NOTICE

All drawings located at the end of the document.

N. Stelmach

21100-WP-OU10.1

UNITED STATES OF AMERICA · DEPARTMENT OF ENERGY

EG&G

ROCKY FLATS

Phase I RFI/RI Work Plan Rocky Flats Plant other outside Closures OU10 Volume I Text 21100-WP-OU10.1

Rocky Flats Environmental Restoration Project

May, 1992

FINAL

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT
OTHER OUTSIDE CLOSURES
(OPERABLE UNIT NO. 10)

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

ENVIRONMENTAL RESTORATION PROGRAM

MAY, 1992

Volume I - Text

21100 - WP - OU10.1

APPROVED BY:

K. Bentzen 12/8/93

K. Bentzen, Director,
Environmental Quality Support

12/7/93

B. D. Peterman, Industrial Area Operable Unit
Manager, Remediation Project Management

12/7/93

G. A. Anderson, Operable Unit 10 Project
Manager, Remediation Project Management

for 7/Dec/93

W. S. Busby, Director,
Remediation Project Management

FINAL

PHASE I RFI/RI WORKPLAN

ROCKY FLATS PLANT
OTHER OUTSIDE CLOSURES
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U.S. DEPARTMENT OF
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Rocky Flats Plant
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ENVIRONMENTAL
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EXECUTIVE SUMMARY

This document presents the work plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RFI/RI) for Operable Unit 10 (OU10), Other Outside Closures at the Rocky Flats Plant (RFP). The objectives of the Phase I RFI/RI are to characterize OU10 source/soil contamination and to provide input to the baseline risk assessment. The present work plan is prepared to be consistent with the Interagency Agreement (IAG) between the DOE, the EPA, and the State of Colorado and the appropriate guidance documents where applicable. This work plan includes a Field Sampling Plan (FSP), Human Health Assessment Plan (HHRAP), and Environmental Evaluation Work plan (EEW).

The following Individual Hazardous Substance Sites (IHSSs) are included in OU10:

- Oil Leak (IHSS 129)
- P.U.&D. Storage Yard - Waste Spills (IHSS 170)
- P.U.&D. Container Storage Facilities (IHSS 174)
- S&W Building 980 Container Storage Facility (IHSS 175)
- S&W Contractor Storage Yard (IHSS 176)
- Building 885 Drum Storage Area (IHSS 177)
- Building 334 Cargo Container Area (IHSS 181)
- Building 444/453 Drum Storage Area (IHSS 182)
- Building 460 Sump #3 Acid Side (IHSS 205)
- Inactive D-836 Hazardous Waste Tank (IHSS 206)

- Inactive Building 444 Acid Dumpsters (IHSS 207)
- Inactive 444/447 Waste Storage Area (IHSS 208)
- Unit 16, Building 980 Cargo Container (IHSS 210)
- Unit 15, 904 Pad Pondcrete Storage (IHSS 213)
- Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214).

The work plan provides an overview of RFP including historical background, environmental setting, geology, and hydrology. Initial evaluation of OU10 includes site locations and histories, descriptions of site physical characteristics, and summaries of previous investigations and contaminants detected. The work plan also includes conceptual models of each type of IHSS that describe potential sources of contamination and types of contaminants, release mechanisms, and known and potential exposure pathways. Identification of potential receptors is discussed in the HHRAP and EEW. The conceptual models assist in identifying sampling needs addressed in the FSP and preliminary identification of possible remedial alternatives.

The initial evaluation of surficial soils data collected previously at some of the IHSSs indicates that none of the data are validated or usable for the baseline risk assessment. These data are used only for planning the RFI/RI field program.

Stage 1 will consist of field screening of sources and soil contamination for both radiological and nonradiological parameters. In addition, a limited number of surficial soil samples will be collected at certain IHSSs to assess nonradiological data variability. The FSPs for subsequent investigative stages will be developed in technical memoranda.

Stages 2 and 3 are planned to include collection of asphalt/concrete samples, soil borings, and additional surficial soil samples to investigate the presence or absence of source/soil contamination and then delineate this contamination. Stage 4 will include any additional soil sampling and collection of sediment, surface water, and screening level groundwater samples use in planning Phase II. Tensiometers or equivalent may be installed during Stage 4 as needed. Piezometers may also be recommended to support Phase II planning.

Surficial soil locations will be both random and deterministic. The number of samples to be collected at each IHSS in Stage 1 has been estimated to provide sufficient data for a variability analysis. This analysis will be used to calculate the number of additional samples that may be required to provide a statistically significant database.

During Stage 1, radiation surveys will be conducted at ten IHSSs and soil gas surveys will be conducted at nine IHSSs. Approximately 197 surficial soil samples and three tank samples will be collected. Test pits will be excavated at one IHSS for the collection of soil samples from around underground piping and tanks.

1.0 INTRODUCTION

This document presents the work plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RFI/RI) for Operable Unit 10 (OU10), Other Outside Closures, at the Rocky Flats Plant (RFP) in Jefferson County, Colorado. This investigation is part of a comprehensive, phased program of site characterization, RFI/RIs, corrective measure studies/feasibility studies (CMS/FSs), and remedial/corrective actions currently in progress at RFP. These investigations are pursuant to an Interagency Agreement (IAG) among the U.S. Department of Energy (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 CERCLA issues. Although the IAG requires general compliance with both RCRA and CERCLA, CDH is the lead agency for OU10. 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," respectively. Also in accordance with the IAG, the term "Individual Hazardous Substance Site" (IHSS) is equivalent to the term "Solid Waste Management Unit" (SWMU).

OU10 is one of 16 OUs units listed for investigation by the IAG (Table 1-1). OU10 contains 15 IHSSs which are also listed in Table 1-1. Figure 1.0-1 shows the locations of the RFP IHSSs. IHSSs were defined from Appendix I, 3004(u) Waste Management Units, of the RCRA Part B permit application, Rev. No. 1, DOE - Rocky Flats Plant, dated December 15, 1987 (Table 2 was revised by the facility [Rev. No. 2], and is dated April 13, 1988); Appendix I, 3004(u) Waste

Table 1-1 Operable Units and Individual Hazardous Substance Sites Included in the IAG

OU Number	OU Name	Individual Hazardous Substance Sites
1	881 Hillside	102, 103, 104, 105.1, 105.2, 106, 107, 119.1, 119.2, 130, 145
2	903 Pad, Mound, and East Trenches	108, 109, 110, 111.1, 111.2, 111.3, 111.4, 111.5, 111.6, 111.7, 111.8, 112, 113, 140, 153, 154, 155, 183, 216.2, 216.3
3	Off-Site Releases	199, 200, 201, 202
4	Solar Ponds	101
5	Woman Creek	115, 133.1, 133.2, 133.3, 133.4, 133.5, 133.6, 142.10, 142.11, 209
6	Walnut Creek	141, 142.1, 142.2, 142.3, 142.4, 142.5, 142.6, 142.7, 142.8, 142.9, 142.12, 143, 156.2, 165, 166.1, 166.2, 166.3, 167.1, 167.2, 167.3, 216.1
7	Present Landfill	114, 203
8	700 Area	118.1, 118.2, 123.1, 135, 137, 138, 139.1, 139.2, 144, 150.1, 150.2, 150.3, 150.4, 150.5, 150.6, 150.7, 150.8, 151, 163.1, 163.2, 172, 173, 184, 188
9	Original Process Waste Lines	121, 122, 123.2, 124, 124.1, 124.2, 124.3, 125, 126.1, 126.2, 127, 132, 146.1, 146.2, 146.3, 146.4, 146.5, 146.6, 147.1, 149, 159, 215
10	Other Outside Closures	129, 170, 174, 175, 176, 177, 181, 182, 205, 206, 207, 208, 210, 213, 214
11	West Spray Field	168
12	400/800 Area	116.1, 116.2, 120.1, 120.2, 136.1, 136.2, 136.3, 147.2, 157.2, 187, 189
13	100 Area	117.1, 117.2, 117.3, 128, 134, 148, 152, 157.1, 158, 169, 171, 186, 190, 191
14	Radioactive Sites	131, 156.1, 160, 161, 162, 164.1, 164.2, 164.3
15	Inside Building Closures	178, 179, 180, 204, 211, 212, 217
16	Low-Priority Sites	185, 192, 193, 194, 195, 196, 197

Management Units, transuranic mixed wastes RCRA Part B permit application, dated July 1, 1988; the Comprehensive Environmental Assessment and Response Program, Phase I (DOE 1991a); and the draft Historical Release Report (HRR). The environmental impact from activities proposed under this plan will be very minor. Drilling and sampling is expected to receive a categorical exclusion. No impacts are expected on soil, groundwater, or surface water. Therefore, the National Environmental Protection Act (NEPA) requirements for an environmental assessment or environmental impact statement (EIS) are not triggered.

As required by the IAG (Attachment 2, I.B. 11.6), this Phase I work plan addresses characterization of source materials and soils at the OU10 IHSSs. A subsequent Phase II RFI/RI will investigate the nature and extent of surface water, groundwater, sediment, biota, and air contamination and evaluate potential contaminant migration pathways.

This work plan was prepared in accordance with CERCLA, the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), RCRA, and applicable Colorado state law and is consistent with the IAG and the following guidance documents where applicable:

- EPA, Compendium of Superfund Field Operations Methods, September 1987a
- EPA, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. OSWER Directive 9355.3-01, October 1988
- EPA, RCRA Facility Investigation Guidance, Interim Final. May 1989a
- EPA, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846. October 1986
- EPA, Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual. OSWER Directive 9285.701A, July 1989c

- EPA, Interim Final Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual. EPA/540/1-89/001, March 1989b

- EPA, Assessment of Errors in the Sampling of Soils. EPA/600/4-90/013, 1990a

- EPA, Data Quality Objectives for Remedial Response Activities: Development Process. Office of Emergency and Remedial Response. EPA/540/G-87/003, 1987b

- EPA, Data Quality Objectives for Remedial Response Activities, Example Scenario: RI/FS Activities at a Site with Contaminated Soil and Ground Water. Office of Emergency and Remedial Response. EPA/540/G-87/004, 1987c

- EPA, Report on Minimum Criteria to Assure Data Quality. EPA/530-SW-90-021, 1989d

- EPA, Guidance for Data Useability in Risk Assessment Interim Final. Office of Emergency and Remedial Response. EPA/540/G-90/008, 1990b

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 (Remedial Investigations) includes planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites and evaluate potential contaminant migration pathways. Phase 3 (Feasibility Studies) includes evaluation of remedial alternatives and development of remedial action plans to mitigate environmental problems identified in Phase 2 as needing correction. Phase 4 (Remedial Design/Remedial Action) includes design and implementation of site-specific remedial actions selected on the basis of Phase 3 FSs. 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 ER Program has been completed at RFP, and Phase 2 is currently in progress for OU10.

1.2 WORK PLAN OVERVIEW

This work plan presents an evaluation and summary of previous data and investigations, defines data quality objectives (DQOs) and data needs based on that evaluation, specifies Phase I RFI/RI tasks, and presents the Field Sampling Plan (FSP) for the Phase I RFI/RI. Also included in the work plan are a Baseline Risk Assessment Plan (BRAP), which consists of a human health risk assessment plan and an environmental evaluation plan (EEW), and Quality Assurance Addendum (QAA). The Health and Safety Plan for this work will be issued as a separate document. The RFP sitewide Quality Assurance Project Plan (QAPjP) provided guidance for the preparation of these plans. The RFP-wide Community Relations Plan (CRP), which is not a part of this document, was released in November 1991.

Section 2.0 (Site Characterization) presents a conceptual model of each IHSS, based on a comprehensive review and detailed analysis of all available historical information, previous site investigations, site geology and hydrology, and available data on the nature and extent of contamination in soils, groundwater, surface water, and sediments. Section 3.0 presents potential sitewide Applicable or Relevant and Appropriate Requirements (ARARs), as required by the IAG, and a discussion of their applicability to RFI/RI activities at OU10. Section 4.0 discusses the DQOs and work plan rationale for the Phase I RFI/RI. Section 5.0 specifies tasks to be performed for the Phase I RFI/RI. Section 6.0 presents the schedule for performing of Phase I RFI/RI activities.

The FSP, presented in Section 7.0, describes the sampling program necessary to determine the nature and extent of contamination, evaluate remedial alternatives, provide data for the HHRA, and provide data for the environmental evaluation (EE). The FSP also describes sampling objectives, sampling locations and frequencies, sample designation, sampling equipment and procedures, and sample handling and analysis.

The HHRAP, presented in Section 8.0, specifies the techniques and methodology necessary to identify and characterize the toxicity of all hazardous and radioactive substances found present in the sources/soils at the OU10 IHSS, to evaluate the potential for human exposure to these substances, and evaluate the risk of potential threats to human health from these substances. The HHRA and EE will provide the justification for performing Corrective/Remedial Actions.

Section 9.0 presents the general EE approach employed at RFP. It describes the way in which the EE will be conducted at OU10 and presents a detailed FSP for work plan implementation. Due to the disturbed and developed nature of OU10, many of the specified EE activities will be reduced in scope.

Section 10.0 contains the QAA. This section describes quality assurance/quality control (QA/QC) requirements specific to the OU10 investigation.

1.3 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

1.3.1 Facility Background and Plant Operations

RFP is a government-owned, contractor-operated facility that is part of the nationwide nuclear weapons production complex. The plant was operated for the U.S. Atomic Energy Commission (AEC) from its inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for 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 facility from 1951 until June 30, 1975. Rockwell International was the prime operating contractor from July 1, 1975, until December 31, 1989. EG&G Rocky Flats, Inc. became the prime contractor on January 1, 1990.

The primary RFP mission is to produce components for nuclear weapons. Plutonium, uranium, beryllium, and stainless steel parts are fabricated at RFP and shipped off site for final assembly. Additional activities include chemical processing to recover plutonium from scrap material, metallurgical research and development, machining, assembly, nondestructive testing, coating remote engineering, chemistry, and physics. Waste handling operations at RFP include storage, transport, treatment, and packaging of waste materials generated on site. The waste forms that are handled include hazardous chemical waste, transuranic (TRU) waste, nonhazardous and nonradioactive waste, and combinations thereof. Current waste handling practices also involve on-site and off-site recycling of hazardous materials, on-site storage of hazardous and radioactive mixed wastes, and off-site disposal of solid radioactive materials at another DOE facility. However, both storage and disposal of hazardous and radioactive wastes occurred on site in the past. Preliminary assessments under the ER Program identified 15 past on-site storage and disposal locations as potential sources of environmental contamination within OU10.

