		GW	SOIL	Water	Soil		
INDICATORS							
Total Organic Carbon	EPA 415 ^d ASTM D4129-82	X ^U	X	5 mg/l		20%RPD ^e	80-120% LCS Recovery
INORGANICS							
Target Analyte List - Metals		X ^P	X			WATER/SOIL	WATER/SOIL
Aluminum	EPA CLP SOW ^a			200 ug/L ^d	40 mg/Kg ^d	**	**
Antimony	EPA CLP SOW ^a			60	12		
Arsenic (GFAA)	EPA CLP SOW ^a			10	2		
Barium	EPA CLP SOW ^a			200	40		
Beryllium	EPA CLP SOW ^a			5	1		
Cadmium	EPA CLP SOW ^a			5	1		
Calcium	EPA CLP SOW ^a			5000	2000		
Chromium	EPA CLP SOW ^a			10	2		
Cobalt	EPA CLP SOW ^a			50	10		
Copper	EPA CLP SOW ^a			25	5		
Cyanide	EPA 335.3	(modified for CLP) ^{ad}		5	10		
Iron	EPA CLP SOW ^a			100	20		
Lead (GFAA)	EPA CLP SOW ^a			3	1		
Magnesium	EPA CLP SOW ^a			5000	2000		
Manganese	EPA CLP SOW ^a			15	3		
Mercury (CVAA)	EPA CLP SOW ^a			0.2	.2		
Nickel	EPA CLP SOW ^a			40	8		
Potassium	EPA CLP SOW ^a			5000	2000		
Selenium (GFAA)	EPA CLP SOW ^a			5	1		
Silver	EPA CLP SOW ^a			10	2		
Sodium	EPA CLP SOW ^a			5000	2000		
Thallium (GFAA)	EPA CLP SOW ^a			10	2		
Vanadium	EPA CLP SOW ^a			50	10		
Zinc	EPA CLP SOW ^a			20	4		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	Required Detection Limits				Precision Objective	Accuracy Objective
		GW	SOIL	Water	Soil		
ANIONS						Water/Soil	Water/Soil
Sulfate	EPA 375.4 ^d		X	1	mg/L		
Nitrate	EPA 353.2 ^d or 353.3 ^d	X ^u	X			Same as Metals	Same as Metals
Fluoride	(TBD)		X				
Target Compound List - Volatiles		X ^u	X			WATER/SOIL	WATER/SOIL
Chloromethane	EPA CLP SOW ^c			10 ug/L	10 ug/Kg (low) ³	**	**
Bromomethane	EPA CLP SOW ^c			10	10		
Vinyl Chloride chloroethane	EPA CLP SOW ^c			10	10		
Methylene Chloride	EPA CLP SOW ^c			10	10		
Acetone	EPA CLP SOW ^c			5	5		
Carbon Disulfide	EPA CLP SOW ^c			10	10		
1,1-Dichloroethene	EPA CLP SOW ^c			5	5		
1,1-Dichloroethane	EPA CLP SOW ^c			5	5		
total 1,2-Dichloroethene	EPA CLP SOW ^c			5	5		
Chloroform	EPA CLP SOW ^c			5	5		
1,2-Dichloroethane	EPA CLP SOW ^c			5	5		
2-Butanone	EPA CLP SOW ^c			1	1		
1,1,1-Trichloroethane	EPA CLP SOW ^c			10	10		
Carbon Tetrachloride	EPA CLP SOW ^c			5	5		
Vinyl Acetate	EPA CLP SOW ^c			5	5		
Bromodichlormethane	EPA CLP SOW ^c			10	10		
1,2-Dichloropropane	EPA CLP SOW ^c			5	5		
cis-1,3-Dichloropropene	EPA CLP SOW ^c			5	5		
Trichloroethane	EPA CLP SOW ^c			5	5		
Dibromochlormethane	EPA CLP SOW ^c			5	5		
1,1,2-Trichloroethane	EPA CLP SOW ^c			5	5		
Benzene	EPA CLP SOW ^c			5	5		
trans-1,2-Dichloropropene	EPA CLP SOW ^c			5	5		
Bromoform	EPA CLP SOW ^c			5	5		
4-Methyl-2-pentanone	EPA CLP SOW ^c			5	5		
2-Hexanone	EPA CLP SOW ^c			10	10		
Tetrachloroethene	EPA CLP SOW ^c			10	10		
Toluene	EPA CLP SOW ^c			5	5		
1,1,2,2-Tetrachloroethane	EPA CLP SOW ^c			5	5		
Chlorobenzene	EPA CLP SOW ^c			5	5		
Ethyl Benzene	EPA CLP SOW ^c			5	5		
Styrene	EPA CLP SOW ^c			5	5		
Total Xylenes	EPA CLP SOW ^c			5	5		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	Required Detection Limits			Precision Objective	Accuracy Objective
		GW	SOIL	Water			Soil
Target Compound List - Semi-Volatiles			X		SOIL	SOIL
Phenol	EPA CLP SOW ^c				330 ug/Kg ³	**
bis(2-Chloroethyl)ether	EPA CLP SOW ^c				330	***
2-Chlorophenol	EPA CLP SOW ^c				330	
1,3-Dichlorobenzene	EPA CLP SOW ^c				330	
1,4-Dichlorobenzene	EPA CLP SOW ^c				330	
Benzyl Alcohol	EPA CLP SOW ^c				330	
1,2-Dichlorobenzene	EPA CLP SOW ^c				330	
2-Methylphenol	EPA CLP SOW ^c				330	
bis(2-Chloroisopropyl)ether	EPA CLP SOW ^c				330	
4-Methylphenol	EPA CLP SOW ^c				330	
N-Nitroso-Dipropylamine	EPA CLP SOW ^c				330	
Hexachloroethane	EPA CLP SOW ^c				330	
Nitrobenzene	EPA CLP SOW ^c				330	
Isophorone	EPA CLP SOW ^c				330	
2-Nitrophenol	EPA CLP SOW ^c				330	
2,4-Dimethylphenol	EPA CLP SOW ^c				330	
Benzoic Acid	EPA CLP SOW ^c				1600	
bis(2-Chloroethoxy)methane	EPA CLP SOW ^c				330	
2,4-Dichlorophenol	EPA CLP SOW ^c				330	
1,2,4-Trichlorobenzene	EPA CLP SOW ^c				330	
Naphthalene	EPA CLP SOW ^c				330	
4-Chloroaniline	EPA CLP SOW ^c				330	
Hexachlorobutadiene	EPA CLP SOW ^c				330	
4-Chloro-3-methylphenol	EPA CLP SOW ^c				330	
2-Methylnaphthalene	EPA CLP SOW ^c				330	
Hexachlorocyclopentadiene	EPA CLP SOW ^c				330	
2,4,6-Trichlorophenol	EPA CLP SOW ^c				330	
2,4,5-Trichlorophenol	EPA CLP SOW ^c				1600 ug/Kg ³	
2-Chloronaphthalene	EPA CLP SOW ^c				330	
2-Nitroaniline	EPA CLP SOW ^c				1600	
Dimethylphthalate	EPA CLP SOW ^c				330	
Acenaphthylene	EPA CLP SOW ^c				330	
2,6-Dinitrotoluene	EPA CLP SOW ^c				330	
3-Nitroaniline	EPA CLP SOW ^c				1600	
Acenaphthene	EPA CLP SOW ^c				330	
2,4-Dinitrophenol	EPA CLP SOW ^c				1600	

TABLE
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Water	Required Detection Limits		Accuracy Objective
					Precision Objective	Accuracy Objective	
Target Compound List - Semi-Volatiles (cont.)	EPA CLP SOW				1600 ug/Kg ²	**	Water/Soil
4-Nitrophenol	EPA CLP SOW				330		
Dibenzofuran	EPA CLP SOW				330		
2,4-Dinitrochlorobenzene	EPA CLP SOW				330		
Dichlorophthalate	EPA CLP SOW				330		
4-Chlorophenyl Phenyl ether	EPA CLP SOW				330		
Fluorene	EPA CLP SOW				330		
4-Nitroaniline	EPA CLP SOW				1600 ug/Kg ²		
4-Nitro-2-methylphenol	EPA CLP SOW				1600		
N-nitrosodiphenylamine	EPA CLP SOW				330		
4-Bromophenyl Phenyl ether	EPA CLP SOW				330		
Hexachlorobenzene	EPA CLP SOW				330		
Penachlorophenol	EPA CLP SOW				1600		
Phenanthrene	EPA CLP SOW				330		
Anthracene	EPA CLP SOW				330		
Di-n-butylphthalate	EPA CLP SOW				330		
Fluoranthene	EPA CLP SOW				330		
Pyrene	EPA CLP SOW				330		
Butyl Benzylphthalate	EPA CLP SOW				330		
3,3'-Dichlorobenzidine	EPA CLP SOW				660		
Benzo(a)anthracene	EPA CLP SOW				330		
Chrysene	EPA CLP SOW				330		
bis(2-ethylhexyl)phthalate	EPA CLP SOW				330		
Di-n-octyl Phthalate	EPA CLP SOW				330		
Benzo(b)fluoranthene	EPA CLP SOW				330		
Benzo(k)fluoranthene	EPA CLP SOW				330		
Benzo(a)pyrene	EPA CLP SOW				330 ug/Kg ²		
Indeno(1,2,3-cd)pyrene	EPA CLP SOW				330		
Dibenz(a,h)anthracene	EPA CLP SOW				330		
Benzo(g,h,i)perylene	EPA CLP SOW				330		

RADIONUCLIDES

(Replicate Analyses)

(Laboratory Control Sample)

TAB
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Required Detection Limits		Precision Objective	Accuracy Objective
				Water	Soil		
Gross Alpha	s,f,g,h,i,k,l,m,n		X	NA	4	pCi/g	**
Gross Beta	s,f,g,h,i,k,l,m,n		X	NA	10	pCi/g	***
Uranium 233+234	f,h,i,m,n,s,l	X ^P	X	0.6	pCi/L .03	pCi/g	
Uranium 235, 238	f,h,i,m,n,s,l		X	NA	.03	pCi/g	
Americium 241	p,q,s,l,i		X	NA	0.02	pCi/g	
Plutonium 239+240	o,p,s,l,i	X ^P	X	0.01	pCi/L 0.03	pCi/g	
Tritium	f,g,h,m,s,i,l	X ^U	X	400	pCi/L 400	pCi/L	
Strontium 89,90	f,h,i,m,s,l		X	NA	1	pCi/g	

TAE
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Required Detection Limits		Precision Objective	Accuracy Objective
				Water	Soil		
FIELD PARAMETERS				Detection Limit	Precision	Accuracy	
1,1,1-Trichloroethane	EPA 502.2		X	5 ug/L	35% RPD		
Carbon tetrachloride	EPA 502.2		X	5 ug/L	35%		
Methylethylketone	EPA 502.2		X	10 ug/L	35%		
Dichloromethane	EPA 502.2		X	5 ug/L	35%		
Perchloroethene	EPA 502.2		X	5 ug/L	35%		
Trichloroethene	EPA 502.2		X	5 ug/L	35%		
Benzene	EPA 502.2		X	5 ug/L			
Toluene	EPA 502.2		X	5 ug/L			
Xylene	EPA 502.2		X	5 ug/L			
pH	1		X	+0.1 pH unit	NA	+0.2 pH units	
Specific conductance	1		X	2.5 umho/cm ⁷	NA	+2.5% max. error at 500,	
				25 umho/cm ⁹		5000, 50000 umhos/cm	
				250 umho/cm ⁹	NA	plus probe;	
						+ 3.0% max. error at 250,	
						2500, and 25000 plus	
						probe accuracy of + 2.0%.	
Temperature	1		X	± 0.1°C	NA	+1.0°C	
Beta/Gamma	Geiger Muller Detector		X	5,000 dpm/100cm ² +20% error		NA	
Alpha Radiation	FIDLER		X	300 dpm/100cm ² +20% error		NA	

TAB
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

** Precision objective = control limits specified in referenced method and/or Data Validation Guidelines.

*** Accuracy objective = control limits specified in referenced method (in GRRASP for radionuclides).

F = Filtered

U = Unfiltered

1. Measured in the field in accordance with instrument manufacturer's instructions. The instruments to be used are specified in Section 12.
2. Medium soil/sediment required detection limits for pesticide/PCB TCL compounds are 15 times the individual low soil/sediment required detection limit.
3. Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.
4. Higher detection limits may only be used in the following circumstances: If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the required detection limit.

This is illustrated in the example below:

For lead:

Method in use - ICP
Instrument Detection Limit (IDL) - 40
Sample Concentration - 220
Required Detection Limit (RDL) - 3

The value of 220 may be reported even though the instrument detection limit is greater than the RDL.

Note: The specified detection limits are based on a pure water matrix. The detection limits for samples may be considerably higher depending on the sample matrix.

5. If gross alpha > 5 pCi/L, analyze for Radium 226; If Radium 226 > 3 pCi/L, analyze for Radium 228.
6. The detection limits presented were calculated using the formula in N.R.C. Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21, and follow:

$$LLD = \frac{4.66 (BKG/BKG \text{ DUR})^{1/2}}{(2.22)(Eff)(CR)(SR)(e^{-t})(Aliq)} \quad MDA = \frac{4.66 (BKG/Sample \text{ DUR})^{1/2}}{(2.22)(Eff)(CR)(CR)(e^{-t})(Aliq)}$$

Where:

LLD = Lower Limit of Detection in pCi per sample unit.	MDA = Minimum Detectable Activity in pCi per sample unit
BKG = Instrument Background in counts per minute (CPM).	BKG = Same as for LLD
Eff = Counting efficiency in cpm/disintegration per minute (dpm).	Eff = Same as for LLD
CR = Fractional radiochemical yield.	CR = Same as for LLD
SR = Fractional radiochemical yield of a known solution	SR = Same as for LLD
= The radioactive decay constant for the particular radio-nuclide	= Same as for LLD
t = The elapsed time between sample collection and counting.	t = Same as for LLD
Aliq = Sample Volume.	Aliq = same as for LLD
BKG DUR = Background count duration in minutes.	Sample DUR = sample count duration in minutes

7. On 500 umho/cm range.
8. On 5000 umho/cm range.
9. On 50000 umho/cm range.
- a. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version).
- b. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version). The specific method to be utilized is at the laboratory's discretion provided it meets the specified detection limit.
- c. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, 2/88 (or latest version).
- d. Methods are from "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, 1983, unless otherwise indicated.
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- k. "Handbook of Analytical Procedures,; USAEC, Grand Junction Lab. 1970, page 196.
- l. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.
- m. "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," U.S.G.S. Book 5, chapter A5, 1977.
- n. "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.
- o. "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium, and Americium," by E.H. Essington and B.J. Drennon, Los Alamos National Laboratory, a private communication.
- p. "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.
- q. "Radioactivity in Drinking Water," EPA 570/9-81-002.
- r. If the sample or duplicate result is $< 5 \times \text{IDL}$, then the control limit is $\pm \text{IDL}$.
- s. U.S. EPA, 1987. "Eastern Environmental Radiation Facility Radiochemistry Procedures Manual," EPA-502/5-84-006.