1.3.2 Previous Investigations

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

- Detailed description of the regional geology (Malde 1955; Spencer 1961; Scott 1960, 1970, 1972, and 1975; Van Horn 1972 and 1976; Dames and Moore 1981; and Robson et al. 1981a and 1981b)
- Several drilling programs initiated in 1960 that resulted in construction of approximately 60 monitoring wells by 1982
- An investigation of surface water and groundwater flow systems by the U.S. Geological Survey (USGS) (Hurr 1976)
- Environmental, ecological, and public health studies that culminated in an EIS (DOE 1980)
- A summary report on groundwater hydrology using data from 1960 to 1985 (Hydro-Search, Inc. 1985)
- A preliminary electromagnetic survey of the RFP perimeter (Hydro-Search, Inc. 1986)
- A soil gas survey of the RFP perimeter and buffer zone (Tracer Research, Inc. 1986)
- Routine environmental monitoring programs addressing air, surface water, groundwater, and soils (Rockwell International 1975 to 1985, and 1986b)

In 1986, two major investigations were completed at RFP. The first was the ER Program Phase 1 installation assessment, which included analysis 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 that could potentially have adverse impacts on the environment were identified. These sites were designated as SWMUs by Rockwell International (1987a). In accordance with the IAG, SWMUs are now designated as IHSSs. IHSSs are divided into three categories:

- Hazardous waste substance sites that will continue to operate and need a RCRA operating permit. These sites will need to have monitoring and maintenance programs developed that are based upon the evaluation of RFI/RI data.

- Hazardous waste substance sites that will be closed under RCRA interim status (OU10 IHSSs fall into this category). The RFI/RI for these sites will be designed to determine the impact of past activities. The data will be used to plan closure activities.

- Inactive waste substance sites that will be investigated and cleaned up under Section 3004(u) of RCRA or CERCLA. The RFI/RI for these sites will be designed to determine the impact of past activities. The data will be used to plan clean up activities that may be different from options considered for sites to be closed, due to difference in future use scenarios.

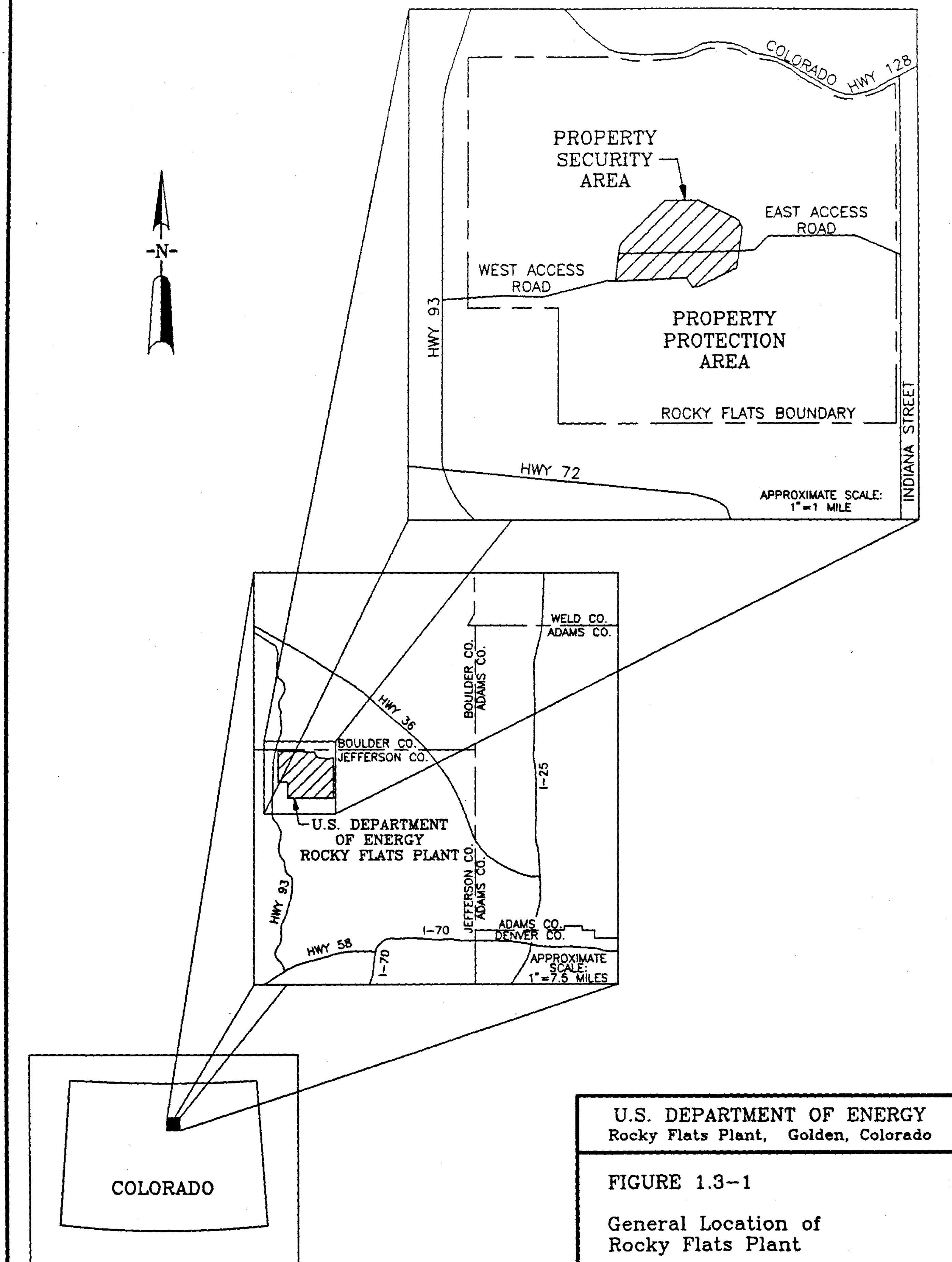
The second major investigation completed at RFP in 1986 involved a hydrogeologic and hydrochemical characterization of the entire site. Plans for this study were presented by Rockwell International (1986c and 1986d), and study results were reported by Rockwell International (1986e).

1.3.3 Physical Setting

1.3.3.1 Location

RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1.3-1). It encompasses approximately 6,550 acres of federally owned land in Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th Principal Meridian. Major buildings are located within the RFP security area of approximately 400 acres. The security area is surrounded by the Property Protection Area (PPA), a buffer zone of approximately 6,150 acres.

The approximately 140 on-site structures encompass approximately 256,400 square meters (2.76 million square feet [ft^2]) of floor space. Of this, major manufacturing, chemical processing,



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

FIGURE 1.3-1

General Location of Rocky Flats Plant

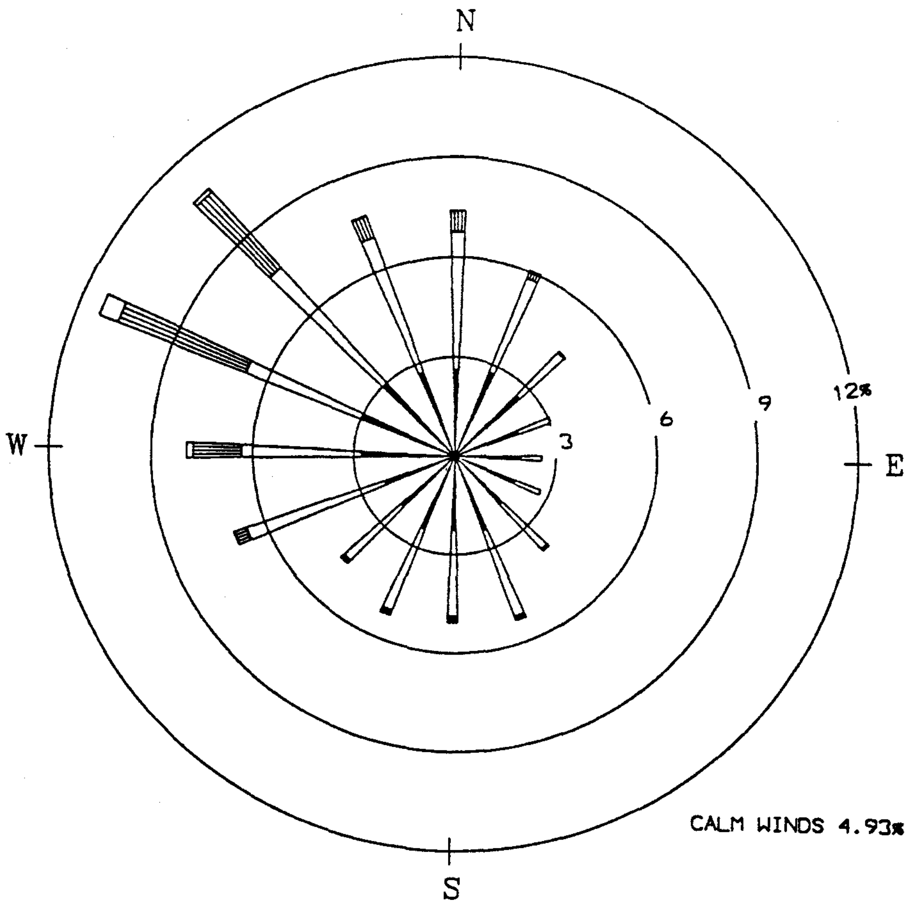
plutonium recovery, and waste treatment facilities occupy about 148,600 square meters (1.6 million ft^2). The remaining floor space is divided among laboratory, administrative, utility, security, warehouse, storage, and construction contractor facilities (107,800 square meters [1.16 million ft^2]).

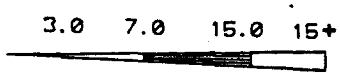
1.3.3.2 Topography

The natural environment in the vicinity of RFP is influenced primarily by its proximity to the Front Range of the Rocky Mountains. Specifically, RFP is situated directly east of the north-south trending Rocky Mountains at an elevation of approximately 6,000 feet (ft) above mean sea level (msl), on a broad, eastward sloping plain of overlapping alluvial fans. The fans extend approximately 5 miles eastward from their origin in the abruptly rising Front Range, and terminate on low rolling hills at a break in slope. RFP is located approximately 25 miles east of the continental divide on a terrace between valleys cut by Walnut Creek and Woman Creek, which are near the eastern edge of the fans.

1.3.3.3 Meteorology

RFP is located in a region of semiarid climate, characterized by warm summers and dry, cool winters, with some snow cover, as it is typical of much of the central Rocky Mountain region. Clear skies, low average precipitation, and low relative humidity are also typical of this location. The elevation of RFP and the major topographical features in the area significantly influence the wind dispersion characteristics of the site. Winds, although variable, are predominantly northwesterly at RFP, with strongest winds occurring during the winter. The wind rose in Figure 1.3-2 provides a graphical illustration of average wind speeds from 1989 and 1990. The area occasionally experiences Chinook winds with gusts up to 100 miles per hour (DOE 1980).





WIND SPEED CLASS BOUNDARIES
(METERS/SECOND)

NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING. EXAMPLE - WIND IS BLOWING FROM THE NORTH 7.4 PERCENT OF THE TIME.

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

FIGURE 1.3-2
Rocky Flats Plant
1989-1990 Windrose

Studies of air flow and dispersion characteristics indicate that RFP meteorology is strongly influenced by the diurnal cycle of mountain and valley winds. Two dominant flow patterns exist, one during the day and one at night. During daylight hours, air tends to flow toward the higher elevations due to the heating of the ground surface. At this time, the air generally flows up the South Platte River Valley from the east, across RFP, and then enters the canyons into the front range west of RFP. After sunset, the air against the mountainside is cooled and begins to flow toward the lower elevations. During the night, air flows down the canyons west of RFP, across RFP, and east to the plains. These meteorological conditions complicate the analysis of airborne contaminant transport from RFP.

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

Approximately 40 percent of the typical 15-inch annual precipitation falls during the spring season, predominantly as wet snow. Thunderstorms, occurring from June to August, account for an additional 30 percent of the annual precipitation. Drier autumn and winter seasons account for 19 and 11 percent of the annual precipitation, respectively. Snowfall, occurring from October through May, averages 85 inches per year. The maximum annual precipitation recorded over a 24-year period was 24.87 inches (63.17 centimeters), measured in 1969.

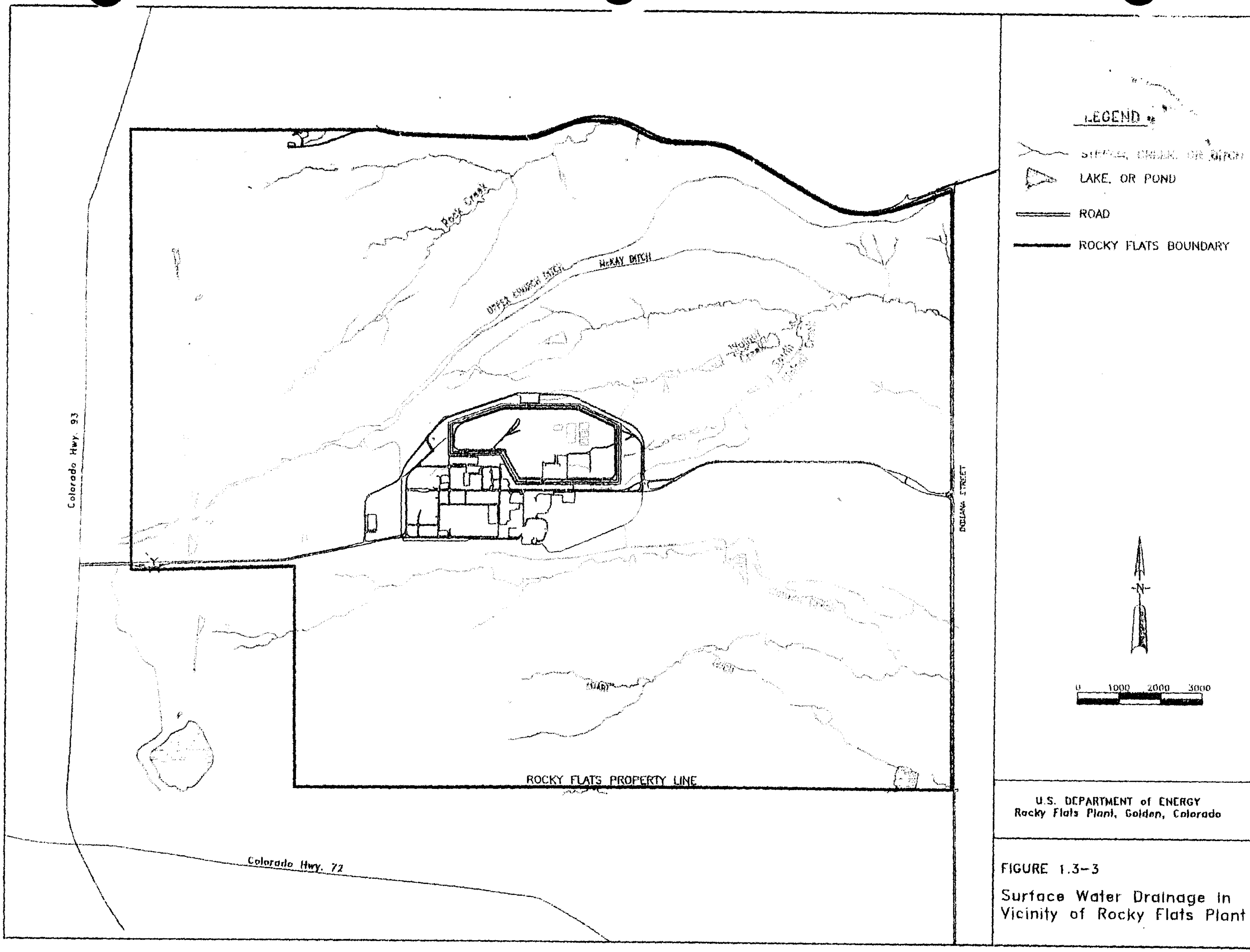
Evaporation rates have been recorded in Denver at the Cherry Creek reservoir by the U.S. Army Corp of Engineers (COE). The average annual pan evaporation rates reported by the COE for the period of 1959 to 1990 is 54.99 inches (Nancy Hedglin, COE. Omaha District, facsimile transmittal to Mark Suehl, Ebasco Environmental, April 3, 1992).

1.3.3.4 Surface Water Hydrology

Three intermittent streams drain RFP, flowing generally from west to east. These drainages are Rock Creek, Walnut Creek, and Woman Creek (Figure 1.3-3). Rock Creek drains the northwestern corner of RFP and flows northeast through the buffer zone to its off-site confluence with Coal Creek. North and South Walnut Creeks and an unnamed tributary drain the northern portion of RFP security area. These three forks of Walnut Creek join in the buffer zone and flow to Great Western Reservoir, which is approximately 1 mile east of the confluence. Woman Creek historically drained the southern RFP buffer zone flowing eastward to Standley Reservoir. A series of ponds designated A-1, A-2, A-3 and A-4 on Walnut Creek; B-1, B-2, B-3, B-4 and B-5 on South Walnut Creek; and C-1 and C-2 on Woman Creek have been constructed to help control surface water flow and sediment transport. The South Interceptor Ditch lies between the RFP Security Area and Woman Creek and currently collects runoff from the southern RFP Security Area and diverts it to Pond C-2, where it is monitored in accordance with the RFP National Pollutant Discharge Elimination System (NPDES) permit prior to discharge to Woman Creek.

1.3.3.5 Ecology

RFP includes species of flora representative of tall grass prairie, short grass plains, lower montane, and foothill ravine communities. Grassland communities in this region are characterized by heavily grazed pastures with a mixture of herbs and relatively unpalatable



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

FIGURE 1.3-3

Surface Water Drainage in Vicinity of Rocky Flats Plant grasses interspersed with isolated, undisturbed sites containing patches of big and little bluestem (*Andropogon gerardi* and *Andropogon scoparius*), needlegrass (*Stipa* sp.), blue grama (*Bouteloua gracilis*), and side-oats grama (*Bouteloua curtipendula*). Prickly pear cactus (*Opuntia* sp.) and yucca (*Yucca glauca*) are invaders where overgrazing has occurred; they are very common in the buffer zone. Montane uplands contain ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*), expressed in the foothills immediately adjacent to RFP as a savannah. Ravines on RFP contain wild plum (*Prunus americana*) and hawthorne (*Crataegus erythropoda*), with willows (*Salix* sp.), false indigo (*Amorpha fruticosa*), and cottonwood (*Populus* sp.) along drainages.

The lands originally acquired for the site in 1951 have been generally undisturbed since that time. Most of the lands acquired in 1974 had been overgrazed. A plant inventory in 1973 reported 327 species of vascular plants, 25 lichens, 15 bryophytes, and one macroscopic green algae (Weber et al. 1974). The site's vegetation was mapped in 1974 (Clark 1977). At that time, the area within the 1951 boundary, especially east and south of the Security Area, was primarily bluegrass (*Poa* sp.) and wheatgrass (*Agropyron* sp.) meadow, with marsh and stream-bank vegetation along the drainages. Higher elevations were more dry and barren, vegetated primarily by cheatgrass (*Bromus tectorum*) and musk thistle (*Carduus nutans*). West of the site and in the PPA, the coarse and rocky substrate was primarily vegetated with junegrass (*Koeleria pyramidata*), Klamath weed (St. Johnswort, *Hypericum perforatum*), and cheatgrass or musk thistle. Musk thistle was particularly abundant throughout the site in fallow and disturbed areas. The local presence of big bluestem and side-oats grama indicated recovery from overgrazing.

A few threatened or endangered species have been identified on RFP, although none have been documented in the OU10 IHSSs. Of the species identified, only the forktip three-awn (Aristida basiramea) is likely to occur as other than a transient at any of the OU10 IHSSs. Section 9.0 includes a further discussion of threatened and endangered wildlife species.

Current studies (December 1990 through August 1991) indicate that plant succession has progressed significantly since studies were conducted in the 1970s. Most areas formerly mapped as annual weed communities now qualify as perennial grassland. Indicator species for perennial grassland such as western wheatgrass (*Agropyron smithii*) and Canada bluegrass (*Poa compressa*) have clearly increased in abundance and now dominate much of the site.

RFP wildlife habitats are similar to other foothills habitats because of the absence of barriers between the site and the surrounding foothill terrain. In such habitats, the most common large mammals are mule deer (*Odocoileus hemionus*). Medium-sized herbivorous mammals are represented primarily by white-tailed jack rabbits (*Lepus townsendii*), prairie dogs (*Cynomus ludovicianus*), desert cottontails (*Sylvilagus audubonii*), and muskrats (*Ondatra zibethicus*). Medium-sized carnivorous mammals are primarily coyotes (*Canis latrans*), red foxes (*Vulpes* vulpes), striped skunks (*Mephitis mephitis*), and long-tailed weasels (*Mustela frenata*), with occasional badgers (*Taxidea taxus*) and raccoons (*Procyon lotor*). Small mammals trapped in 1973 included deer mice (*Peromyscus maniculatus*), thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*), northern pocket gophers (*Thomomys talpoides*), hispid pocket mice (*Perognathus hispidus*), silky pocket mice (*Perognathus flavus*), harvest mice (*Reithrodontomys sp.*), meadow voles (*Microtus pennsylvanicus*), and house mice (*Mus musculus*) (Winsor 1975). Current studies (December 1990 to August 1991) have added several additional small mammal species, of which two are common: prairie voles (*Microtus ochrogaster*) and porcupines (*Erethizon dorsatum*).

Common small birds known to breed on RFP (based on 1991 studies) are mourning doves (*Zenaidura macroura*), common nighthawks (*Chordeiles minor*), western kingbirds (*Tyrannus verticalis*), Say's phoebes (*Sayornis phoebe*), horned larks (*Eremophila alpestris*), barn swallows (*Hirundo rustica*), black-billed magpies (*Pica pica*), American robins (*Turdus migratorius*), European starlings (*Sturnus vulgaris*), yellow warblers (*Dendroica petechia*), blue grosbeaks (*Guiraca caerule*), green-tailed towhees (*Pipilo chlorurus*), rufous-sided towhees (*Pipilo erythrophthalmus*), vesper sparrows (*Pooecetes gramineus*), song sparrows (*Melospiza melodia*), western meadowlarks (*Sturnella neglecta*), red-winged blackbirds (*Agelaius phoeniceus*), Brewer's blackbirds (*Euphagus cyanocephalus*), brown-headed cowbirds (*Molothrus ater*), northern orioles (*Icterus galbula*), American goldfinches (*Carduelis tristis*), and house finches (*Carpodacus mexicanus*). Common birds-of-prey are turkey vultures (*Cathartes aura*), northern harriers (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), Swainson's hawks (*Buteo swainsoni*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), American kestrels (*Falco sparverius*), and great horned owls (*Bubo virvinianus*). Mallards (*Anas platyrhynchos*) and, less commonly, Canada geese (*Branta canadensis*) and pintails (*Anas acuta*) breed on small ponds. Several species of diving ducks (*Aythya* sp.) are found in these ponds during migration. Great blue herons (*Ardea herodias*), and killdeer (*Charadrius vociferous*), spotted sandpipers (*Actitis macularia*), common snipe (*Calidris canulus*), and ring-billed gulls (*Larus delawarensis*) are also commonly found in the vicinity of the ponds.

Bullsnakes (*Pituophis melanoleucus*), prairie rattlesnakes (*Crotalus viridis*), and eastern yellow-bellied racers (*Coluber constrictor*) occur sitewide. Western painted turtles (*Chrysemys picta*) and western plains garter snakes (*Thamnophis radix*) appear in moist areas. Short-horned lizards (*Phrynosoma douglassi*) and red-sided garter snakes (*Thamnophis sirtalis*) occur, but are less common.

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

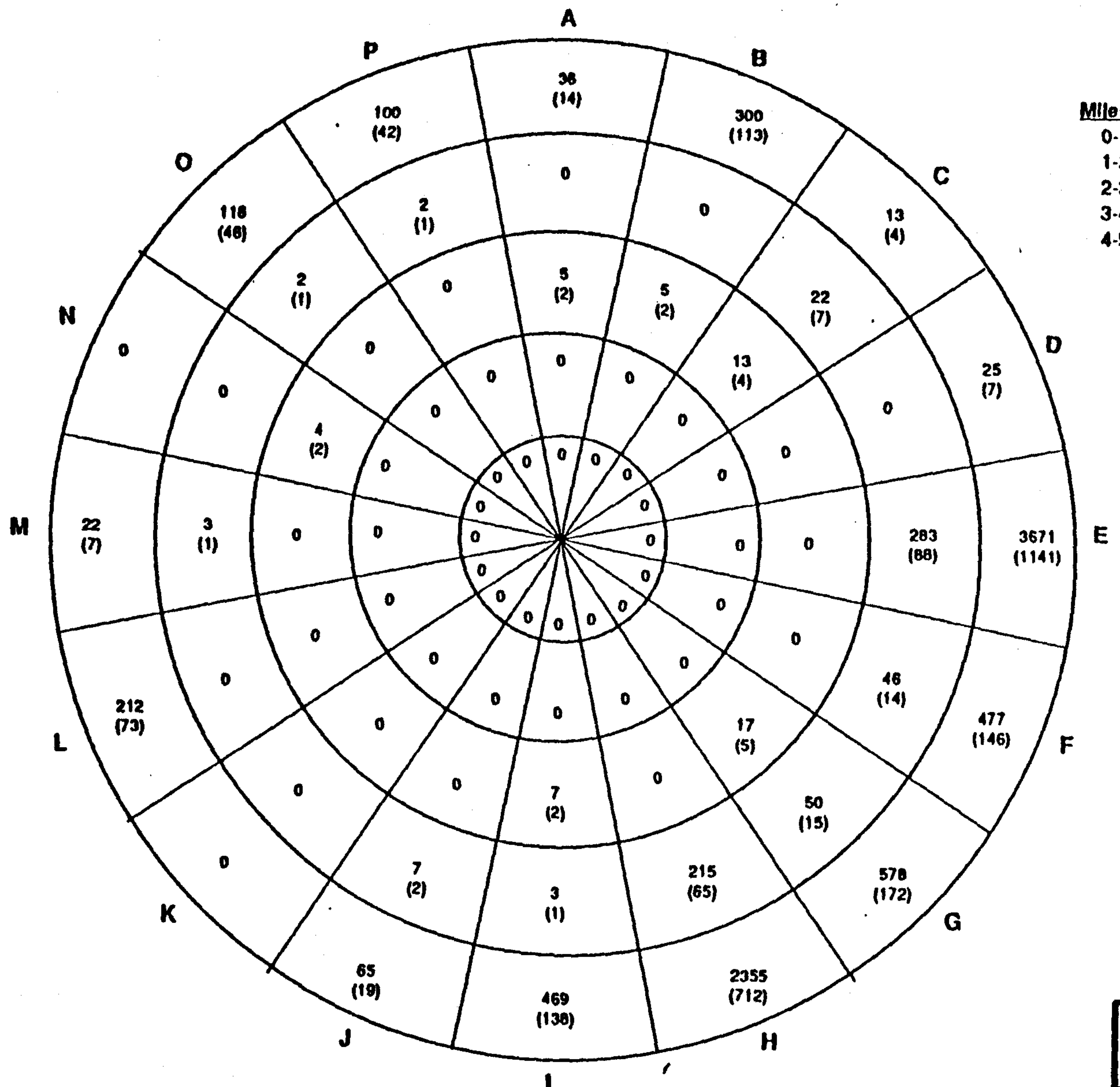
Within the vegetation communities and the habitats they provide on RFP, protected wildlife, vegetation, and habitats potentially occur. Of these species, only forktip three-awn (*Aristida basiramea*) is likely to occur as other than a transient at any of the OU10 IHSSs based on the habitats and substrates noted during the reconnaissance site visit. None of the small wetland areas within OU10 are eligible for jurisdictional status. Section 9.1.2.2 discusses these species and habitats in detail.

1.3.3.6 Surrounding Land Use and Population Density

The population, economics, and land use of the areas surrounding RFP are described in a 1989 vicinity demographics report by DOE (DOE 1991b). This report divides general use of areas within 0 to 10 miles (0 to 16 kilometers [km]) of RFP into residential, commercial, industrial, parks and open spaces, agricultural and vacant, and institutional classifications, and considers current and future land use near the plant.

The majority of residential use within 5 miles (8 km) of RFP is located immediately north and southwest of Standley Lake. Single-family dwellings are located in unincorporated areas immediately east and south of RFP. Figure 1.3-4 shows the 1989 population distribution within areas up to 5 miles from RFP. Commercial development is concentrated near the residential developments north and southwest of Standley Lake, and around the Jefferson County Airport approximately 3 miles (4.8 km) northeast of RFP. Industrial land use within 5 miles (8 km) of the plant is limited to quarrying and mining operations. Open space lands are located northeast of RFP near the city of Broomfield, and in small parcels adjoining major drainages and small neighborhood parks in the cities of Westminster and Arvada. Standley Lake is surrounded by Standley Lake Park. Irrigated and nonirrigated croplands, producing primarily wheat and barley, are located northeast of 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 plant. Several horse operations and small hay fields are located south of the RFP. The demographics report characterizes much of the vacant land adjacent to RFP and the reservoirs as rangeland (DOE 1991b).

Future land use in the vicinity of RFP most likely involves continued suburban expansion, increasing the density of residential, commercial, and perhaps industrial land use in the areas.



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

SOURCE: DOE, "1989 POPULATION, ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT", (IN PRESS).