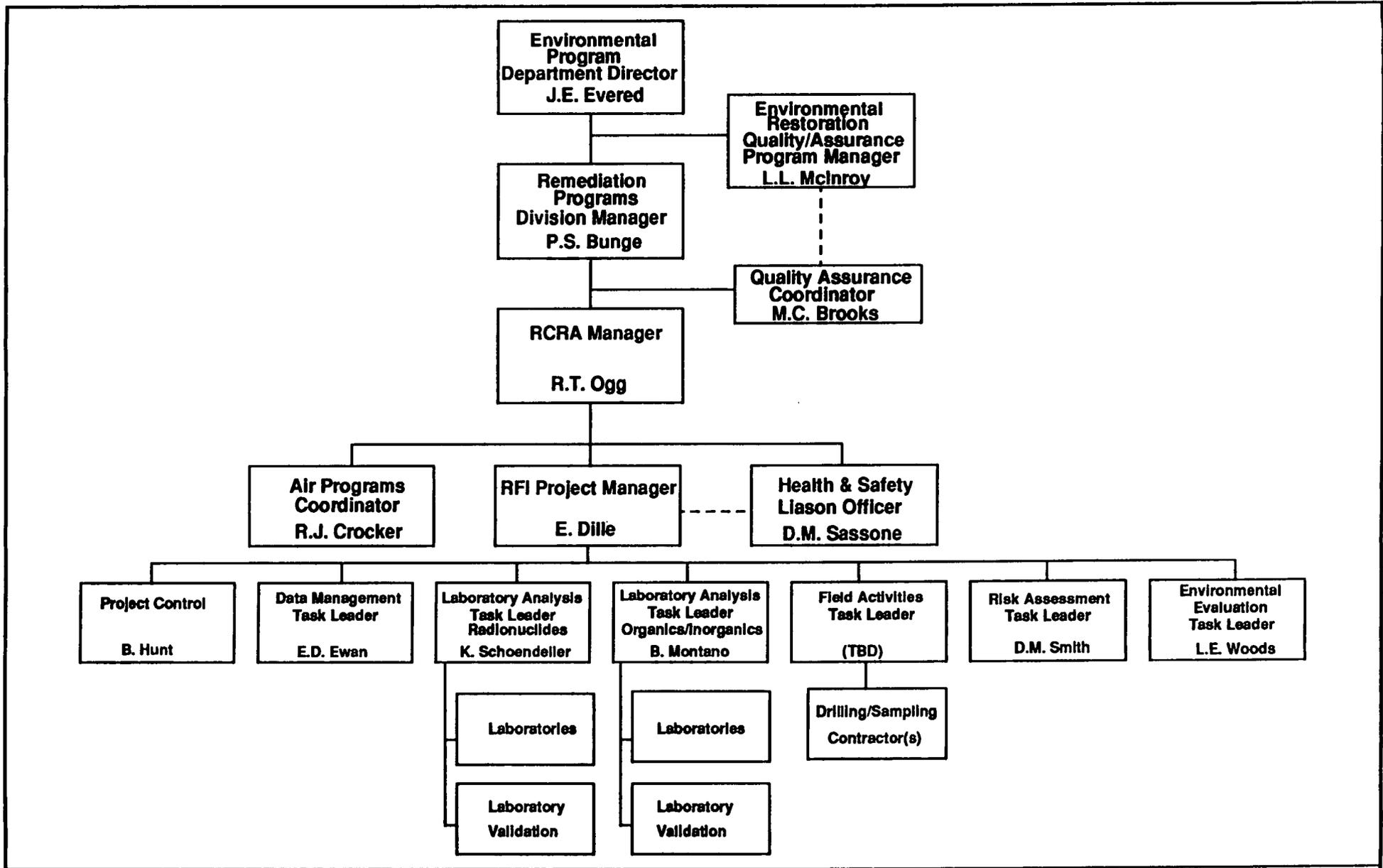


FIGURE 10-1
PROJECT MANAGEMENT FOR OPERABLE UNIT NO. 13

OPERABLE UNIT NO. 13
 PHASE I RFI/RI WORK PLAN
 U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado

**ENVIRONMENTAL MANAGEMENT
PROGRAM**
Phase I RFI/RI Work Plan for
Operable Unit 13
100 Area

Manual 21100-WP-OU13.1
Section No.: 11.0, REV. 2
Page: 1 of 10
Effective Date: May 11, 1992
Organization: Environmental Management

TITLE:
Phase I RFI/RI Work Plan for
Operable Unit 13

Approved By:

11.0 REFERENCES

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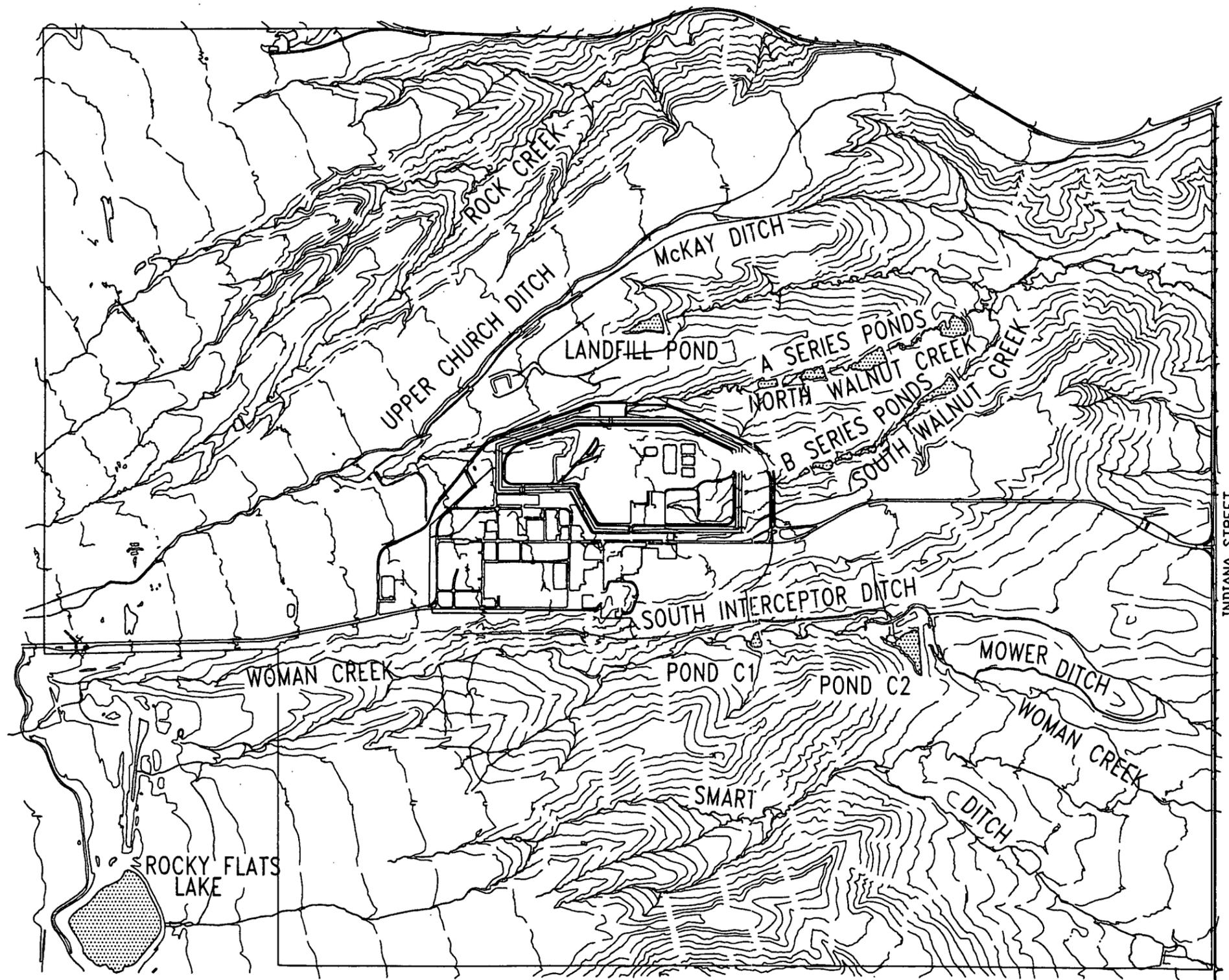
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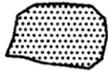
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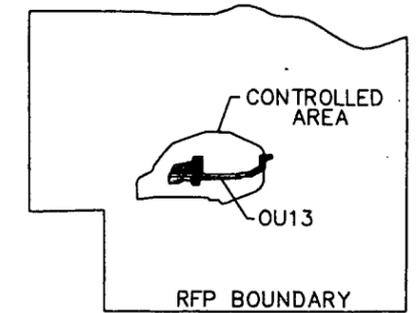
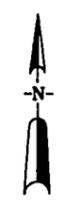
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EXPLANATION

-  CURRENT RFP WATER STORAGE FACILITIES
-  PAVED ROADS
-  STREAMS DITCHES DRAINAGE FEATURES

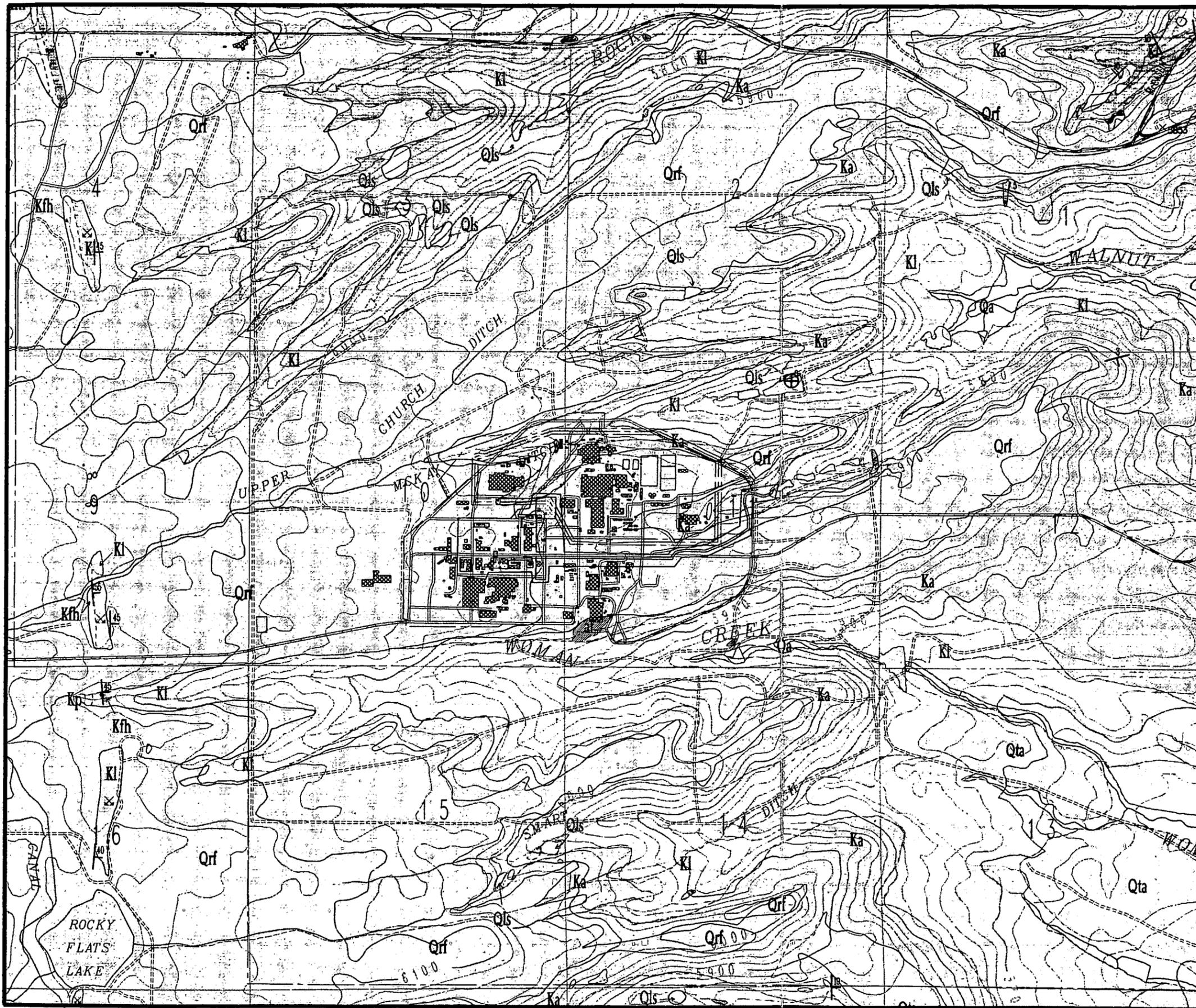


U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN

FIGURE 1-4

LOCATION OF SURFACE WATER FEATURES



EXPLANATION

- Artificial Fill (RECENT)
- Valley Fill Alluvium (RECENT)
- Landslide Slump (RECENT)
- Undiff. Terrace Alluvium (PLEISTOCENE)
- Rocky Flats Alluvium (PLEISTOCENE)
- Arapahoe Formation (CRETACEOUS)
- Laramie Formation (CRETACEOUS)
- Fox Hills Sandstone (CRETACEOUS)
- Pierre Shale (CRETACEOUS)