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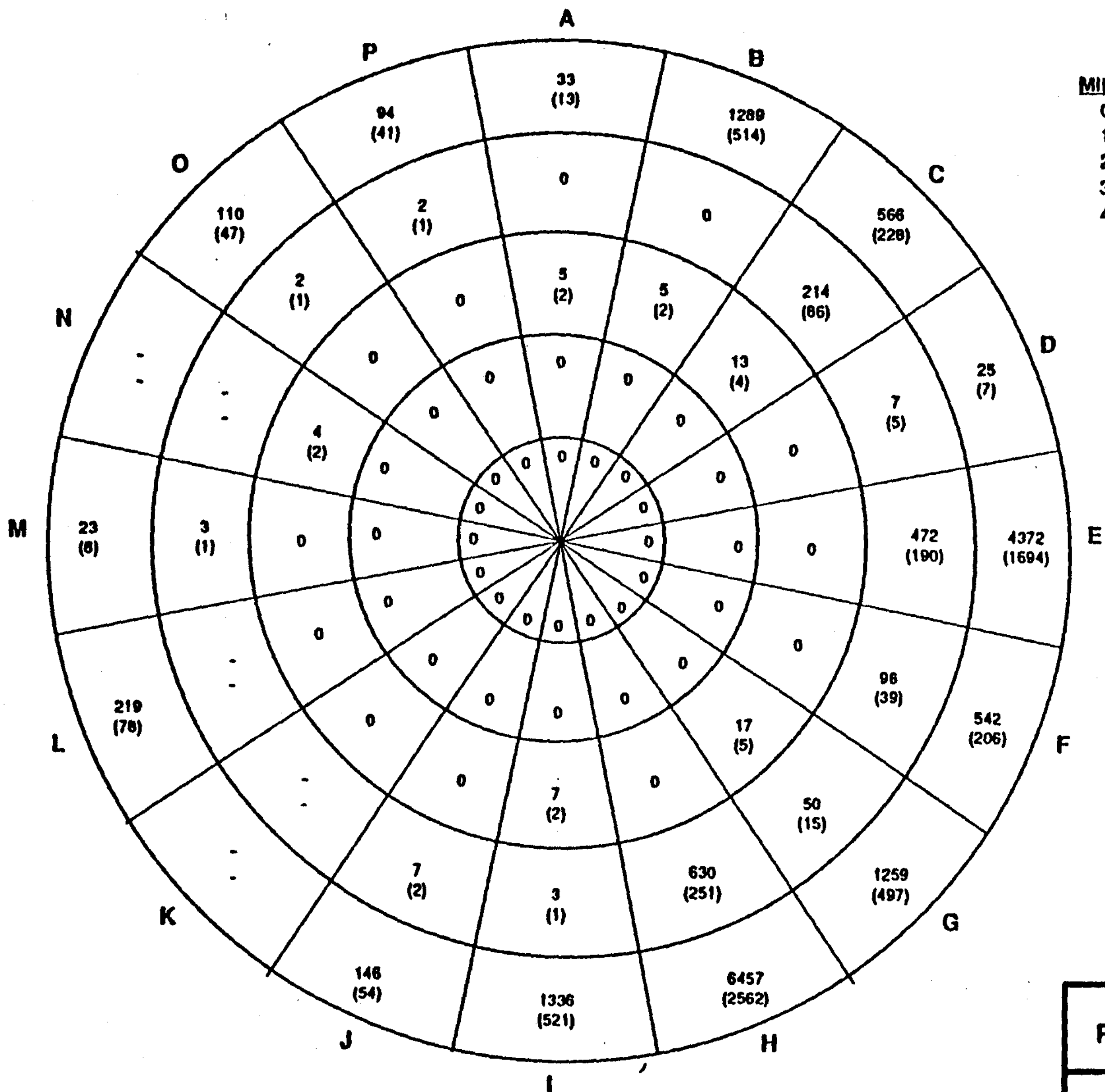
FIGURE 1.3-4
1989 Populations and (Households), Sectors 1-5

The expected trend in population growth in the vicinity of 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 1.3-5 and 1.3-6, respectively. Table 1-2 summarizes the population data presented in Figures 1.3-4, 1.3-5, and 1.3-6.

1.3.3.7 Regional Geology and Hydrogeology

Water-bearing units at RFP include alluvium and bedrock. The alluvium consists of fan deposits of the Rocky Flats Alluvium; terrace deposits of the Verdos, Slocum, and Louviers Alluviums, and valley-fill deposits of the Pre-Piney Creek, Piney Creek, and Post-Piney Creek Alluviums (Figure 1.3-7). The bedrock consists of sandstones and weathered and unweathered claystones of the Fox Hills Sandstone, Laramie Formation, and Arapahoe Formation (Figure 1.3-8). Alluvium, colluvium, and valley fill alluvium best fit the RCRA definition of "uppermost or unconfined aquifer" based on their proximity to the ground surface and higher hydraulic conductivities relative to bedrock units. Unweathered claystones are interpreted to be aquitards because of their low hydraulic conductivity (from 1 x 10^{-8} to 1 x 10^{-7} centimeters/second [cm/s]). Bedrock sandstones beneath unweathered claystones are considered part of the confined aquifer. Bedrock sandstones and weathered claystones, which are hydraulically connected to the alluvial materials, may or may not be part of the "uppermost aquifer." In some locations at RFP, sandstones and weathered claystones have estimated hydraulic conductivities similar to those of unweathered claystones and are, therefore, not considered part of the uppermost aquifer. In other



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

SOURCE: DOE, "1989 POPULATION, ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT", (IN PRESS).

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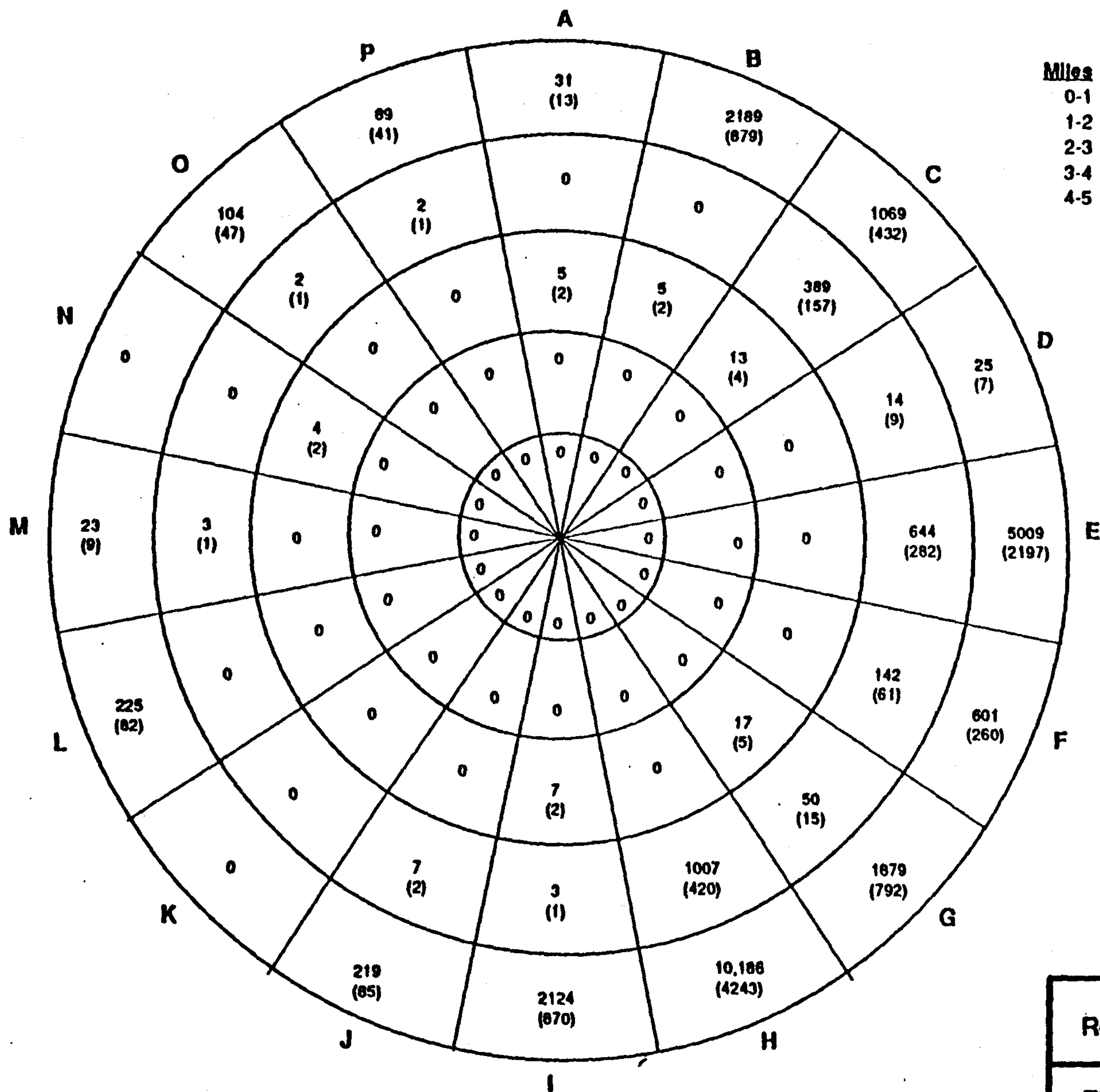
FIGURE 1.3–5
2000 Populations and (Households), Sectors 1–5



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

SOURCE: DOE, "1989 POPULATION, ECONOMIC AND LAND USE DATA BASE FOR ROCKY FLATS PLANT", (I…SS).

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FIGURE 1.3-6
2010 Populations and (Households), Sectors 1-5

Table 1-2 Current and Projected Population in the Vicinity of the Rocky Flats Plant

Sector	B	C	D	Segment E	F	G	H	Sum
Year: 1989								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	5	13	0	0	0	17	0	35
4	0	22	0	283	46	50	215	616
5	300	13	25	3,671	477	578	2,355	7,419
Sum	305	48	25	3,954	523	645	2,570	8,070
Year: 2000								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	5	13	0	0	0	17	0	35
4	0	214	7	472	96	50	630	1,469
5	1,289	566	25	4,372	542	1,259	6,457	14,510
Sum	1,294	793	32	4,844	638	1,326	7,087	16,014
Year: 2010								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	5	13	0	0	0	17	0	35
4	0	389	14	644	142	50	1,007	2,246
5	2,189	1,069	25	5,009	601	1,879	10,186	20,958
Sum	2,194	1,471	39	5,653	743	1,946	11,193	23,239

Source: DOE (in press)

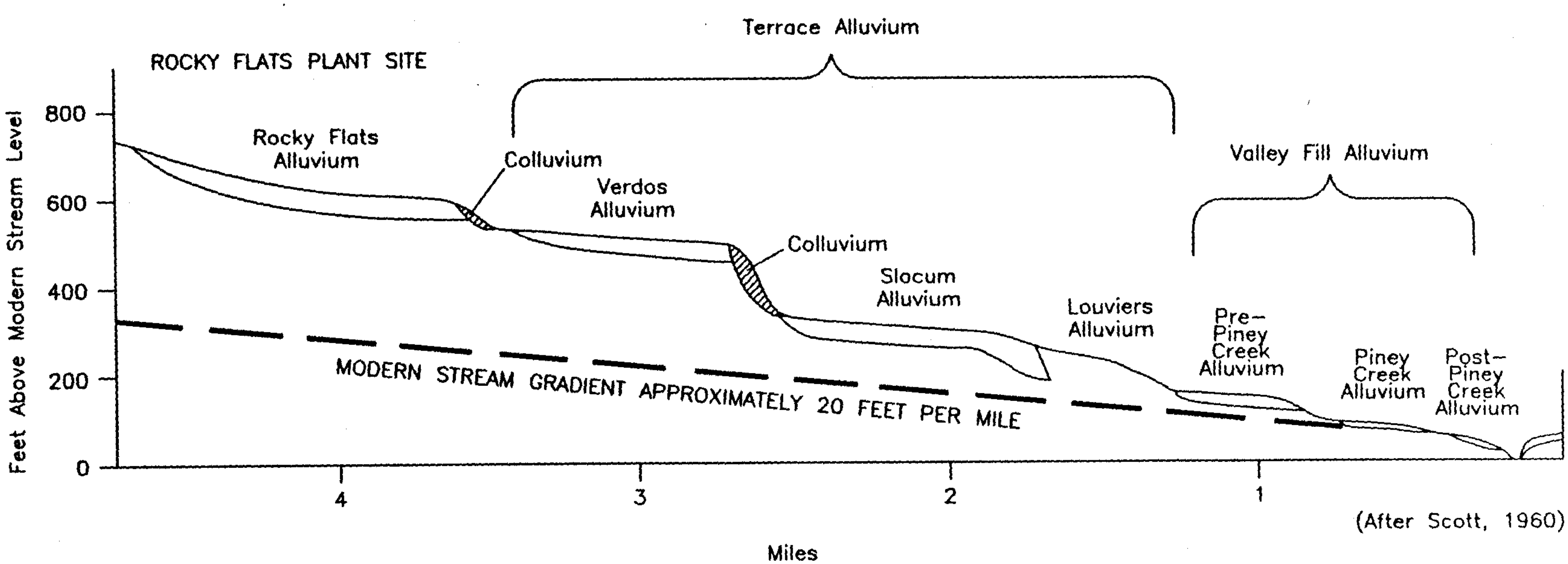

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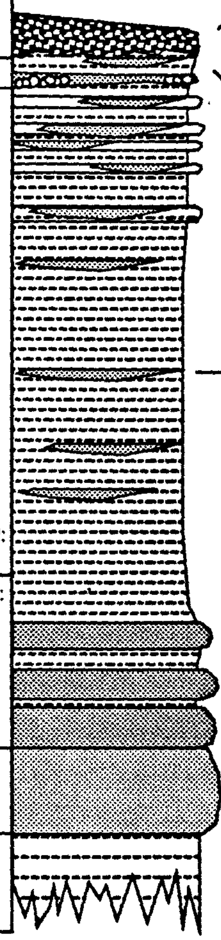
FIGURE 1.3-7

Erosional Surfaces and Alluvial Deposits East of the Front Range, Colorado

Age	Formation	Thickness (feet)
Quaternary	Rocky Flats Alluvium	10-20
Cretaceous	Arapahoe Fm.	15-25
	Laramie Formation	600-800
		upper interval: 300-500
		lower interval: 300
	Fox Hills Sandstone	90-140
	Pierre Shale and older units	



Clayey Sandy Gravels - reddish brown to yellowish brown matrix, grayish-orange to dark gray, poorly sorted, angular to subrounded, cobbles, coarse gravels, coarse sands and gravelly clays: varying amounts of caliche

Claystones, Silty Claystones, and Sandstone - light to medium olive-gray with some dark olive-black claystone and silty claystone; weathers yellowish orange to yellowish brown; a mappable, light to olive gray, medium- to coarse-grained, frosted sandstone to conglomeratic sandstone occurs locally at the base (Arapahoe marker bed)

Claystones, Silty Claystones, Clayey Sandstones, and Sandstones - kaolinitic, light to medium gray claystone and silty claystone and some dark gray to black carbonaceous claystone, thin (2 ft) coal beds and thin discontinuous, very fine to medium-grained, moderately sorted sandstone intervals

Claystones, Sandstones, and Coals - light to medium gray, fine- to coarse-grained, poorly to moderately sorted, silty, immature quartzitic sandstone with numerous lenticular, sub-bituminous coal beds and seams that range from 2' to 8' thick

Sandstones - grayish orange to light gray, calcareous, fine-grained, subrounded, glauconitic, friable sandstone

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Figure 1.3-8

Generalized Stratigraphic Section for the Central Portion of Rocky Flats Plant

After EG&G, 1992 — April 1992

locations, sandstones and weathered claystones have estimated hydraulic conductivities more like those of alluvial units. Sandstones and weathered claystones will be considered part of the "uppermost aquifer" where weathered claystones and sandstones subcrop beneath an IHSS, and where saturated sandstones subcrop beneath saturated surficial material that has been contaminated by a regulated unit, regardless of the location with respect to the regulated unit. Figure 1.3-9 is a water table elevation map for the uppermost hydrostratigraphic unit beneath the security area.