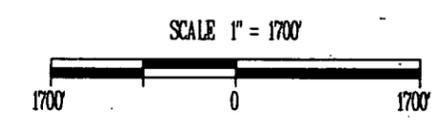
- Strike and dip of bedding planes in bedrock
- inclined
 - vertical
 - overturned
 - horizontal

- Gravel, sand, or clay pit
- BM Benchmark

- Area of bedrock exposure

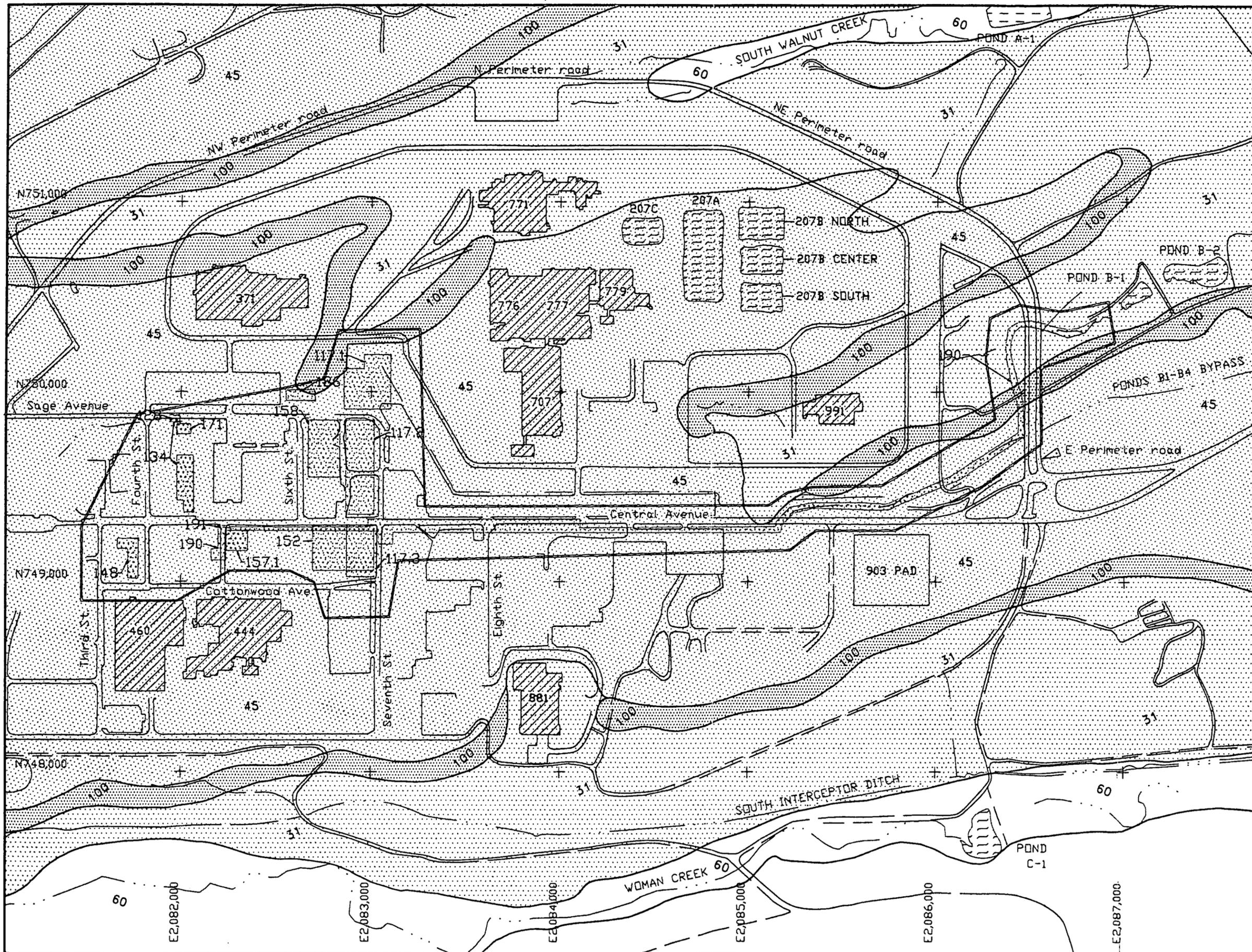
- Contact
dashed where approx located
dotted where concealed

From EG & G, 1992



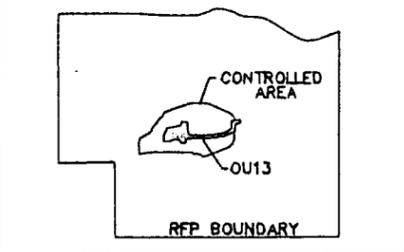
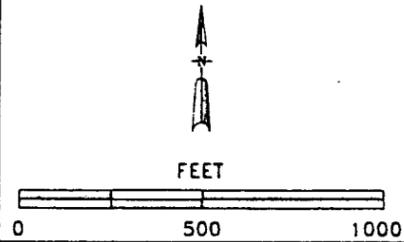
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Rocky Flats Plant, Golden, Colorado

FIGURE 1-9
SURFICIAL GEOLOGY
FOR THE
ROCKY FLATS PLANT



MAP LEGEND

-  OPERABLE UNIT
-  STREAMS DITCHES DRAINAGE FEATURES
-  PAVED ROADS
-  DIRT ROADS
-  SURFACE WATER IMPOUNDMENTS
-  BUILDINGS
-  INDIVIDUAL HAZARDOUS SUBSTANCE SITES
-  100 NEDERLAND
-  45 FLATIRONS
-  31 DENVER-KUTCH-MIDWAY
-  60 DOES NOT OCCUR WITHIN OU 13 BOUNDARY

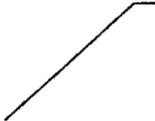


U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN

FIGURE 1-10
SOILS IN THE VICINITY
OF ROCKY FLATS PLANT
SOURCE:
SOIL CONSERVATION SERVICE, 1980.

LEGEND

-  FENCE
-  128  BUILDINGS
-  BUILDINGS

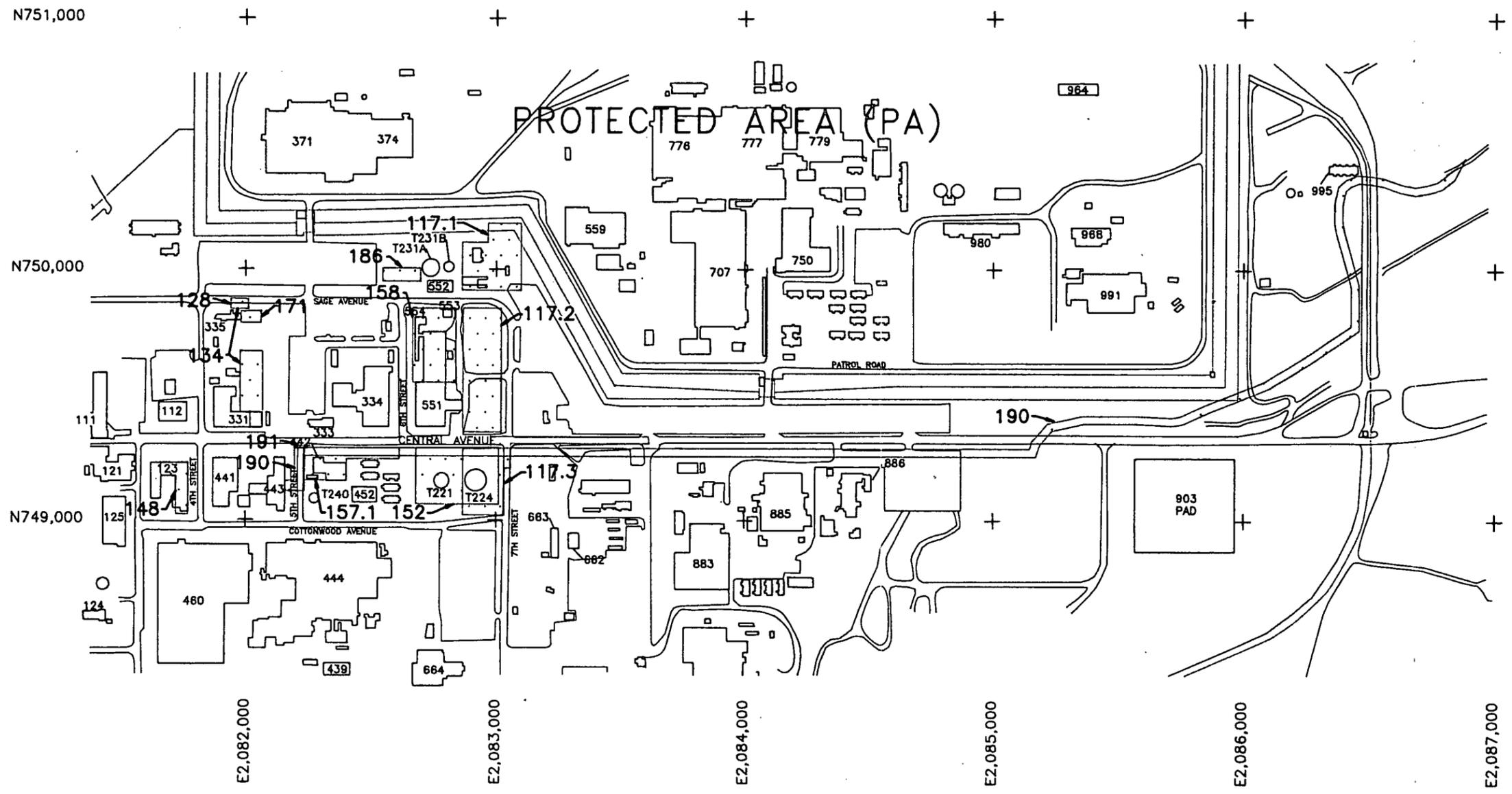


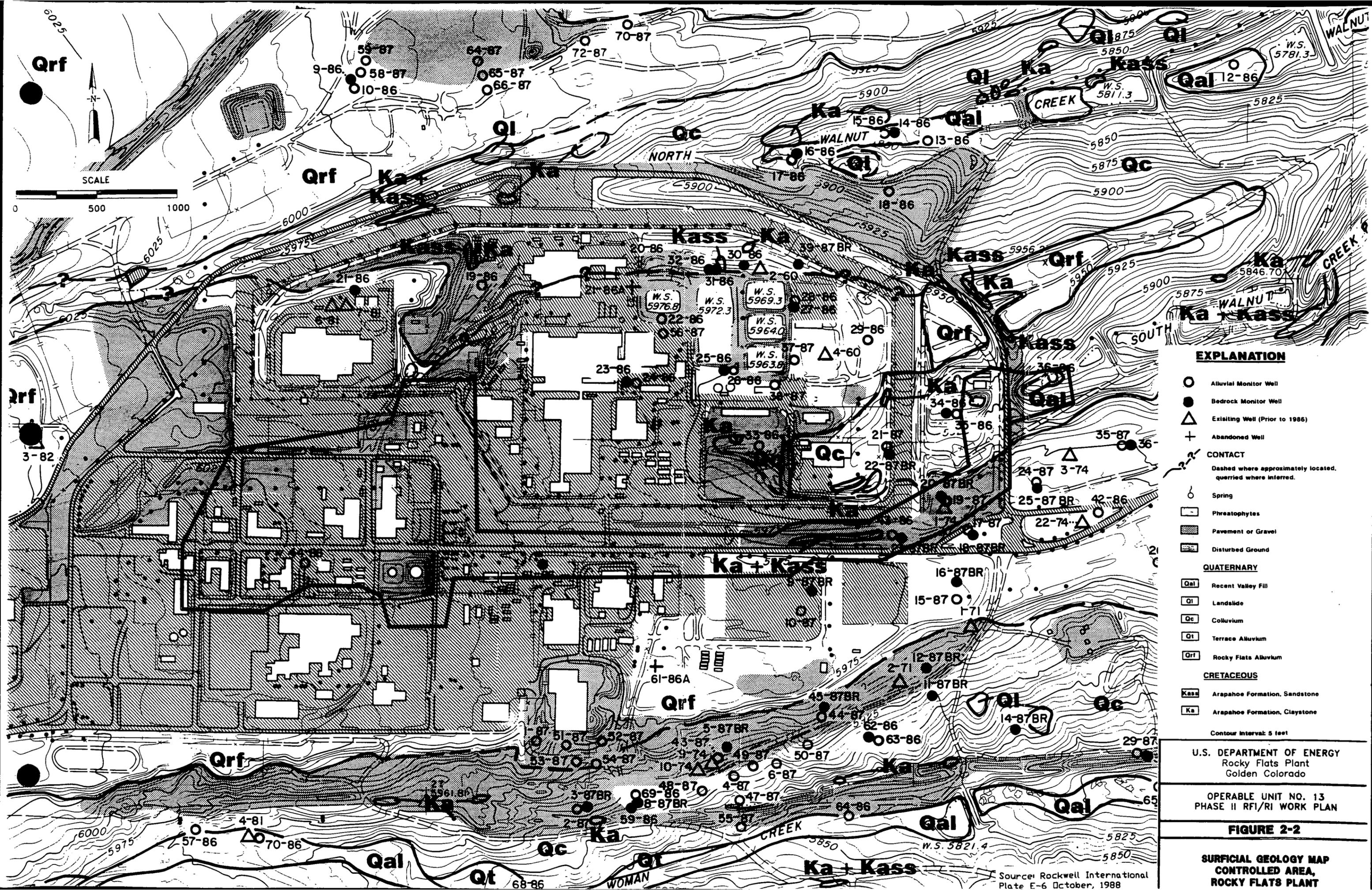
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN

FIGURE 2-1

**LOCATION OF BUILDINGS
AND IHSSs IN OU13**





EXPLANATION

- Alluvial Monitor Well
- Bedrock Monitor Well
- △ Existing Well (Prior to 1986)
- + Abandoned Well
- CONTACT
Dashed where approximately located, queried where inferred.
- ♂ Spring
- ▭ Phreatophytes
- ▨ Pavement or Gravel
- ▩ Disturbed Ground
- QUATERNARY**
- Qal Recent Valley Fill
- Ql Landslide
- Qc Colluvium
- Qt Terrace Alluvium
- Qrf Rocky Flats Alluvium
- CRETACEOUS**
- Kass Arapahoe Formation, Sandstone
- Ka Arapahoe Formation, Claystone
- Contour Interval: 5 feet

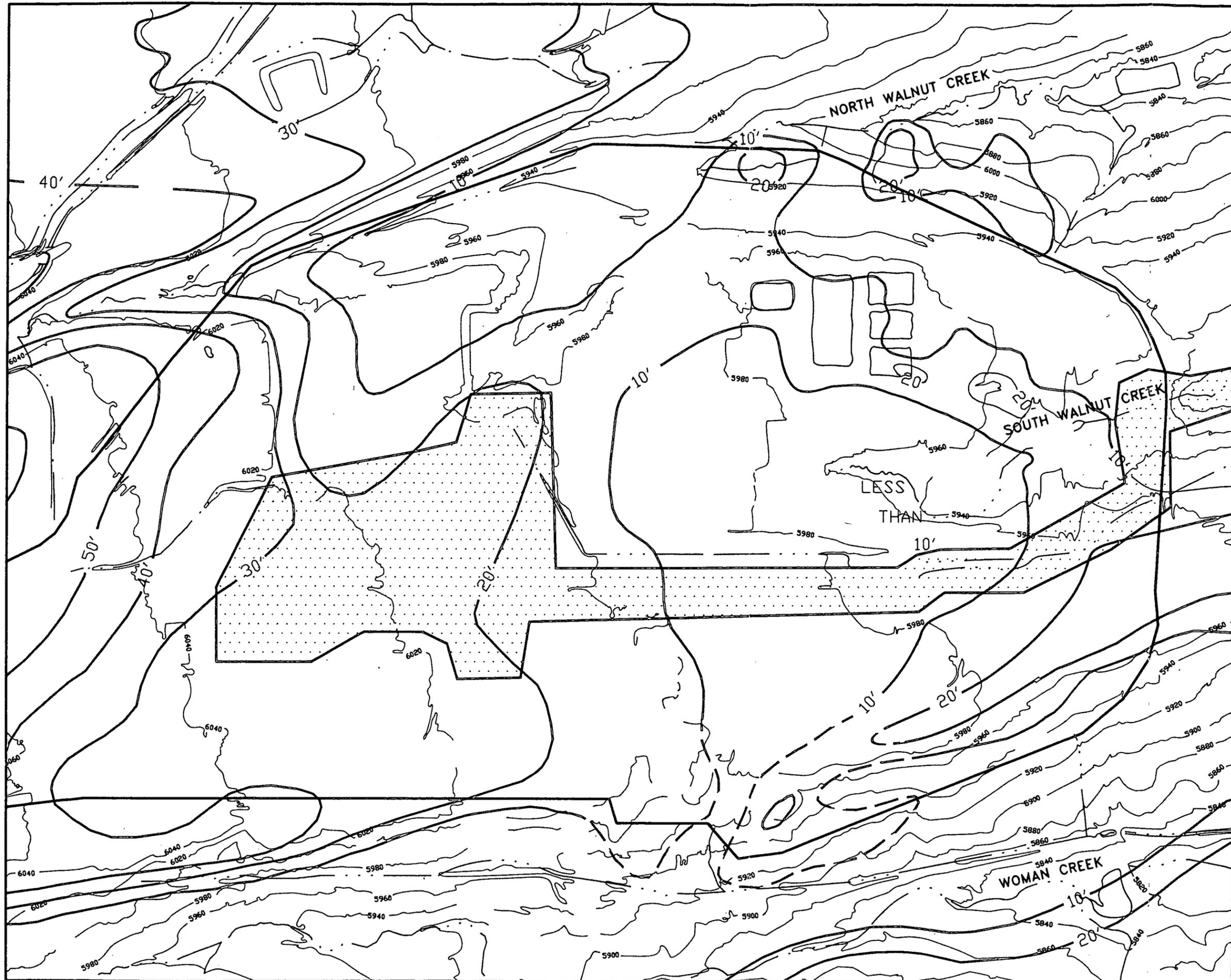
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 13
PHASE II RFI/RI WORK PLAN

FIGURE 2-2

**SURFICIAL GEOLOGY MAP
CONTROLLED AREA,
ROCKY FLATS PLANT**

Source: Rockwell International
Plate E-6 October, 1988

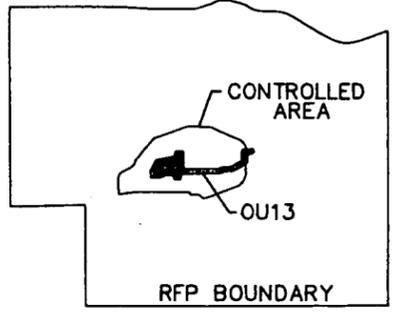
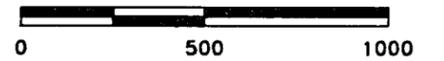


LEGEND

- 10' — ISOPACH FILL/ALLUVIUM
- 5860 — SURFACE ELEVATION (BROKEN WHERE INTERRUPTED BY BUILDINGS)
- CONTROLLED AREA
- — OU 13 BOUNDARY
- STREAMS DITCHES DRAINAGE FEATURES



SCALE

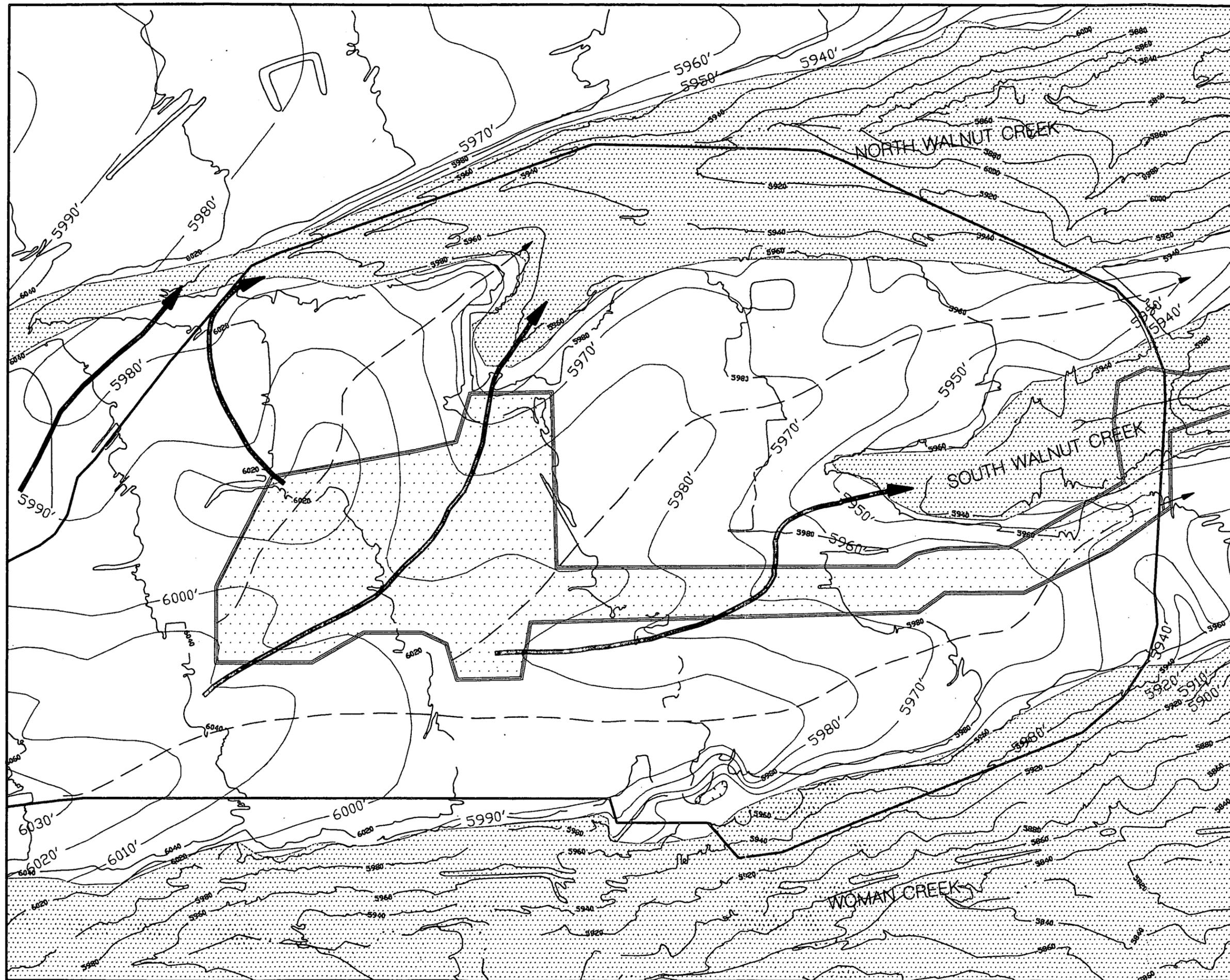


U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN

FIGURE 2-3

MAP OF TOPOGRAPHY AND ISOPACH OF SURFICIAL MATERIALS AT THE CONTROLLED AREA, ROCKY FLATS PLANT

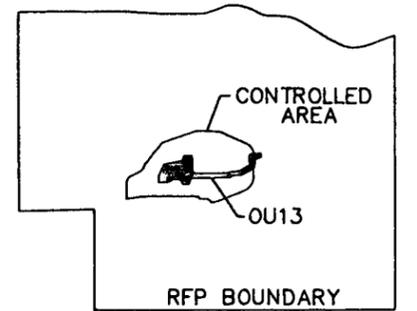


LEGEND

- 5940' — PEDIMENT ELEVATION
- 5880 — GROUND SURFACE ELEVATION
- PALEO RIDGE
- ➔ PALEO DRAINAGE
- ▭ OU 13 BOUNDARY
- CREEKS
- ▨ AREA SUBJECT TO EROSION AT PEDIMENT DUE TO LOSS OF ROCKY FLATS ALLUVIUM



SCALE

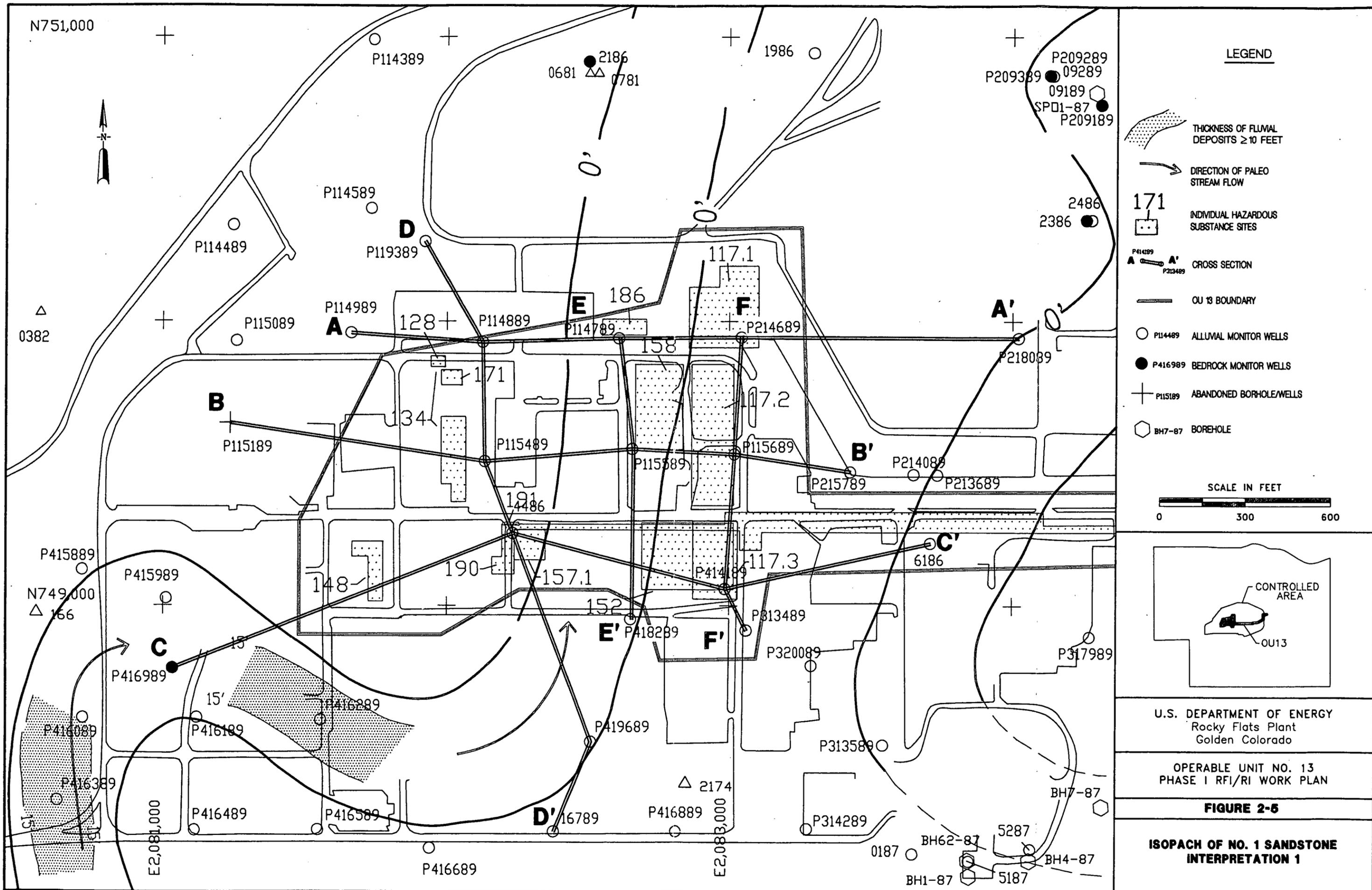


U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

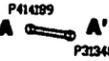
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PHASE I RFI/RI WORK PLAN