Rocky Flats Alluvium

The Rocky Flats Alluvium is an alluvial fan deposit that occupies an extensive erosional surface beneath RFP. It ranges from 1 to 100 ft in thickness with a maximum of approximately 50 ft beneath the security area (Figure 1.3-10). The Rocky Flats Alluvium is thickest west of RFP near the apex of the fan and thinnest just east of RFP near the depositional limit of the fan. The Rocky Flats Alluvium has been removed by erosion along the Rock Creek, Walnut Creek, and Woman Creek drainages and tributaries. Because of the location of the erosional and depositional limits of the Rocky Flats Alluvium, wells downgradient of RFP are all screened in lithologic units beneath the Rocky Flats Alluvium. The Rocky Flats Alluvium is composed of poorly sorted, coarse, bouldery gravel in a sand matrix with lenses of clay, silt, and sand and groundwater is present under unconfined conditions. Hydraulic conductivities range from 1.6×10^{-5} to 1.3×10^{-3} cm/s (Rockwell International 1989). Groundwater in the Rocky Flats Alluvium generally flows from west to east in the direction of surface water drainage. Paleochannels in the bedrock surface also control the direction of groundwater flow. The water table rises in response to recharge during the spring, and falls throughout the remainder of the year. Alluvial recharge occurs through precipitation, snowmelt, and water losses from ditches, streams, and ponds. Alluvial discharge occurs at minor seeps on hillslopes at the alluvial/bedrock contact.

Other Alluvial Deposits

Various other alluvial deposits occur downslope from the Rocky Flats Alluvium. Colluvium (slope wash) mantles the valley slopes between the pediment on which the Rocky Flats Alluvium is deposited and the valley bottoms. The range of hydraulic conductivity for the colluvium is 7.7×10^{-5} to 1.4×10^{-4} cm/s (EG&G 1991a). In addition, remnants of younger terrace deposits including the Verdos, Slocum, and Louviers Alluviums occur occasionally along the valley slopes. The hydraulic conductivity range for the Verdes, Slocum, and Louviers Alluviums would be similar to the Rocky Flats Alluvium because they are similar in composition. Recent valley fill alluvial deposits occur in the active stream channels. The range of hydraulic conductivity for the valley fill alluvium is 3×10^{-4} to 3×10^{-3} cm/s (EG&G 1991a).

Unconfined groundwater flow occurs in these surficial units. Recharge is from precipitation, percolation from streams during periods of surface water runoff, and by seeps discharging from the Rocky Flats Alluvium. Discharge occurs by evapotranspiration and by seepage into other geologic formations and into surface streams. The direction of groundwater flow is generally downslope through colluvial materials and then along the course of the stream in valley fill materials. During periods of high surface water flow, water is lost to bank storage in the valley fill alluvium and returns to the stream after the runoff subsides.

Arapahoe Formation

The Arapahoe Formation underlies the Rocky Flats Alluvium. The Arapahoe Formation is 0 to 120 ft thick in the vicinity of RFP and is 15 to 25 ft thick under the central portion of the plant

(EG&G 1992). It is composed of sandstones and claystones similar to those in the underlying Laramie Formation. The base of the Arapahoe Formation is marked by the presence of medium-grained to conglomeratic sandstones composed of well-rounded, frosted quartz sand grains with pebbles of chert, rock fragments, and ironstone (EG&G 1992). Dip of the sandstone beds is approximately 1 to 2 degrees east (EG&G 1992). Sandstone channels in the Arapahoe Formation were identified and mapped in OU2 using shallow, high-resolution seismic surveys (EG&G 1991b). Drill core data confirms that these channel sandstones are composed of medium-grained to conglomeratic sandstones of the basal Arapahoe Formation (EG&G 1992).

Recharge of the Arapahoe Formation occurs by leakage from the Rocky Flats Alluvium. Recharge is greatest during the spring and early summer when rainfall is at a maximum and water levels in the Rocky Flats Alluvium are high. Where Arapahoe Formation sandstones subcrop beneath the alluvial material, they are in hydraulic connection with the water table aquifer, and in these limited areas become a part of the uppermost hydrostratigraphic unit. Elsewhere, the sandstones exist as confined aquifers isolated by the relatively impermeable Arapahoe Formation claystones (EG&G 1991c). When the Arapahoe Formation sandstones subcrop beneath the alluvial materials, the possibility exists for contaminants to move into the sandstones from the alluvium. Groundwater movement in the Arapahoe Formation is generally toward the east, although flow within individual sandstones is not fully characterized at this time. Regional groundwater flow in the Arapahoe Formation is east toward the South Platte River in the center of the Denver Basin. The hydraulic conductivity range for the Arapahoe Formation is 1.0×10^{-8} to 4.6×10^{-4} cm/s (Rockwell International 1989).

Laramie Formation and Fox Hills Sandstone

The Laramie Formation underlies the Arapahoe Formation and is informally subdivided into two members: an upper claystone member and a lower sandstone member. The upper claystone member is 300 to 500 ft thick and is composed of relatively impermeable claystones, silty claystones, and thin discontinuous sandstones. Hydraulic conductivities are very low. The lower sandstone member of the Laramie Formation is approximately 300 ft thick and is composed of sandstones with numerous lenticular claystone and coal beds. The Fox Hills Sandstone is 90 to 140 ft thick and is composed of massive, friable sandstones (EG&G 1992). The hydraulic conductivity range for the Laramie Formation is 1.0×10^{-8} to 5.5×10^{-7} cm/s (Rockwell International 1989).

The lower sandstone member of the Laramie Formation and the underlying Fox Hills Sandstone comprise a regionally important aquifer in the Denver Basin known as the Laramie-Fox Hills aquifer. These units subcrop west of RFP and can be seen in clay pits excavated through the Rocky Flats Alluvium. Lower Laramie Formation sandstones dip 45 degrees east at the clay pits although the dip flattens abruptly to 1 to 2 degrees east under RFP (EG&G 1992). Recharge to the aquifer occurs along the limited outcrop/subcrop area along the Front Range that is exposed to surface water flow and leakage from the alluvium. Because there is little, if any, hydraulic connection between the Laramie-Fox Hills aquifer and the overlying Arapahoe aquifer, and the recharge area for the Laramie-Fox Hills aquifer is west of RFP, plant operations should have little or no effect on the Laramie-Fox Hills aquifer (Hurr 1976).

2.0 SITE CHARACTERIZATION

A total of 15 Individual Hazardous Substance Sites (IHSSs) have been grouped into OU10, Other Outside Closures. Their locations are illustrated on Plate 1.

Section 2.1 discusses each IHSS in detail outlining the location and history, previous investigations, physical characteristics, and nature and extent of contamination. Most of the information is derived from the IHSS closure plans and the Draft HRR. Section 2.2, the site conceptual model, will discuss sources of contamination, types of contamination, release mechanisms, contaminant migration pathways, and receptors.

The soil data used in this report are 1988 soil data analyzed by Weston Analytics (Appendix A-1). The data were collected in support of the closure plans and are not known to be validated (Schoendaller 1990).

The groundwater quality data are from the RFP database (Appendix A-2). These data are presented for those wells in the IHSS's immediate vicinity that provide relevant information. These data are validated.

2.1 BACKGROUND AND PHYSICAL SETTING OF OU10

2.1.1 Oil Leak (IHSS 129)

The following discussion is summarized from the Closure Plan for the Building 443 No. 4 Fuel Oil Tank (Rockwell International et al. 1988a), the RCRA Part B permit application for the Rocky Flats Plant Hazardous and Radioactive Mixed Wastes (Rockwell International 1987), and the Draft Historical Release Report (DOE 1992).

2.1.1.1 Location and History

The Building 443 No. 4 Fuel Oil Tank (IHSS 129) is one of four fuel oil tanks located approximately 25 ft east of Building 443 (Figures 2.1-1 and 2.1-2). Since it is no longer in use, tank No. 4 is the only tank included in IHSS 129. The other three tanks are currently being used. The fuel oil tanks are oriented longitudinally east to west in a north-south line. Tank No. 4 is the southernmost of these tanks. The top of this carbon steel tank is located approximately 4 ft below grade without secondary containment. It is 11 ft in diameter by 27 ft in length and has a total storage capacity of approximately 19,000 gallons.

Five pipelines are connected with tank No. 4 (Figure 2.1-1). Four steel supply and return lines connect each of the four tanks to Building 443. These four lines consist of a steam line to supply the heaters located inside each tank, a return condensation line from the heaters, a pump line to pump fuel oil to Building 443, and a return line for oil being circulated from the Building 443 boilers. An additional aboveground line connects two supply tanks south of Building 551 to the four tanks. The portion of this line that is connected to tank No. 4 is an underground steel pipe.

The four fuel oil tanks historically supplied #6 fuel oil to the Building 443 steam plant. Two of the tanks were installed in 1952, while tank No. 4 and another tank were installed in 1967. Although tank No. 4 was primarily used from 1967 to 1984 to store #6 fuel oil, during the 1970s it was used to store #2 diesel oil. From 1984 to 1986, tank No. 4 was used to store a waste mixture of water and compressor oil prior to disposal. The compressor waste was a mixture of approximately 9 parts water to 1 part oil and was stored at a rate up to approximately 30 gallons per day. Solvents used to clean equipment and for cleaning up fuel oil spills have also been added to tank No. 4 from 1967 to 1986. Reportedly, solvents were not added to any of the other tanks. The solvents were added by pouring them through a vertical pipe located at the east end of tank No. 4. Approximately 55 gallons of solvent were used every 2 years in Building 443. This amount corresponds to the approximate quantity of solvents added to tank No. 4. Use of