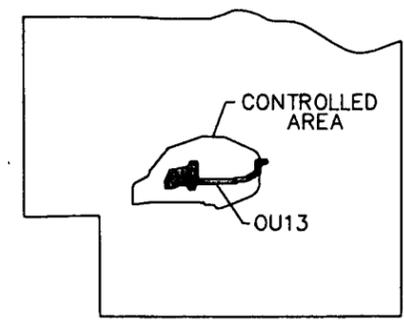
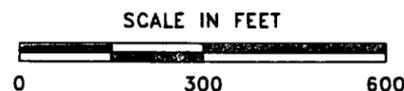
FIGURE 2-4

**MAP OF PRESENT-DAY TOPOGRAPHY
AND SUBSURFACE, PRESERVED
PRE-ROCKY FLATS ALLUVIUM
PEDIMENT SURFACE**



LEGEND

-  THICKNESS OF FLUVIAL DEPOSITS ≥ 10 FEET
-  DIRECTION OF PALEO STREAM FLOW
-  171 INDIVIDUAL HAZARDOUS SUBSTANCE SITES
-  P41489 P313489 CROSS SECTION
-  OU 13 BOUNDARY
-  P114489 ALLUVIAL MONITOR WELLS
-  P416989 BEDROCK MONITOR WELLS
-  P115189 ABANDONED BORHOLE/WELLS
-  BH7-87 BOREHOLE

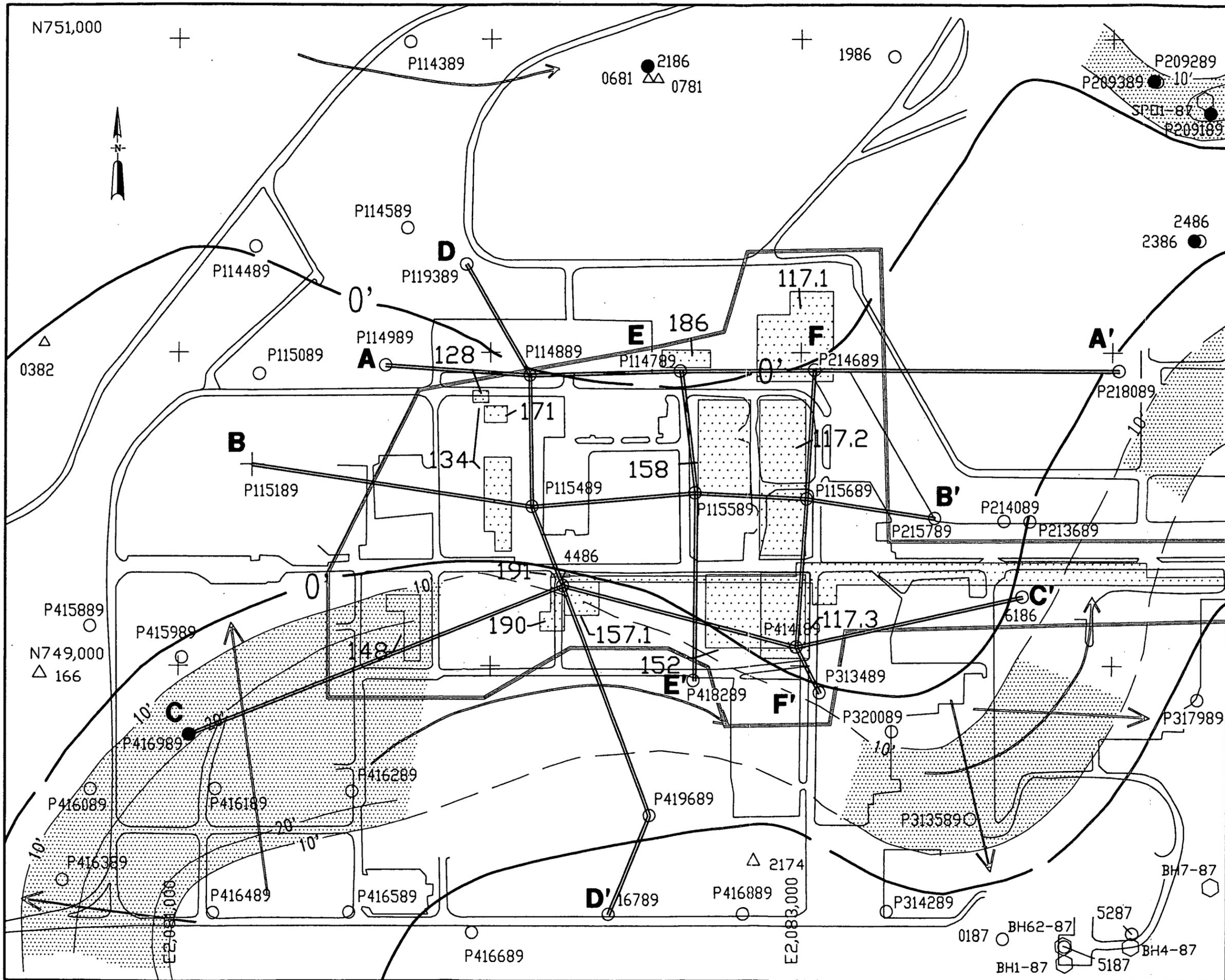


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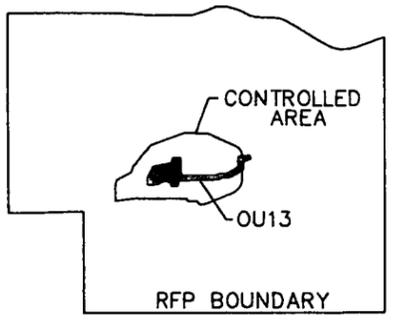
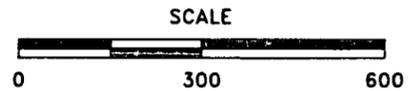
FIGURE 2-5

ISOPACH OF NO. 1 SANDSTONE INTERPRETATION 1



LEGEND

- THICKNESS OF FLUVIAL DEPOSITS ≥ 10 FEET
- DIRECTION OF PALEO STREAM FLOW
- DIRECTION OF CHANNEL AND POINT BAR MIGRATION
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- CROSS SECTION
- OU 13 BOUNDARY
- ALLUVIAL MONITOR WELLS
- BEDROCK MONITOR WELLS
- ABANDONED BOREHOLE/WELLS
- BOREHOLE

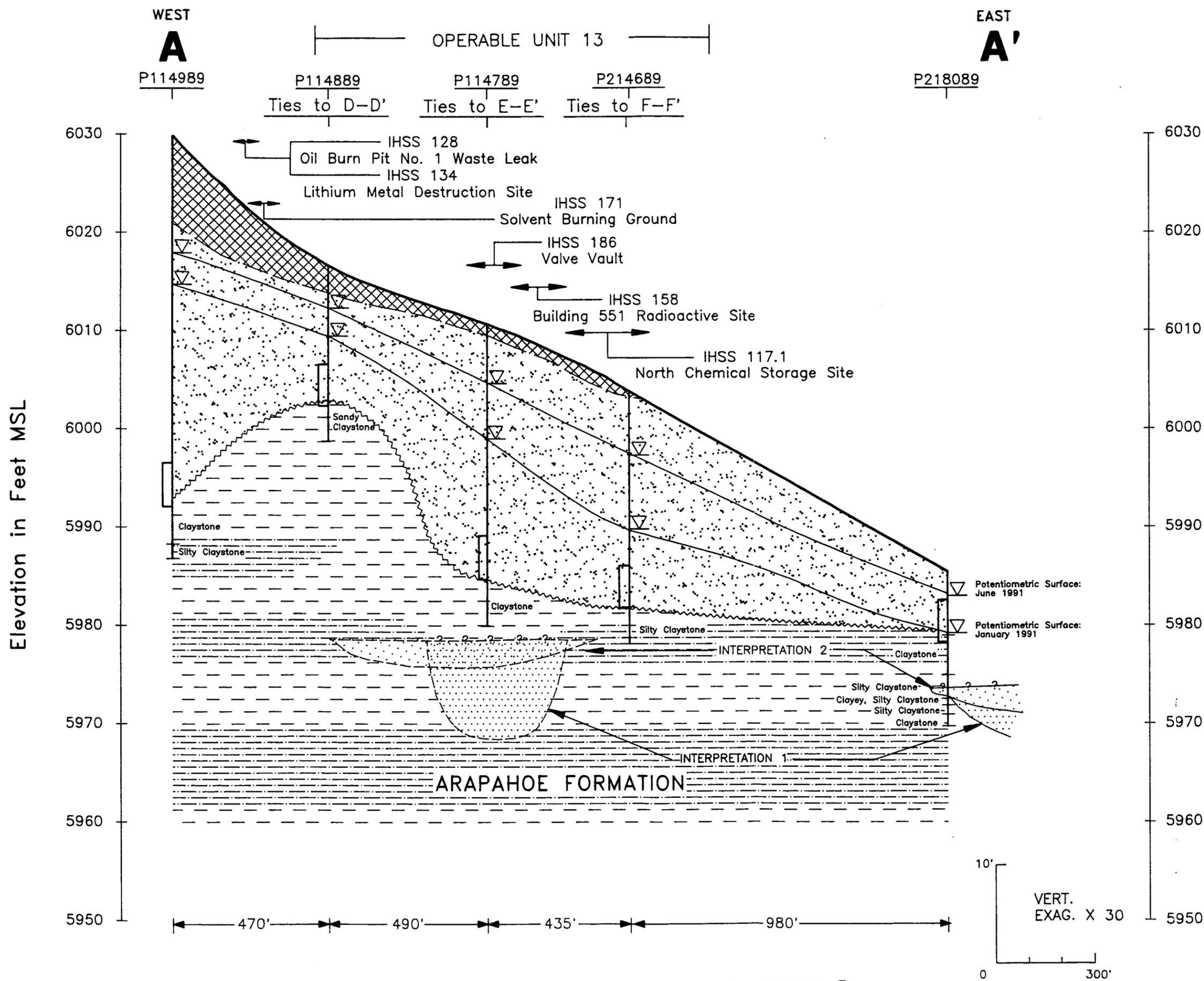


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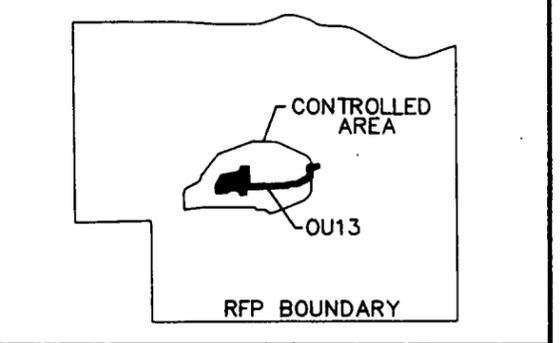
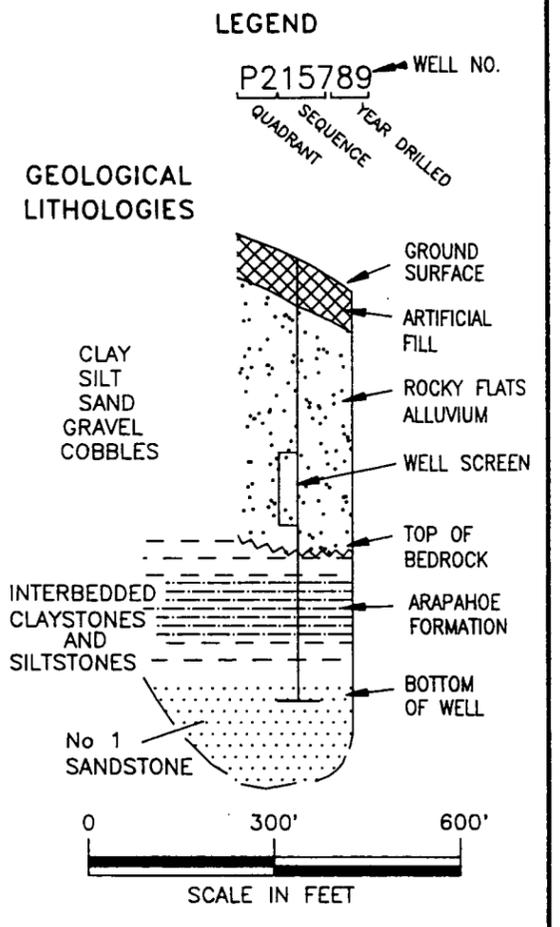
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FIGURE 2-6

**ISOPACH OF NO. 1 SANDSTONE
INTERPRETATION 2**



NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991) AND IS A CONCEPTUAL INTERPRETIVE MODEL.

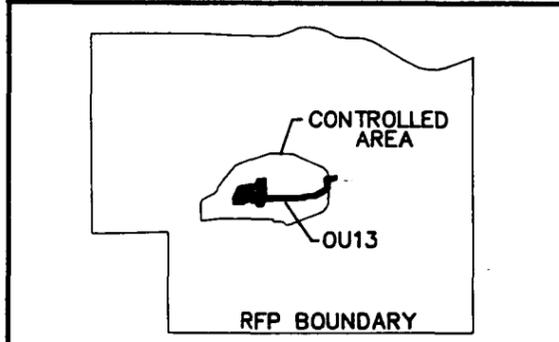
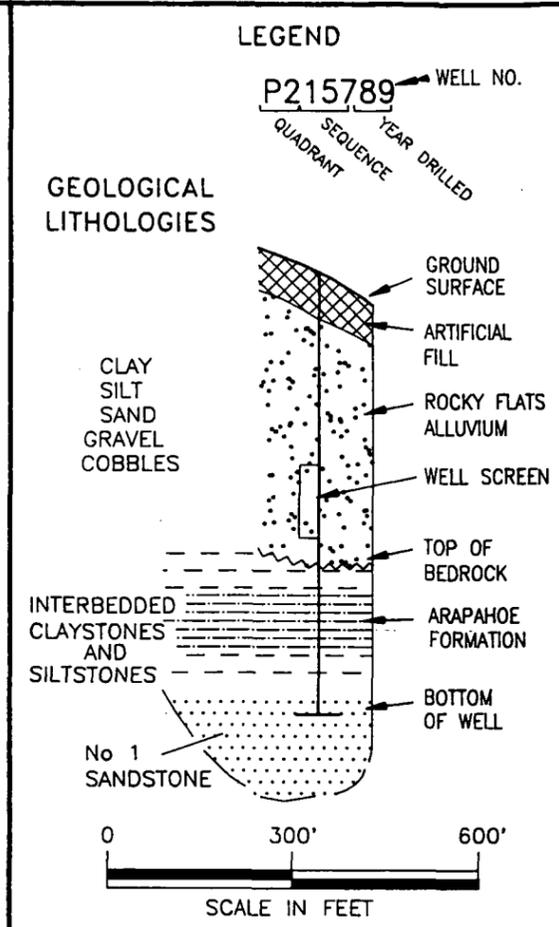
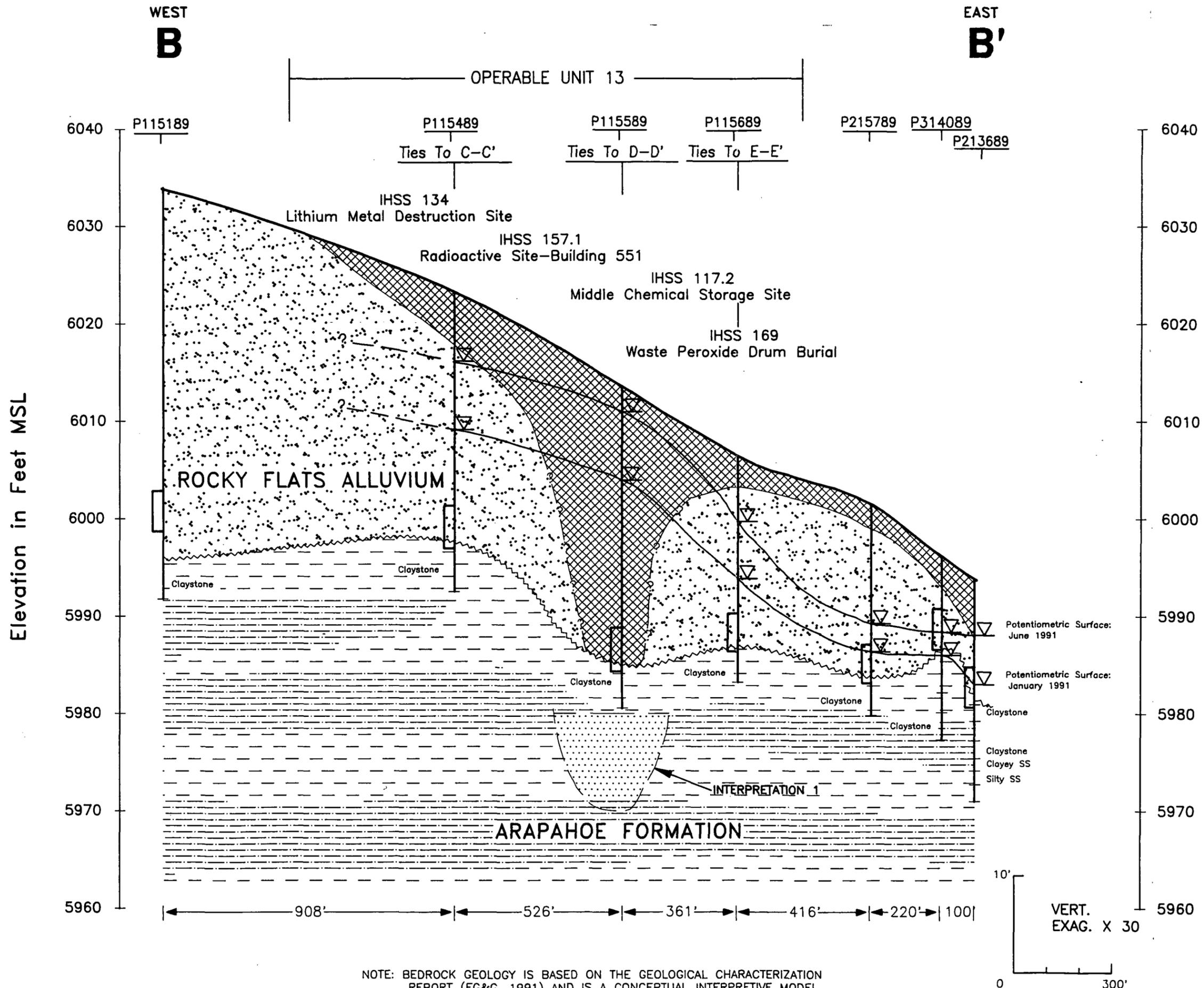


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FIGURE 2-7

**GEOLOGICAL CROSS-SECTION
A-A'**
Reference Figures 2-5 & 2-6



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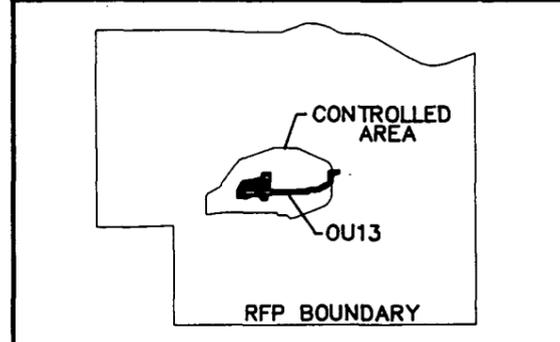
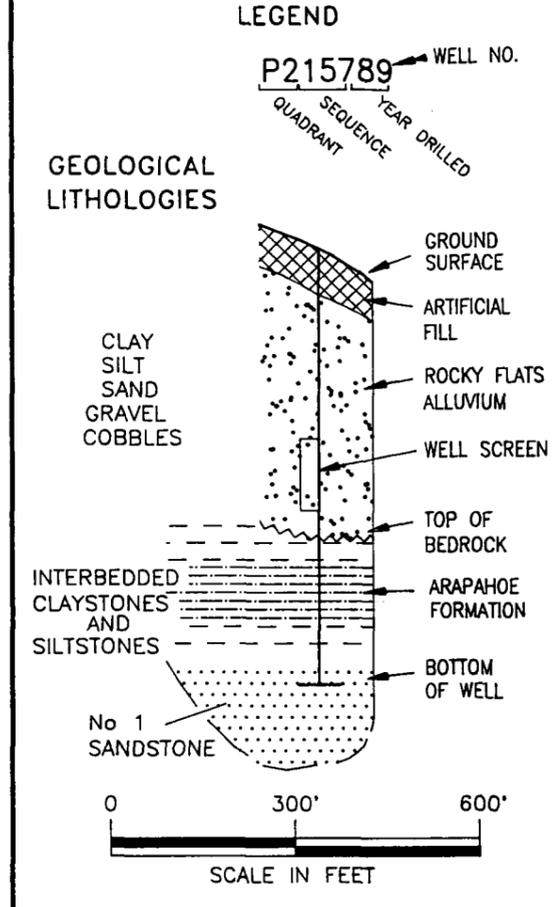
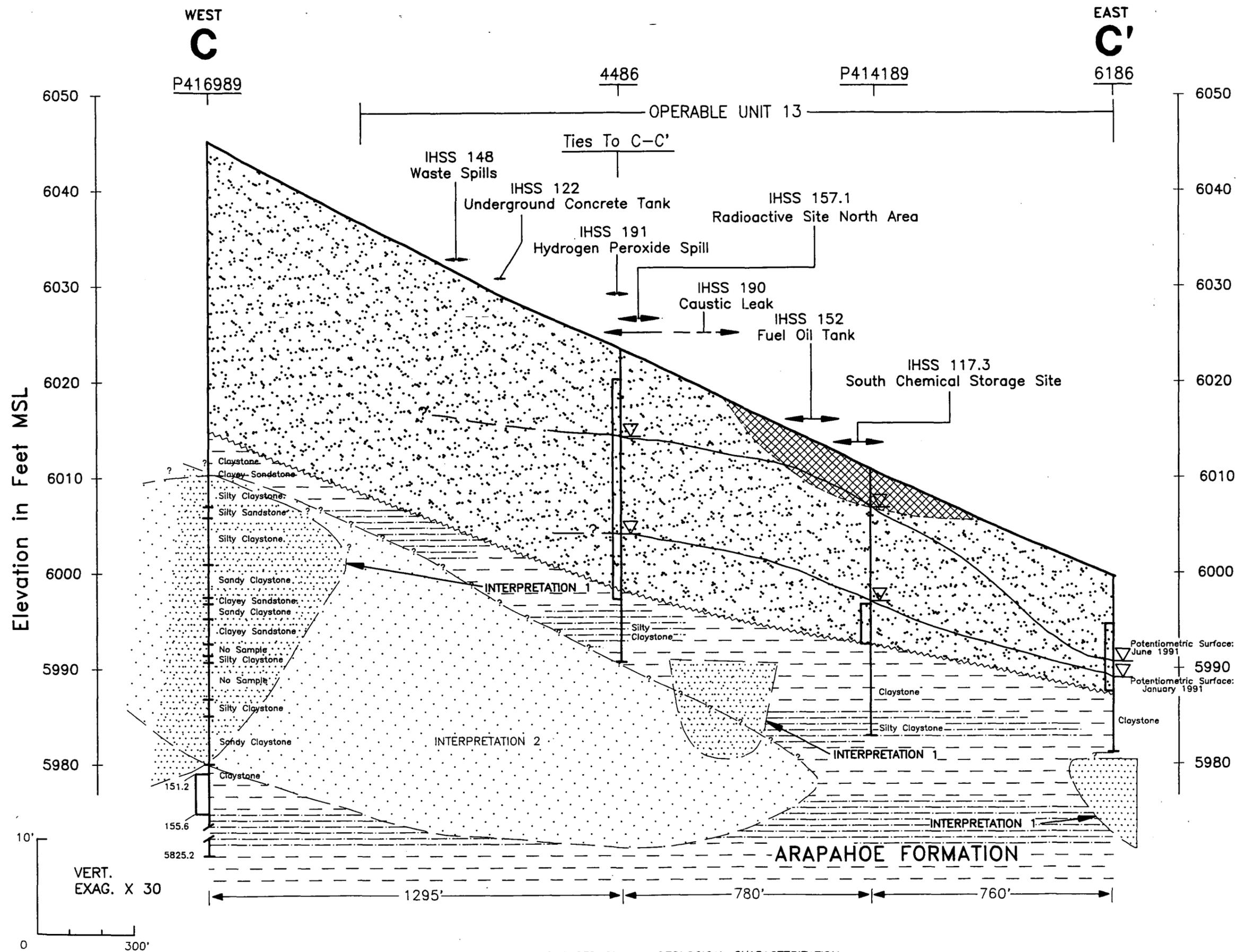
OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN

FIGURE 2-8

**GEOLOGICAL CROSS-SECTION
B-B'**

Reference Figures 2-5 & 2-6

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991) AND IS A CONCEPTUAL INTERPRETIVE MODEL.



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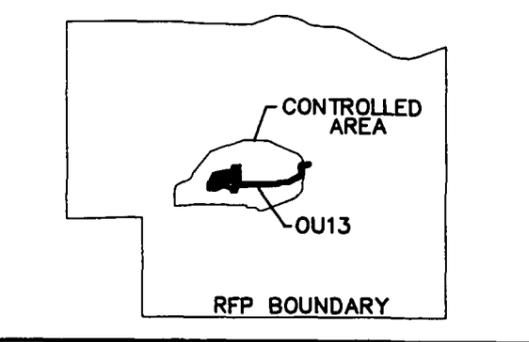
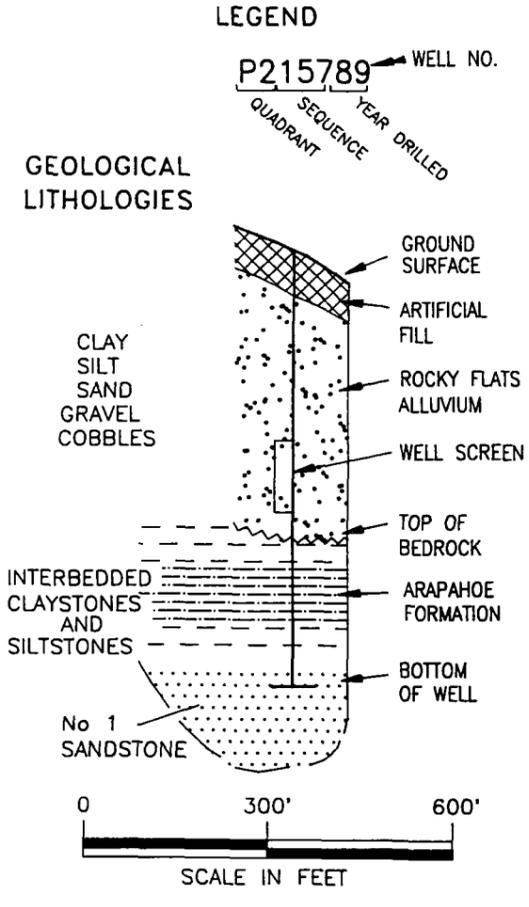
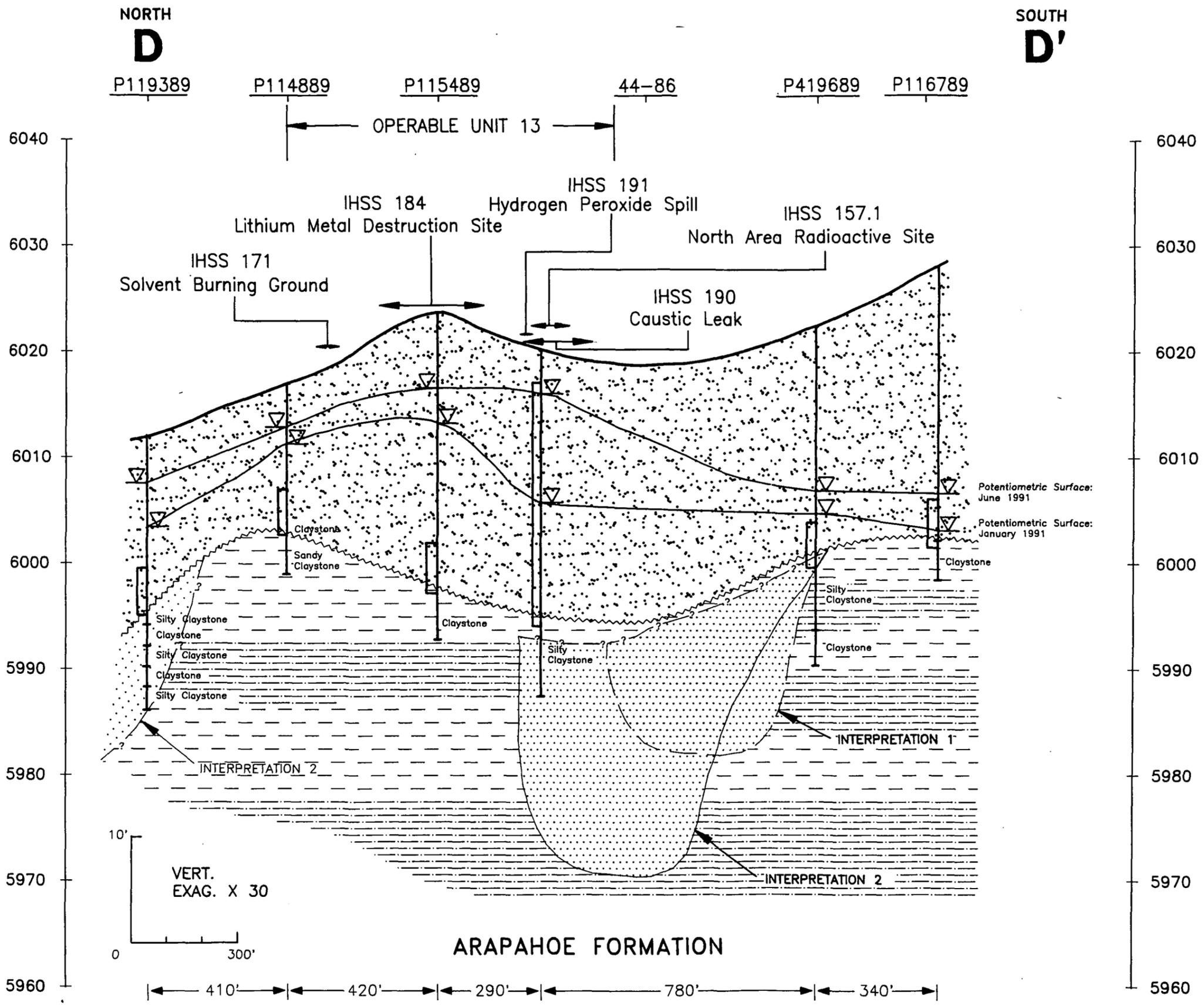
OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN