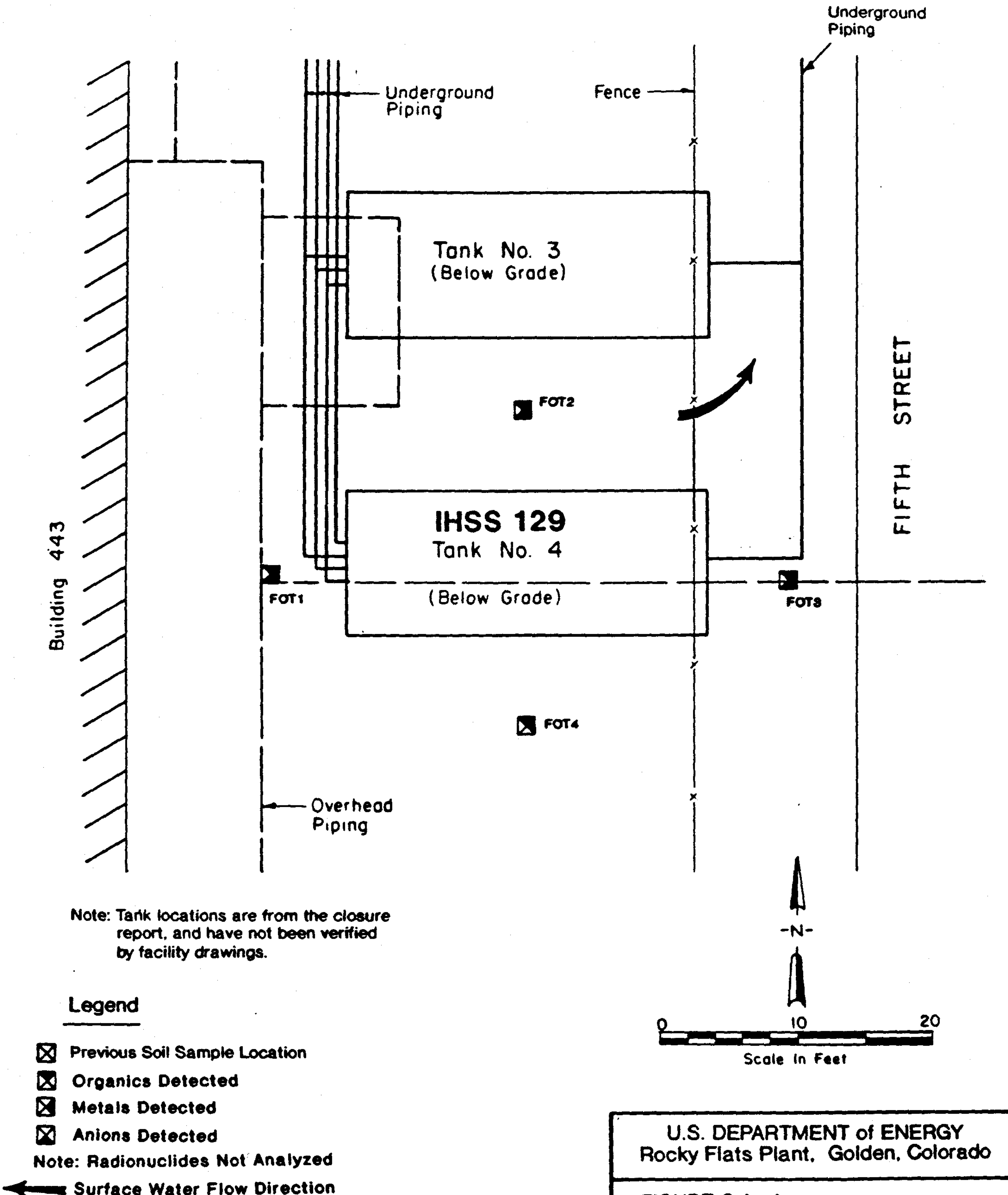

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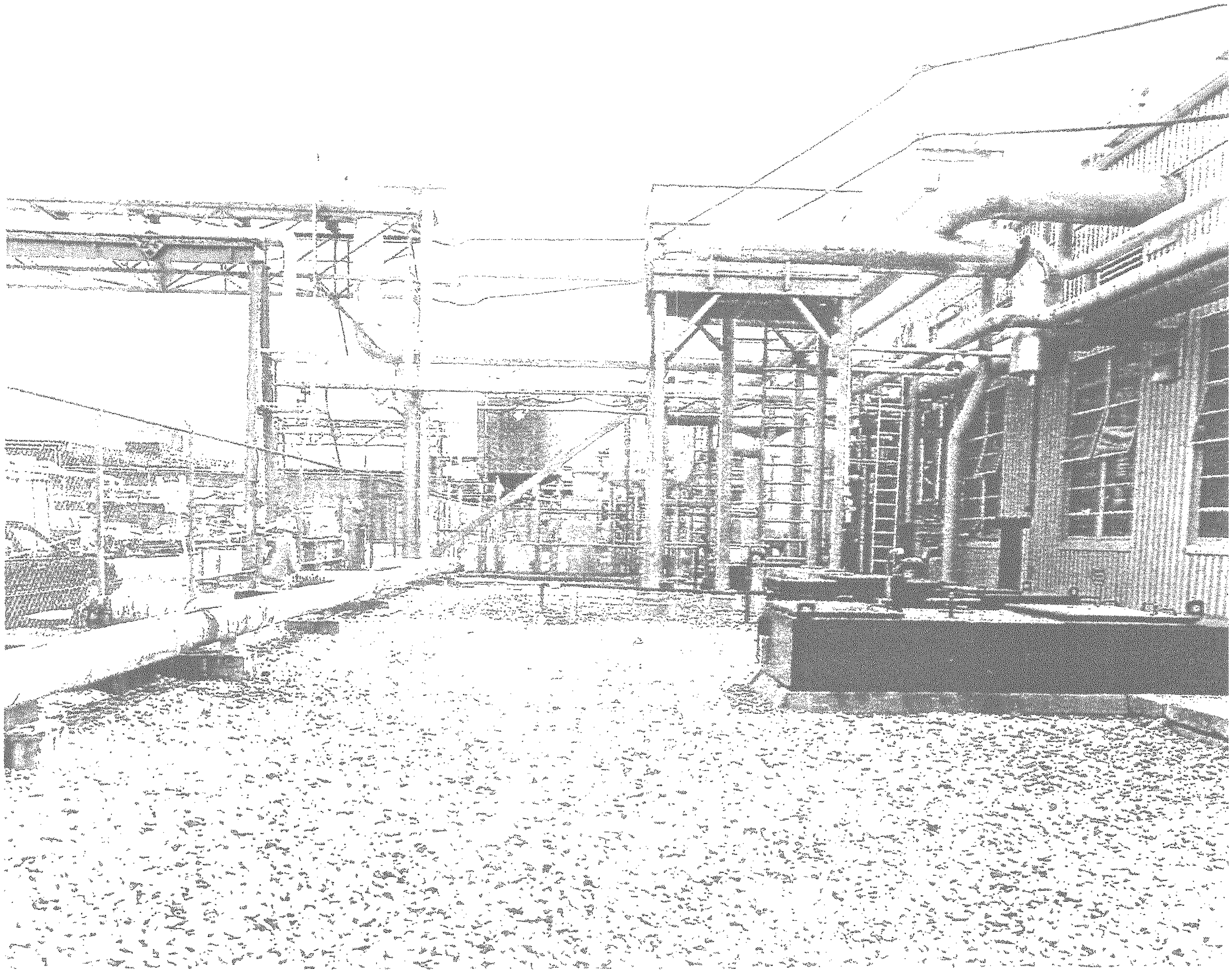
FIGURE 2.1-1
IHSS Location Map and Previous Sampling Locations – Oil Leak (IHSS 129)



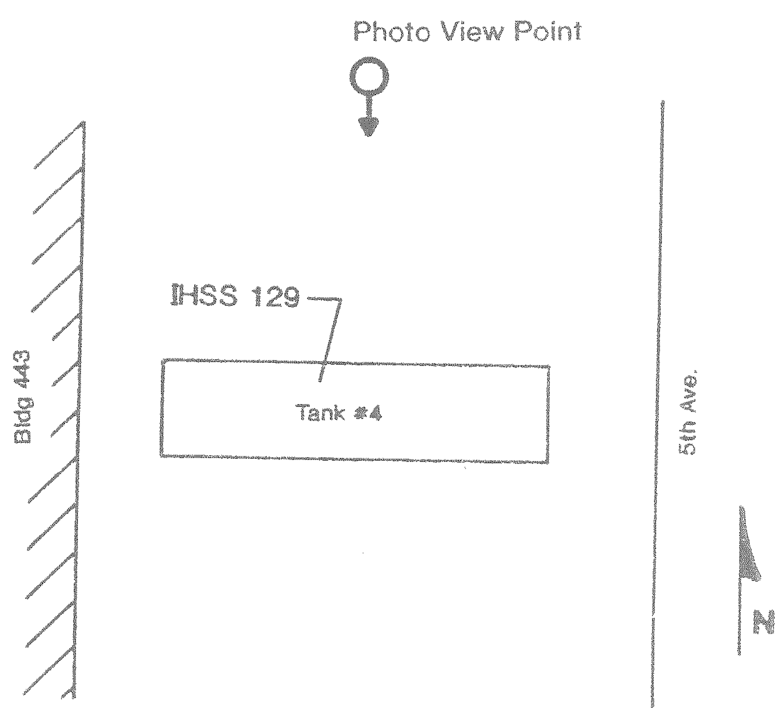


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FIGURE 2.1- 2
Oil Leak (IHSS 129)
Site Photo

tank No. 4 was discontinued in 1986 when a 4-ft-deep fence post hole excavation located approximately 6 inches east of the eastern edge of tank No. 4 partially filled with a material appeared to be compressor oil. Subsequently, the contents of tank No. 4, approximately 12,900 gallons of material, were removed and thermally destroyed by an off-site contractor in May 1986. Minor amounts of sludge may remain in tank No. 4 and associated lines.

There are no documented decreases in the level of material stored in tank No. 4 which would have indicated releases of material. Nevertheless, the source of the material in the fence post hole is believed to be spills associated with filling and possible leakage from tank No. 4. The closure plan for this IHSS reports that this theory is supported by documented increases in the level of material in tank No. 4 due to groundwater entering through a leak on the top of the tank. The location of a leak on the top of the tank could not be verified from surface inspection or additional documentation examined during the preparation of this work plan. A summary of information pertaining to releases of fuel oil in the vicinity of the four #6 fuel oil tanks is presented below.

During 1967 and 1968, reported spills of #6 fuel oil were traced to overfilling the supply tanks because of inadequate instrumentation. The amount of fuel oil released is unknown.

In November 1977, approximately 600 gallons of #6 fuel oil were recovered from the sewage treatment plant. A cracked transfer pipe in an underground pipeline near tank No. 4 was determined to be the source of the oil. The oil had reportedly leaked out of the pipe, travelled through the pipe backfill and bedding materials, and seeped into a sump in Building 443 that was connected to the sewage treatment plant. The total amount of oil released is unknown. The pipe was repaired, and oil-contaminated soil encountered in the excavation was disposed of in the RFP sanitary landfill. Since 1983, aboveground transfer lines have been used.

Following the observation of oil in the fence post hole east of tank No. 4 in 1986, a trench approximately 3 ft wide, 4 ft deep, and 100 ft long was excavated east of the four Building 443 fuel oil tanks. The western edge of the trench was located approximately 3 to 4 ft east of the four fuel oil tanks. Dark fuel oil stains were observed in the southernmost 30 ft of the trench, immediately east of tank No. 4, and were believed to be related to previously mentioned spills and leakage events. No free product was present in the trench.

In February 1989, the level indicator in one of the tanks failed while the tank was being filled with #6 fuel oil causing 500 gallons of fuel to be released to the immediate area and to the street. The spill did not reach a water source. The oil was left on the ground until the next day to let it solidify in the cold. During the same month, 50 more gallons were spilled because the valves were left open. In July 1989, 1,700 gallons were released to the environment. The cause is unknown.

2.1.1.2 Previous Investigations

In 1986, samples of the material stored in tank No. 4 and the liquid that partially filled the excavated fence post hole east of tank No. 4 were collected. These samples were analyzed by both an on-site and an independent laboratory. The volatile organic compounds (VOCs) trichloroethylene, 1,1,1-trichloroethane, methylene chloride, and trichlorofluoromethane were detected in materials stored in tank No. 4. All of these compounds except trichloroethylene were also detected in the sample from the fence post hole. The Closure Plan for tank No. 4 (Rockwell International et al. 1988a) indicates that the No. 4 Fuel Oil Tank was the potential source of volatile organics in the material collected from the fence post hole.

The Closure Plan for the No. 4 Fuel Oil Tank (Rockwell International et al. 1988a) presents results of groundwater analyses from five quarterly samplings of nearby alluvial Well 44-86 in 1986 and 1987. Well 44-86 is located approximately 150 ft northeast and cross-gradient of tank

No. 4, and is not indicative of impacts to groundwater because of leakage or spills from tank No. 4. Trichloroethylene, 1,1,1-trichloroethane, and methylene chloride were the common analytes detected in tank No. 4 and the fence post hole, and were sampled for in Well 44-86. 1,1,1-trichloroethane was found in two out of five sampling events; in one sampling event the concentration was less than one order of magnitude below the Maximum Contaminant Level (mcl) of 0.20 milligram per liter (mg/l), and in the other sampling event the concentration was an estimated value below the analytical detection limit. Methylene chloride was detected in one out of two sampling events. The value for methylene chloride was actually an estimated value below the detection limit. Methylene chloride was also detected in a blank. Trichloroethylene was not detected in five out of five sampling events.

The Closure Plan for the Building 443 No. 4 Fuel Oil Tank (Rockwell International et al. 1988a) specifies an initial soil characterization program to determine the nature and extent of soil contamination. Subsequent to submittal of this Closure Plan, soil samples were obtained in 1988 from the four approximate locations shown in Figure 2.1-1 (Weston 1988). These borings were proposed to extend 10 ft below the water table or to a maximum depth of 30 ft. The actual depth of these borings is presently unknown. Analysis of soil samples included Hazardous Substance List (HSL) volatile organic analysis (VOAs), HSL base neutral acid extractable organics (BNAs), and HSL metals. Section 2.1.1.4 presents the results.

2.1.1.3 Physical Characteristics

The land surface at IHSS 129 gently slopes to the northeast (Plate 1). Approximately 25 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 129. The geologic materials in the vicinity of IHSS 129 consist of Rocky Flats Alluvium, fill, and Arapahoe Formation deposits. Unconfined groundwater flows to the east and probably intercepts the south Walnut Creek drainage. Depth to groundwater is estimated to be approximately 10 ft.

2.1.1.4 Nature and Extent of Contamination

Analytical results for soil samples taken in the area (Weston 1988) indicate the presence of organics above detection limit including 1,1,1-trichloroethane, methylene chloride, benzene, toluene, ethylbenzene, and total xylenes. The organic 1,1,1-trichloroethane was also detected by a portable gas chromatograph during field sampling. Table C-1 (Appendix C) lists the organics detected, present below detection limits, and present in blanks. Metals detected include aluminum, arsenic, beryllium, calcium, cadmium, chromium, copper, iron, mercury, magnesium, manganese, nickel, potassium, lead, vanadium, and zinc. Table C-1 also lists these metals. Radionuclides were not tested at this site. The sampling locations of analytes detected are illustrated in Figure 2.1-1.

No upgradient or downgradient analytical groundwater data are available for this area.

2.1.2 P.U.&D. Container Storage Yard - Waste Spills (IHSS 170)

The following discussion is summarized from the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b) and Draft Historical Release Report (DOE 1992).

2.1.2.1 Location and History

The P.U.&D. Storage Yard, approximately 260 ft by 1,000 ft in size is located southeast of the present landfill (Figures 2.1-3 and 2.1-4). The P.U.&D. Storage Yard began to be used in 1974 when operations were moved from the north end of the 551 Storage Yards. The P.U.&D. Storage Yard is presently active. It has been used to store containers such as barrels, drums, and cargo boxes, spent batteries, empty dumpsters, dumpsters filled with metal shavings coated with lathe coolant, and drums of spent solvents (paint thinners) and waste oils (Rockwell International et al. 1988b).

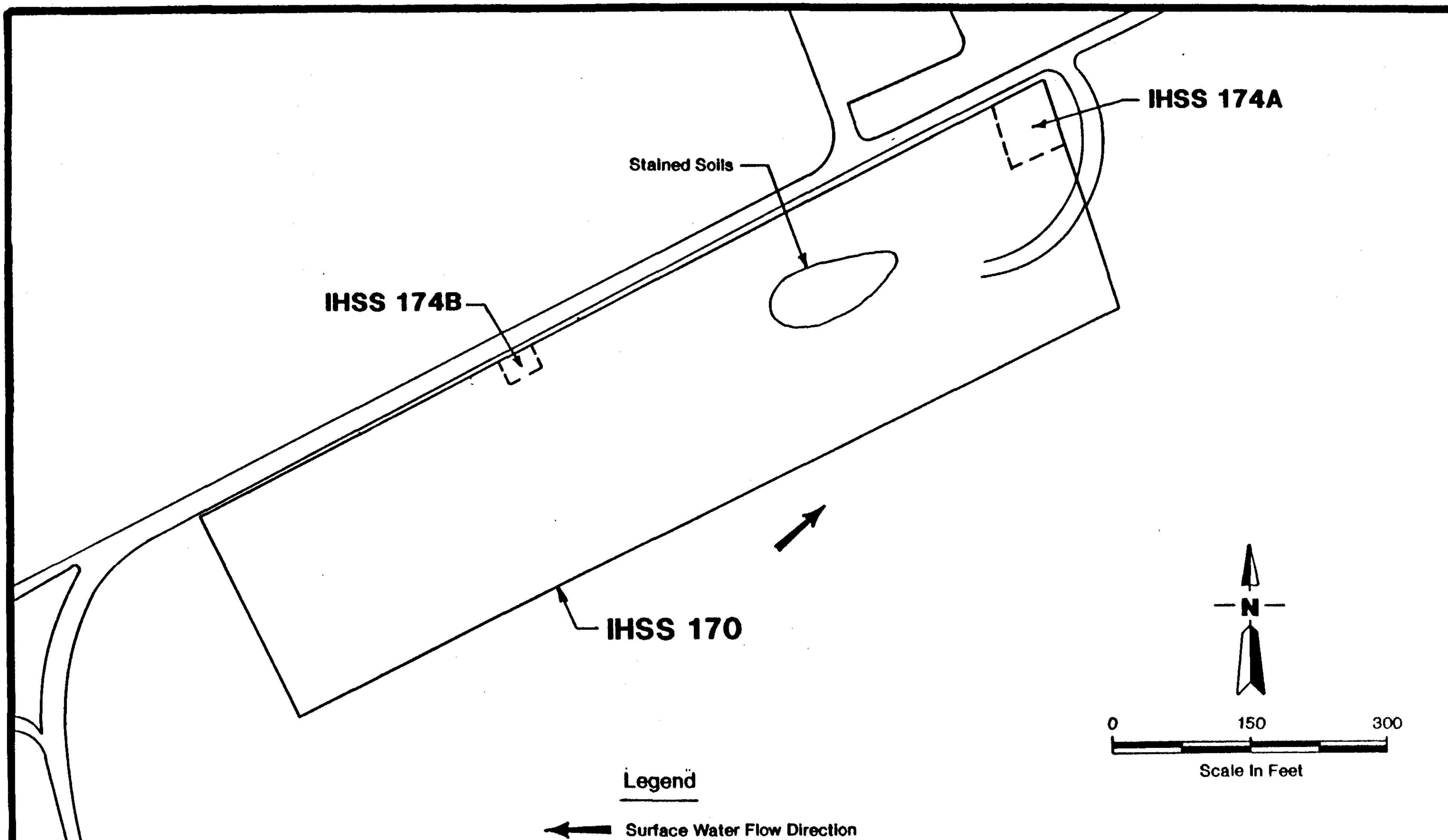

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FIGURE 2.1-3
P.U. & D. Storage Yard - Waste Spills (IHSS 170) Location Map

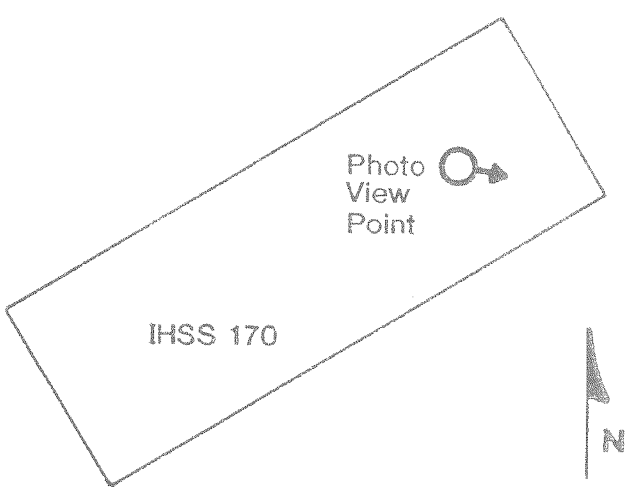

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FIGURE 2.1- 4

P.U. & D. Storage Yard - Waste Sp
(IHSS 170) Site Photo

The P.U.&D. Storage Yard is divided into thirds with wire fences. The eastern third is used for the storage of scrap metal and contains the drum storage area. In this area, scrap metal may have been stored without prior decontamination. In addition, hazardous materials in drums were transferred within this area. The middle third is used for the storage of equipment (e.g., stainless steel tanks). Dumpsters containing hazardous materials were transferred in this area. The western third is used for the storage of excess property (DOE 1992). The types of excess property were not identified in the HRR.