FIGURE 2-9

**GEOLOGICAL CROSS-SECTION
C-C'**

Reference Figures 2-5 & 2-6

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991) AND IS A CONCEPTUAL INTERPRETIVE MODEL.



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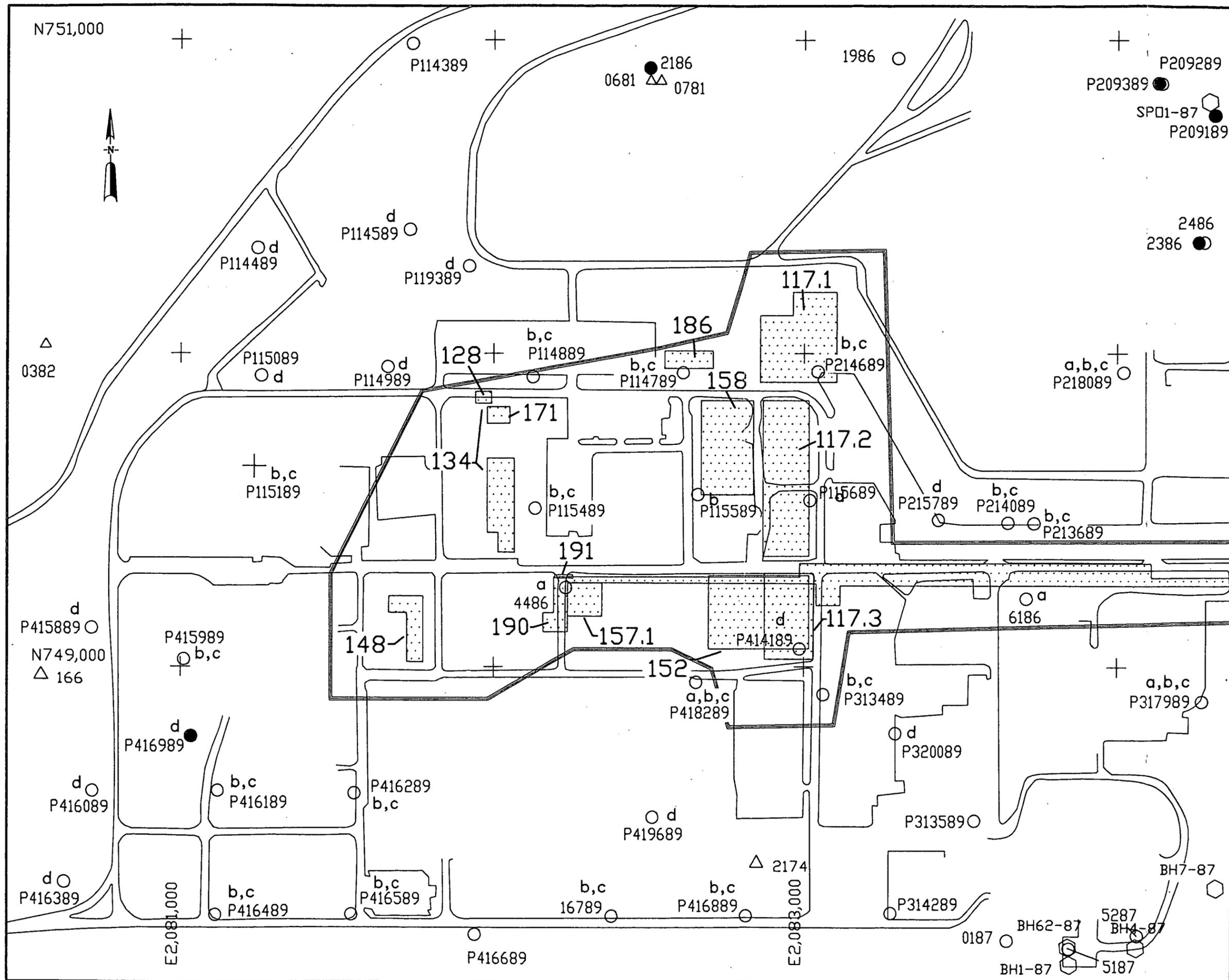
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FIGURE 2-10

**GEOLOGICAL CROSS-SECTION
D-D'**

Reference Figures 2-5 & 2-6

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991) AND IS A CONCEPTUAL INTERPRETIVE MODEL.



MAP LEGEND

171 INDIVIDUAL HAZARDOUS SUBSTANCE SITES

OU 13 BOUNDARY

a GROUNDWATER CHEMISTRY DATA

b BOREHOLE SAMPLE CHEMISTRY DATA FOR SURFICIAL MATERIALS

c BOREHOLE SAMPLE CHEMISTRY DATA FOR BEDROCK

d DATA REQUESTED BUT NONE IS AVAILABLE

THE ABSENCE OF ONE OF THE ABOVE IDENTIFIERS SIGNIFIES THAT NO DATA WAS REQUESTED FOR THIS WELL

ALLUVAL WELL/PIEZOMETER

BEDROCK WELL

BOREHOLE

SCALE

0 300 600

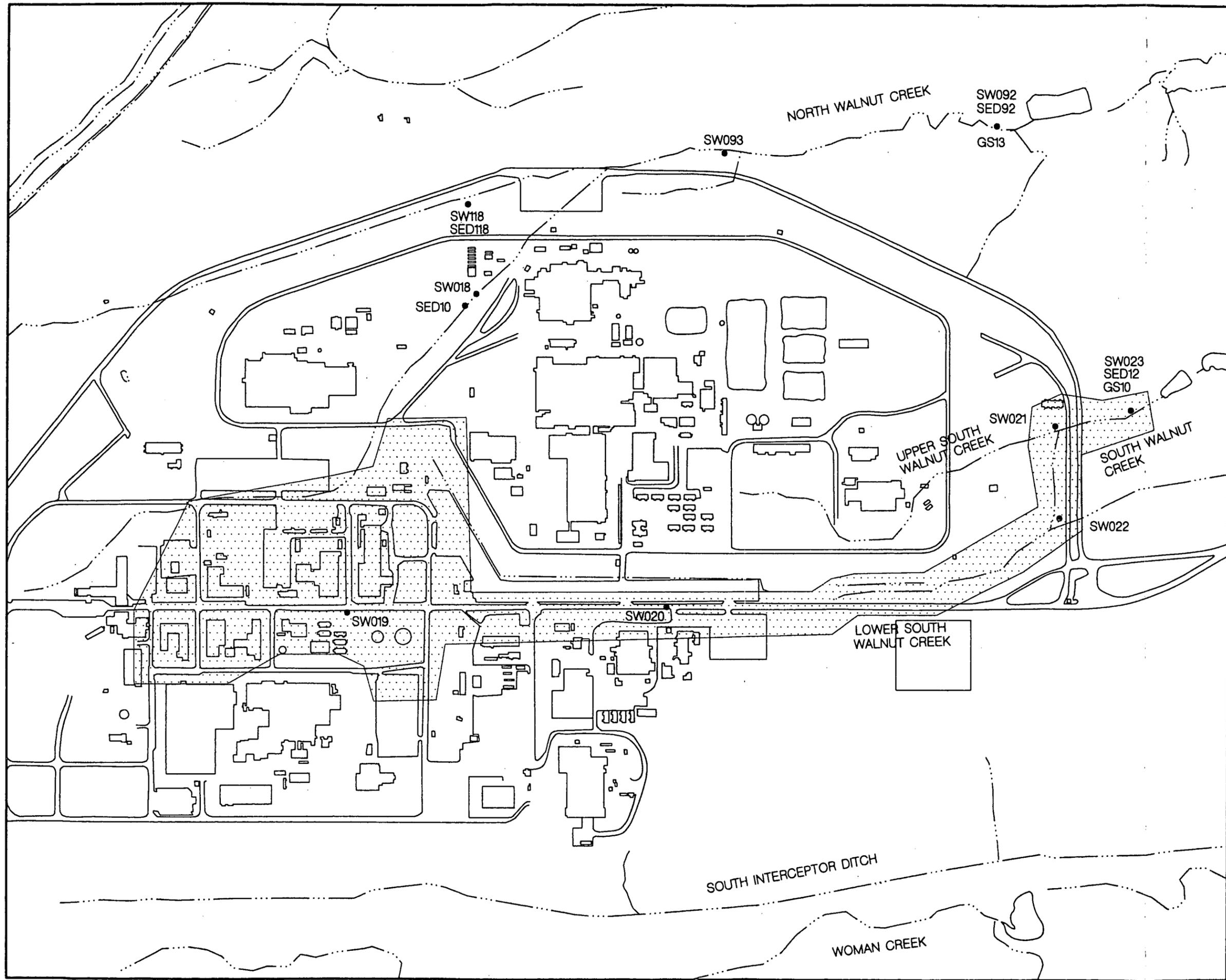
CONTROLLED AREA
OU13

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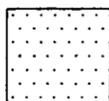
OPERABLE UNIT NO. 13
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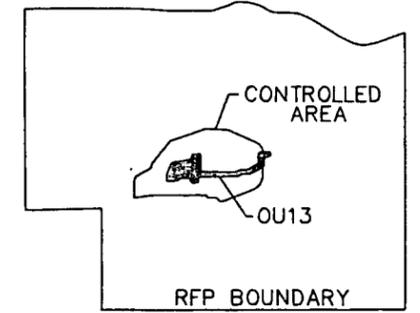
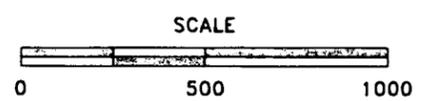
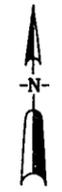
FIGURE 2-16