Six tanks, containing approximately 1,800 gallons of liquid waste, were filled during a cleanup of the RFP P.U.&D. Storage Yard. Water from the accumulation of rain and snow in open empty drums was transferred to these tanks. In late 1990 or early 1991, the contents of Tanks numbered 1, 2, 4, 5, and 6 were pumped into drums and the drums were removed by OSCO, a contractor waste hauler from RFP. The five tanks are still located at the P.U.&D. and they may contain rainwater. Radiation measurements from Tank number 3 exceeded shipping criteria. Tank number 3 was moved from the P.U.&D. Storage Yard and is still at RFP in the Unit 1 storage area (personal communication, L. Sobchak, RFP employee, April 24, 1992).

Releases of battery acids have occurred in the past during removal of the batteries by recyclers. RFP personnel interviewed indicated that other releases have occurred from leaking dumpsters and drums of solvents and waste oils (Rockwell International et al. 1988b).

In December 1987, a small amount of unknown radioactive powder spilled out of a drum in the yard. This powder was not detected by exterior radiation monitoring (DOE 1992).

During a site visit in May 1990, EBASCO personnel observed that machined steel is currently stored near the middle of the P.U.&D. Storage Yard in a dumpster located several hundred feet from the reported location of the IHSS 174 Dumpster Storage Area (Rockwell International et al.

1988b). Stained soil was also observed in the vicinity of this area. Inspection of air photos revealed a patch of stained soil near the center of the Storage Yard in 1985, which coincides with the current dumpster location. The dumpsters in current use reportedly do not contain hazardous constituents (Rockwell International et al. 1988b).

In October 1990, rainwater had entered approximately 100 drums with unsecured bungs. Residual hazardous materials left in the drums contaminated the rainwater. The rainwater was not radioactively contaminated. An off-site contractor disposed of the liquid in the drums. A procedure is being implemented to ensure that the approximately 1,000 drums stored in the P.U.&D. Storage Yard do not contain rainwater contaminated with hazardous materials (DOE 1992).

2.1.2.2 Previous Investigations

It is unknown if any previous soil or water sampling investigations have been performed at IHSS 170, but the six tanks described in the previous section were sampled. The results from analytical report E90-2032, for sampling tanks 1 through 6 are listed below. These values represent ranges of concentrations for all six tanks and are expressed in parts per million (ppm).

	Range (PPM)	Frequency		Range	Frequency
Acetone	ND-0.30	2/6	Aluminum	ND-300	1/6
Methylethyl ketone	ND-0.30	1/6	Calcium	4.0-250	4/6
Ethylene dichloride	ND-5.0	3/6	Iron	4.0-700	6/6
Freon 113	ND-8.0	1/6	Potassium	ND-300	3/6
Ethyl acetate	ND-1.8	1/6	Sodium	ND-300	4/6
Trichloroethane	ND-260	5/6	Gross Alpha	(1.0±12)-(230±20)	6/6
Perchloroethylene	ND-0.50	1/6	Gross Beta	(2.0±29)-(220±20)	6/6
Toluene	ND-0.50	1/6			

(ND - Not Detected)

The tanks contain separate organic and aqueous phases. The organics above were sampled from the organic phase; there was no analysis of the organics in the aqueous phase. The organic layers all had VOCs. Samples from these tanks contained 6 to 23 percent organics by volume, although Waste Guidance states that the layers of organic were approximately 1/4 to 1 inch thick. Therefore, the samples probably had a higher percentage organic than the tank (EG&G et al. 1990).

2.1.2.3 Physical Characteristics

The topography gently slopes to the northeast and east (Plate 1). Approximately 35 to 55 ft of Rocky Flats Alluvium and fill overlie the Arapahoe Formation in the vicinity of the P.U.&D. Storage Yard. The groundwater flows to the northeast, and probably intercepts the Present Landfill's groundwater extraction system on the north tributary of Walnut Creek. The depth to groundwater is approximately 10 ft. The closest well, Well 1086, is located 550 ft to the northeast of IHSS 170 (Plate 1).

2.1.2.4 Nature and Extent of Contamination

No previous investigations were performed so the nature and extent of contamination is unknown.

Acetone, methylene chloride, and nitrate/nitrite were detected in the groundwater of downgradient Well 1086 (Table C-2, Appendix C). Well 1086 is located 550 ft northeast of IHSS 170. Additional sampling is required to characterize the nature and extent of contamination.

2.1.3 P.U.&D. Container Storage Yard - Waste Spills (IHSS 174)

The following discussion is summarized from the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b) and Draft Historical Release Report (DOE 1992).

2.1.3.1 Location and History

Two separate areas are located within the P.U.&D. Container Storage Yard, the Drum Storage Area (IHSS 174A) and the Dumpster Storage Area (IHSS 174B) (Figures 2.1-5 and 2.1-6). IHSS 174A is a square area located within the northeast corner of the P.U.&D. Storage Yard and has dimensions of approximately 60 by 60 ft. The P.U.&D. Storage Yard was recently identified as IHSS 170 and is discussed in Section 2.1.2. IHSS 174B was reportedly located along the northern fence line, approximately 300 ft east of the western fence line of the P.U.&D. Storage Yard. There are discrepancies between the location of IHSS 174B as given by the IAG, the Closure Plan, the HRR description, and the HRR CAD drawing. The IAG and the Closure Plan give the location shown in Figure 2.1-5. The HRR description agrees with the IAG but states that the area is significantly larger. The HRR CAD drawing shows IHSS 174B to be over the stained soils area shown in Figure 2.1-3. This work plan will use the area defined by the IAG; between IHSS 170 and IHSS 174, the entire P.U.&D. Storage Yard will be addressed by the OU10 field sampling plan. Section 7.0 of this report will contain additional data with sampling results of the stained soils area in IHSS 170.

Operations began in IHSS 174A sometime between 1974 and 1976 and ended in 1985. IHSS 174A was used for storage of 55-gallon steel drums that primarily contained waste oils from equipment and vehicle maintenance as well as waste paints and paint thinners from the RFP Paint Shop. These drums were placed directly on the ground surface without secondary containment. The drums and their contents were periodically sold for recycling until 1984, when the oil was determined to contain hazardous constituents. The closure plan does not indicate the nature of the hazardous constituents. It has been estimated that a total of 460 drums were stored during the operation of the IHSS 174A, although the maximum number of drums stored at any one time may have been considerably less (Rockwell International et al. 1988b). Assuming a total drum storage of 460 drums, this corresponds to a total storage capacity of 25,300 gallons over the IHSS's operating life. Drums were generally stored for 1 to 2 years prior to removal

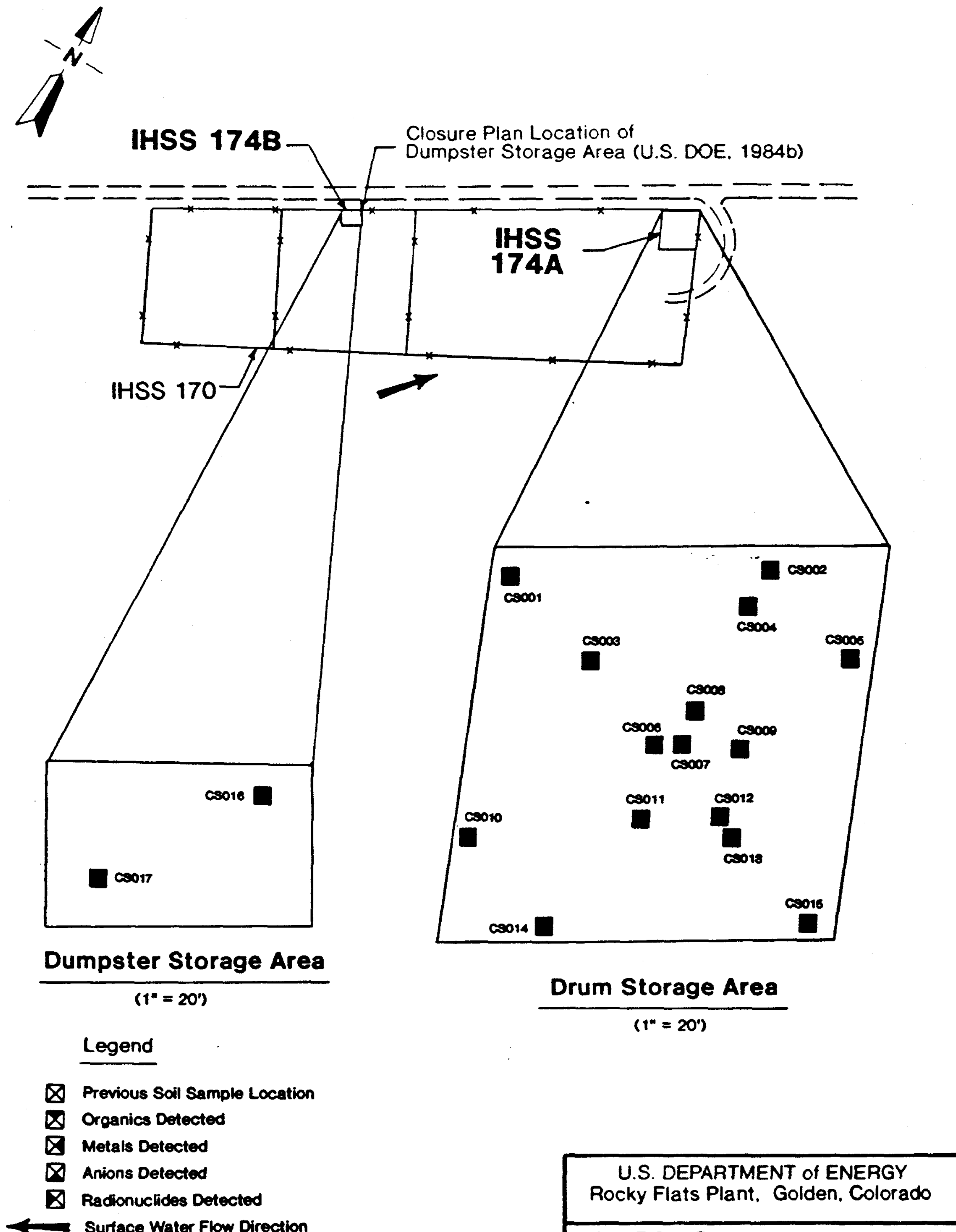

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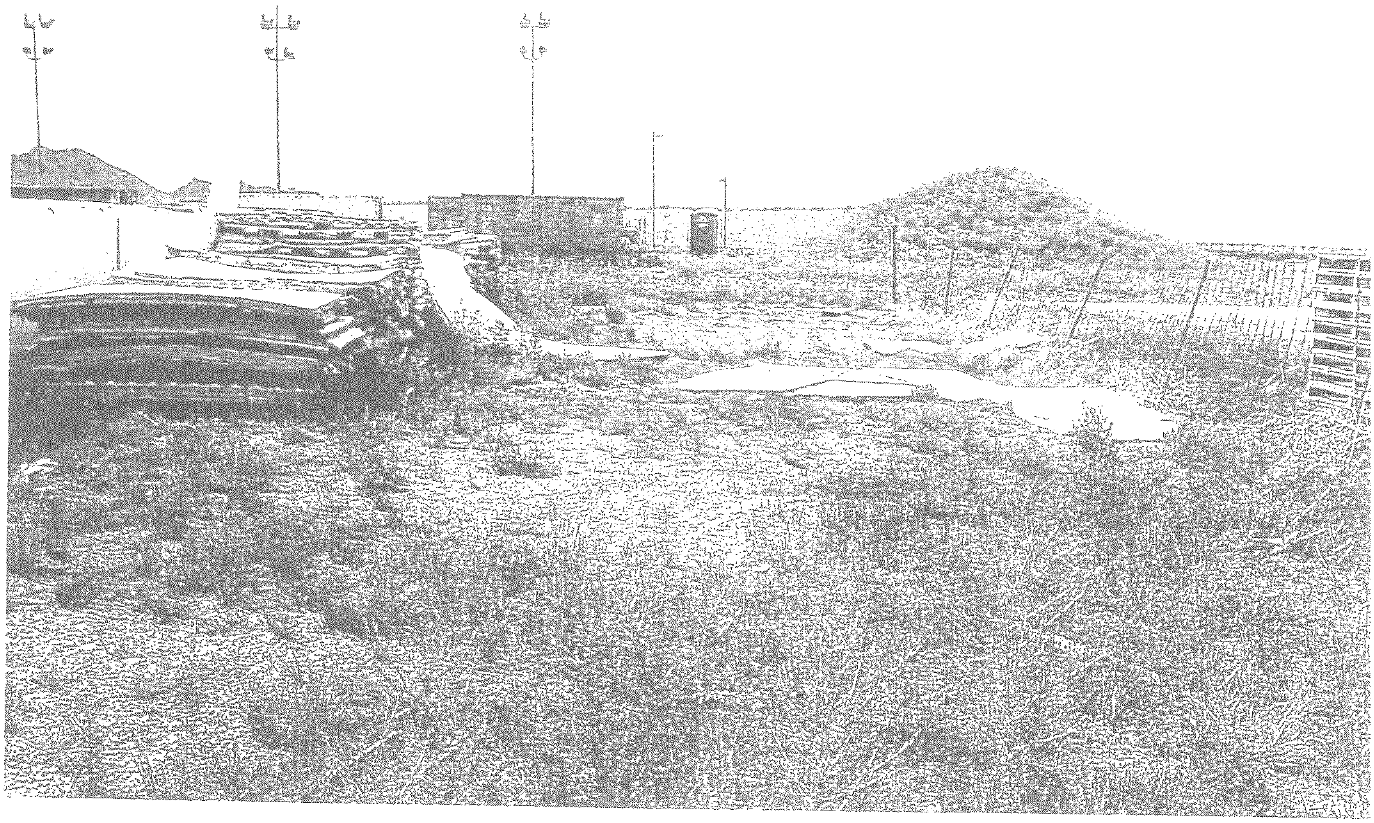
FIGURE 2.1-5
IHSS Location Map and Previous Sampling Locations – P.U. & D. Container Storage Facilities (IHSS 174)



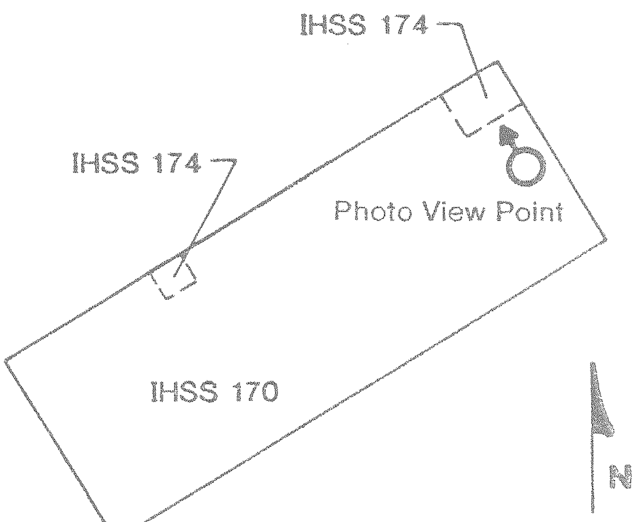


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FIGURE 2.1- 6

P.U. & D. Container Storage Facilities (IHSS 174) Site Photo and sale for recycling of their contents. In May 1982, a liquid drum exploded with the bottom blown out. Two other drums were found to have pressurized bulging tops. Documentation reporting a release to the environment was unavailable. These drums were subsequently transferred to the hazardous waste storage area west of the Present Landfill (IHSS 203) and the contents identified. The types of materials identified were not documented in any of the source reports used for preparation of this work plan. In August 1985, all the drums were removed from the area for disposal by the Oil and Solvent Company. Since then, it has been used for the storage of empty drums.