**TYPES OF ANALYTICAL DATA
AVAILABLE FOR
WELLS AND PIEZOMETERS**



LEGEND

-  PAVED ROADS
-  WATER
-  SITE LOCATIONS
-  OPERABLE UNIT 13

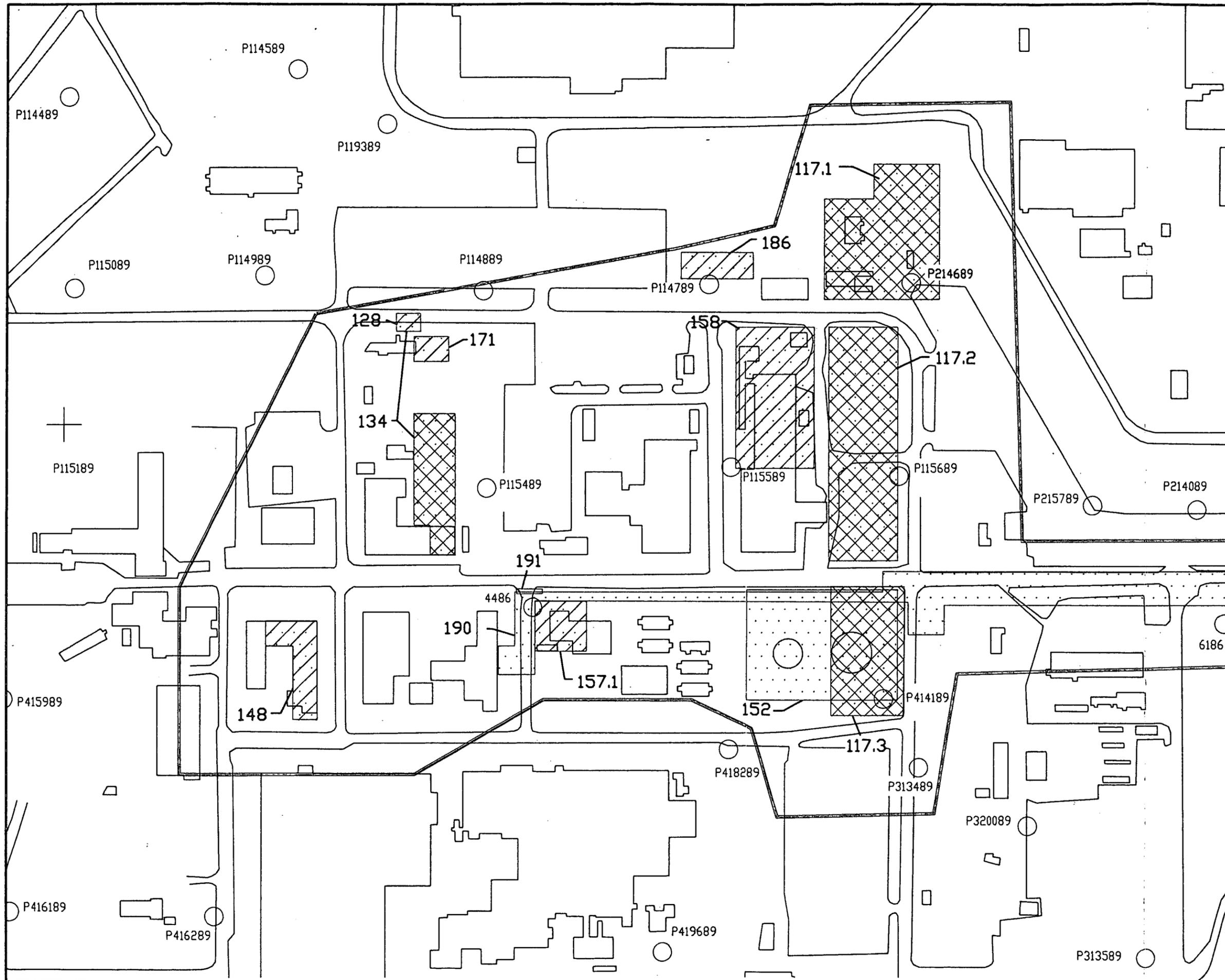


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FIGURE 2-24

**SURFACE WATER MONITORING
SITE LOCATION MAP**



LEGEND

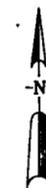
 GRID SPACING OF 10 FEET, ADJUSTED TO 2 FEET IF ELEVATED ACTIVITY LEVEL DETECTED

 GRID SPACING OF 20 FEET, ADJUSTED TO 2 FEET IF ELEVATED ACTIVITY LEVEL DETECTED

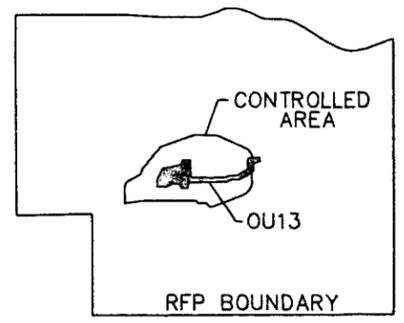
191
 INDIVIDUAL HAZARDOUS SUBSTANCE SITES

 OPERABLE UNIT 13 BOUNDARY

NOTE: FOR BUILDING NUMBERS REFER TO FIGURE 2-1



SCALE

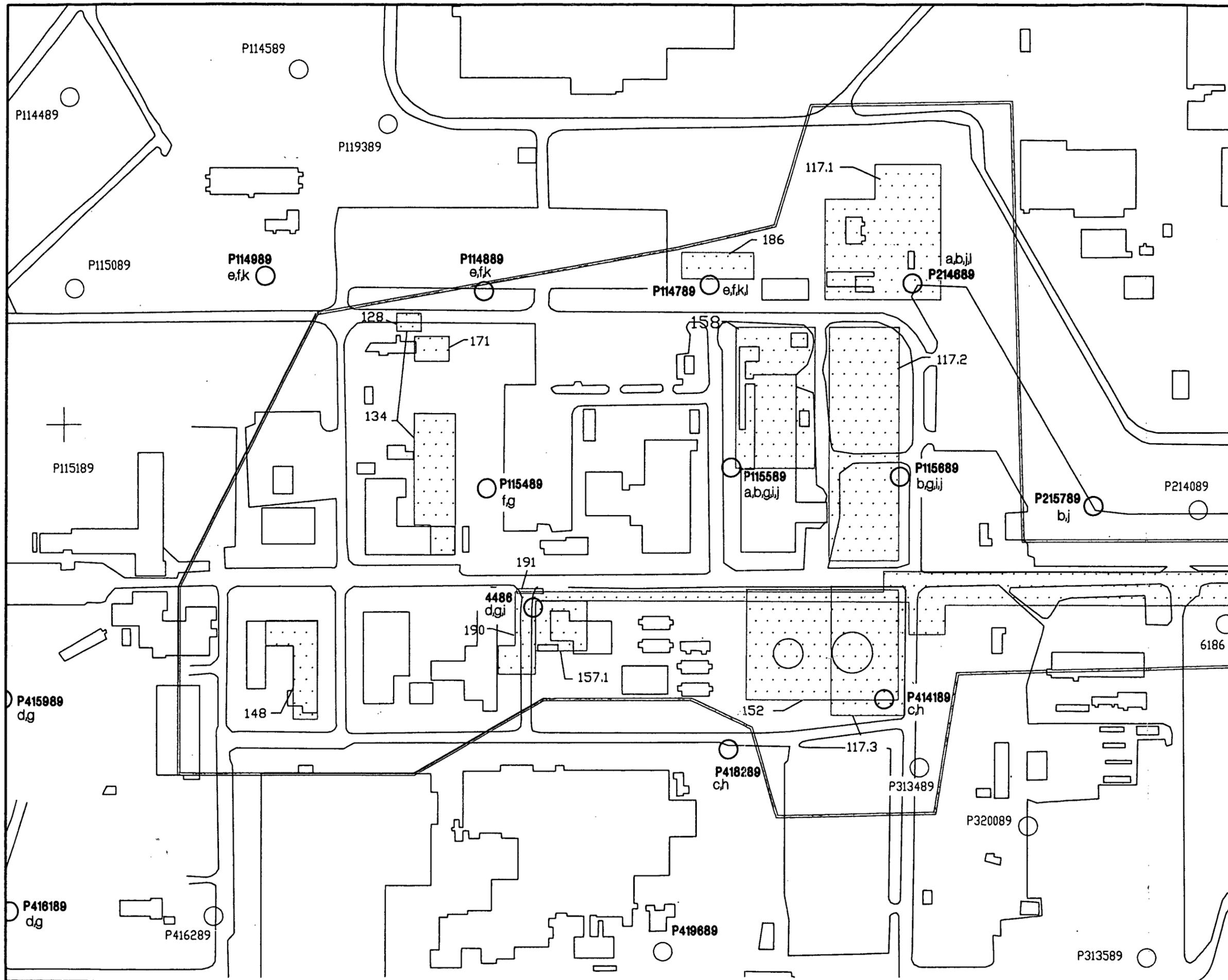


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FIGURE 6-2

**STAGE 1
RADIATION SURVEY GRID SIZES**

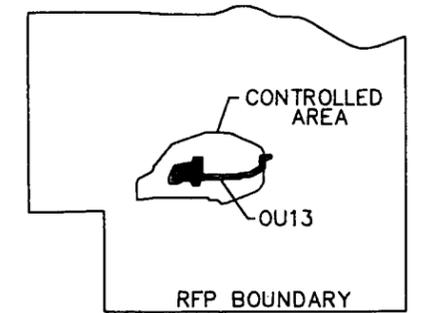
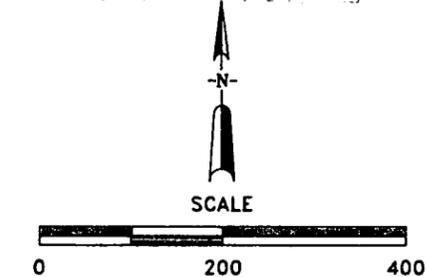


LEGEND

INDIVIDUAL HAZARDOUS SUBSTANCE SITES TO WHICH GROUNDWATER DATA MAY BE APPLICABLE

a	117.1	g	148
b	117.2	h	152
c	117.3	i	157.1
d	122	j	158
e	128	k	171
f	134	l	186

- 191 INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- OPERABLE UNIT 13
- 4486 EXISTING WELL OR PIEZOMETER TO BE SAMPLED DURING STAGE 1
- NOTE: FOR BUILDING NUMBERS REFER TO FIGURE 2-1

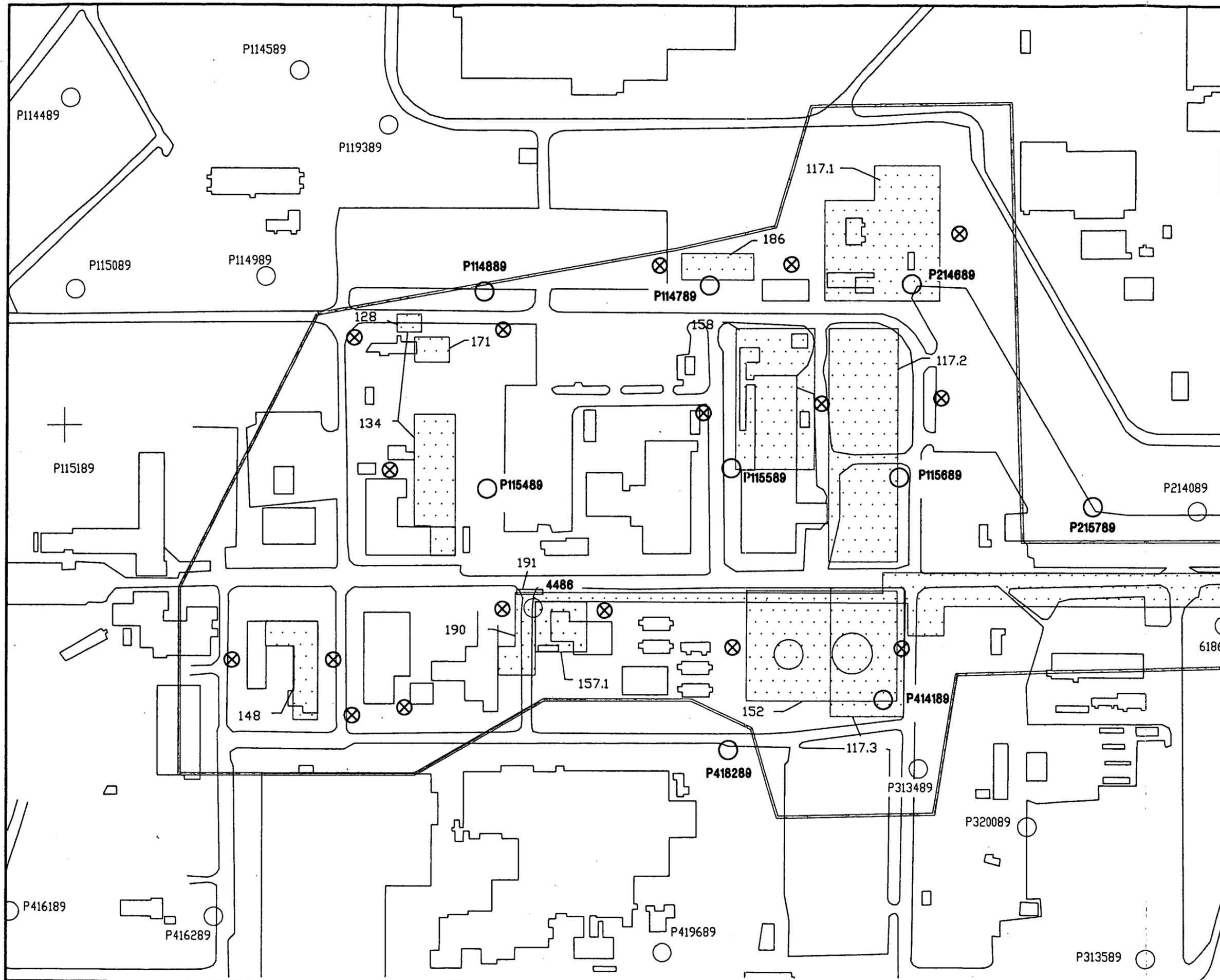


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PHASE I RFI/RI WORK PLAN

FIGURE 6-4

**STAGE 1
EXISTING GROUNDWATER MONITORING
WELLS AND PIEZOMETERS TO BE SAMPLED**



LEGEND

⊗ PRELIMINARY LOCATION OF ALLUVIAL GROUNDWATER MONITORING WELL TO BE INSTALLED IN STAGE 3

4486 ○ EXISTING WELL OR PIEZOMETER THAT MAY BE SAMPLED DURING STAGE 3

— OPERABLE UNIT 13 BOUNDARY

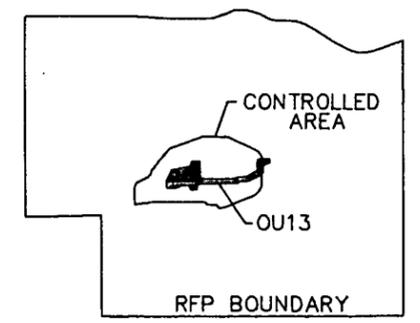
191 □ INDIVIDUAL HAZARDOUS SUBSTANCE SITES

NOTE: THE FINAL NUMBER AND LOCATION OF NEW WELLS TO BE INSTALLED OR EXISTING WELLS AND PIEZOMETERS TO BE SAMPLED WILL BE ESTABLISHED AFTER STAGE 2 HAS BEEN COMPLETED

NOTE: FOR BUILDING NUMBERS REFER TO FIGURE 2-1



SCALE



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FIGURE 6-6

**STAGE 3
PRELIMINARY LOCATIONS OF
GROUNDWATER MONITORING
WELLS/PIEZOMETERS**