IHSS 174B was used from 1974 to 1985 for storage of stainless steel machining chips that were coated with lathe coolant prior to off-site recycling. Two coolants were used. One was freon based and the other was composed of approximately 70 percent hydraulic oil and 30 percent carbon tetrachloride. Only one 12- by 16-ft dumpster with a total storage capacity of 860 cubic ft (ft^3) was used to contain the coated chips at any one time. The dumpster was located directly on the ground surface without secondary containment. Storage of these RCRA-regulated materials in the dumpster was discontinued in 1985, possibly due to elimination of solvents from the chip generating process. Visible staining is apparent on the soil in IHSS 174B from spills which occurred during transfer and from rainwater washing residual oil from metal shavings onto the ground.

Administrative controls were implemented to prevent radioactively contaminated material from being shipped to the yard. All drums were monitored externally for radiation prior to shipment to IHSS 174. Drums shipped from areas that handled radioactive materials were sampled and analyzed prior to shipment to IHSS 174.

2.1.3.2 Previous Investigations

In May 1985, samples were collected from 101 of the remaining 158 drums, composited into 12 samples, and analyzed. The oil fraction of the composited samples was analyzed quantitatively to determine which constituents composed the makeup of the oil. The remaining portions of the sample were analyzed by infrared spectroscopy. Components of the drummed waste were determined to include paraffinic base mineral oil, a volatile hydrocarbon solvent (e.g., mineral spirits such as aliphatic naphtha), carbon dioxide, methyl alcohol, silicone lubricant, freon, freon TF, water, and xylenes. Metals and other inorganics detected in the samples included aluminum, barium, beryllium, calcium, chromium, copper, iron, potassium, lithium, magnesium, molybdenum, sodium, nickel, lead, silicon, and zinc (Rockwell International et al. 1988b).

An initial soil characterization program to determine the nature and extent of soil contamination was specified for IHSSs 174A and B in the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b). Subsequent to submittal of the Closure Plan, soil samples were obtained in 1988 from the approximate locations shown in Figure 2.1-6 (Weston 1988). These soil samples were collected from 1-ft-deep excavations and were composited over the 1 ft interval except for VOA samples, which were grab samples from a depth of 1 ft. Analysis of soil samples included HSL VOAs, HSL BNAs, HSL metals, inorganics, and radionuclides. Results are presented in Section 2.1.3.4.

Prior to soil sampling, visual and direct radiation surveys were also conducted at IHSSs 174A and B to identify areas of potential contamination. The radiation surveys consisted of gamma surveys with a Field Instrument for Detection of Low Energy Radiation (FIDLER). The FIDLER surveys at IHSS 174A and 175B were conducted on October 12, 1988. Background was determined to be 500 counts per minute (cpm). The surveys across both 174A and 175B did not detect activity above the background with readings ranging from 250 to 300 cpm. Since no areas exceeded background, no additional soil samples were collected (Weston 1988).

During the visual surveys, several areas of stained soil and stressed vegetation were observed in the IHSS 174A. Staining was also observed in the northeast portion of this area where a dumpster of vanadium shavings was previously stored. Some shavings were still present on the ground surface.

2.1.3.3 Physical Characteristics

The topography of IHSS 174 gently slopes to the northeast and east (Plate 1). Approximately 30 to 50 ft of Rocky Flats Alluvium and fill overlie the Arapahoe Formation in the vicinity of IHSS 174, P.U.&D. Container Storage Facilities. The unconfined groundwater flows to the northeast and probably intercepts the groundwater extraction system of the Present Landfill on the north tributary of Walnut Creek. The depth to groundwater is approximately 10 ft below the ground surface. The closest well, Well 1086, is located 550 to 1,250 ft northeast of the IHSS 174 sites.

2.1.3.4 Nature and Extent of Contamination

The soil characterization program of IHSS 174B was conducted at the location along the northern fence line, approximately 300 ft east of the western fence line of the P.U.&D. Storage Yard.

There have been no documented spills at IHSSs 174A or B. An initial soil characterization program to determine the nature and extent of soil contamination in IHSSs 174A and B was initiated in 1988. Analysis of soil samples taken from borings in the area indicate the presence of organics above detection limit including acetone, 4-chloro-3-methylphenol, tetrachloroethene, 1,1,1-trichloroethane, and bis (2-ethylhexyl) phthalate.

Metals and inorganics detected include aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium, magnesium, sodium, nickel, lead, iron, manganese, zinc, vanadium, copper, potassium, and nitrates. Radionuclides detected include gross alpha, gross beta, tritium, americium 241, uranium 233, 234, plutonium 239, 240, and uranium 238. Table C-3 (Appendix C) summarizes the organics, metals, inorganics, and radionuclides detected. The sampling locations of these analytes detected above background are illustrated in Figure 2.1-5.

Analysis of groundwater samples taken from downgradient Well 1086 resulted in detections of acetone and methylene chloride (Plate 1). Inorganics detected include nitrate/nitrite. Table C-4 (Appendix C) lists the organics detected and the inorganics above background.

No upgradient well data are known to have been collected and Well 1086 is located approximately 500 ft from the east site and 1,250 ft form the west site of IHSS 174. Due to the distance of Well 1086 from the IHSS 174 locations, a groundwater plume may not be intercepted, so further data are needed to assess the possibility of groundwater contamination from IHSS 174 more accurately.

2.1.4 S&W Building 980 Container Storage Facility (IHSS 175)

The following discussion is summarized from the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b).

2.1.4.1 Location and History

The S&W Building 980 Container Storage Facility is reportedly located in the eastern third of a storage yard located south of Building 980 (Figure 2.1-7). The site has dimensions of approximately 25 by 25 ft. The precise location of IHSS 175 could not be determined during a site visit in May 1990. The general area was reportedly regraded in spring 1988 (Rockwell International et al. 1988b).

IHSS 175 was used from approximately 1980 to 1986 for storage of 55-gallon steel drums containing wastes generated by the S&W contractor's maintenance and fabrication shops. These

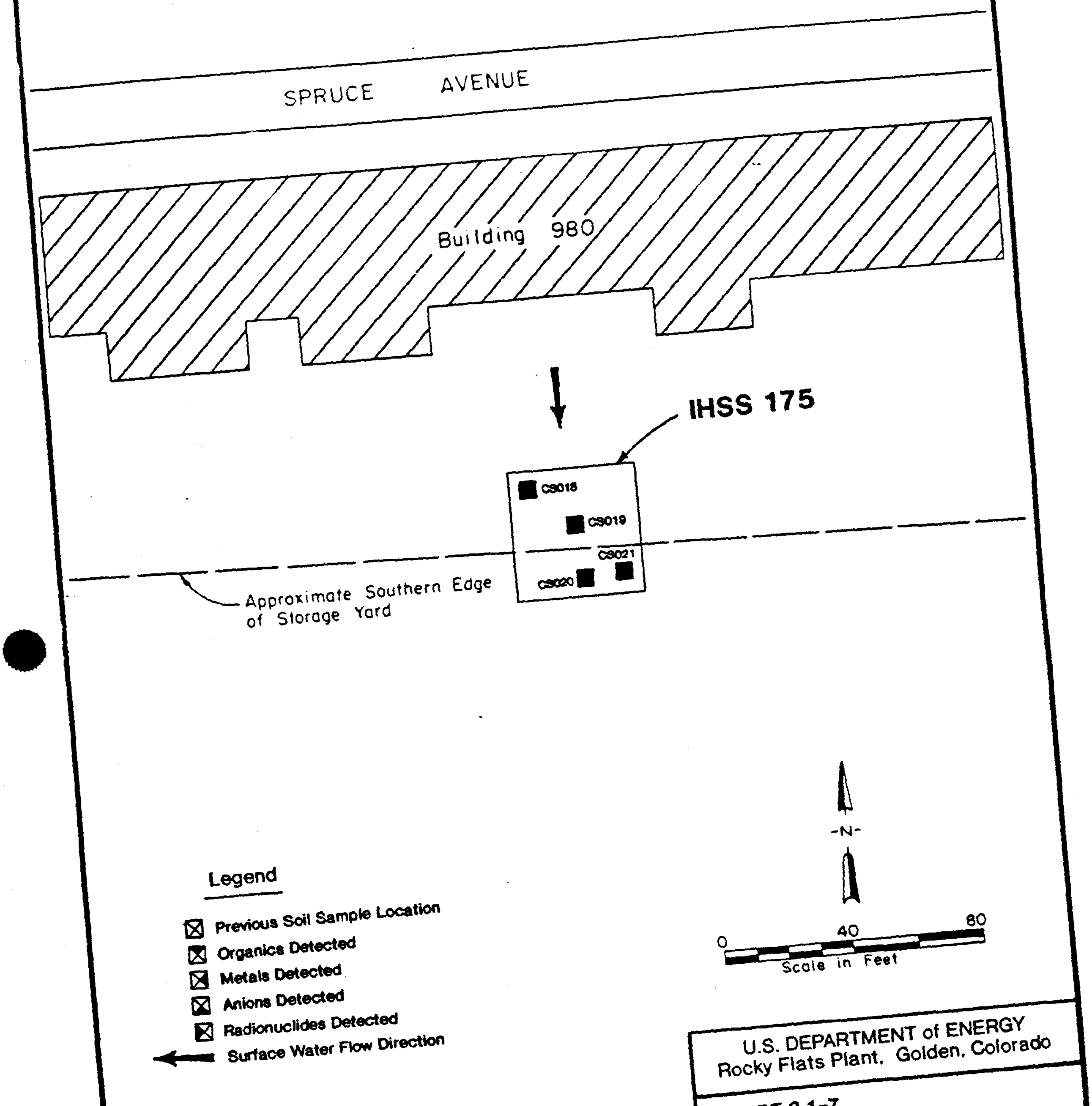

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FIGURE 2.1-7
IHSS Location Map and Previous Sampling Locations - S & W Building 980 Container Storage Facility (IHSS 175)

wastes typically came from vehicle maintenance and painting activities and contained paraffinic-based mineral oil, a mixture of paraffinic- and naphthenic-based mineral oil, xylenes, freon TF, glycol ether/borate-based brake fluid, aluminum, barium, beryllium, calcium, sodium, lead, silicon, and zinc. A maximum of ten drums containing waste have been stored there at any one time. The drums were placed directly on the ground surface. A berm approximately 1 to 1.5 ft high was reportedly located on the west, south, and east sides of the overall storage yard. There have been no documented spills or leaks from this area; however, ground stains are visible. The area has been used from 1986 to the present as a 90-day accumulation area.

2.1.4.2 Previous Investigations

In May 1985, samples were collected from seven drums, composited into five samples and qualitatively analyzed. The oil layers of the composited samples were analyzed to determine their base materials, and the remaining portions of the samples were analyzed by infrared spectroscopy. Components of the drummed waste were determined to include paraffinic-based mineral oil, a mixture of paraffinic- and naphthenic-based mineral oil, xylenes, freon TF, and glycol ether/borate-based brake fluid. Metals detected in the samples included aluminum, barium, beryllium, calcium, sodium, lead, silicon, and zinc.

An initial soil characterization program to determine the nature and extent of soil contamination was specified for the S&W Building 980 Container Storage Facility in the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b). Subsequent to submittal of the Closure Plan, soil samples were obtained in 1988 from the approximate locations shown in Figure 2.1-7 (Weston 1988). One soil sample was collected from an area of stained soil and three samples were collected based on the random systematic grid sampling program. These soils samples were collected from 1-ft-deep excavations and were composited over the 1-ft-deep interval except for VOA samples, which were grab samples from a depth of 1 ft. Analysis of soil samples included HSL VOAs, HSL BNAs, HSL metals, inorganics, and radionuclides. (The results are presented in Section 2.1.4.4.)

Prior to soil sampling, a visual and a direct radiation survey using a FIDLER probe were also conducted to identify areas of potential contamination. Several areas of ground staining were observed during the visual survey and by the FIDLER survey it was noted that vegetation was sparse in the area. Gamma activity background was determined to be 500 cpm. All readings were below background and no additional soil samples were collected (Weston 1988).

2.1.4.3 Physical Characteristics

The topography of IHSS 175 gently slopes to the northeast and more steeply to the east (Plate 1). Less than 10 ft of Rocky Flats Alluvium and fill overlie the Arapahoe Formation in the vicinity of IHSS 175. The alluvium consists of clays, silts, sands, and gravel, and the bedrock is composed on claystone. The unconfined groundwater flows to the east, following the slope of the weathered bedrock surface and probably intercepts the south Walnut Creek drainage.

The depth to groundwater is approximately 15 ft below the ground surface. The closest well, Well 3386, is located 300 ft southeast of IHSS 175.

For a more detailed description of the geology, reference the bore log for Well 3386 found in Appendix B.

2.1.4.4 Nature and Extent of Contamination

Analysis of soil samples taken from borings in the area indicate detections of organics that include methylene chloride and acetone (which were also present in sample blanks). Metals and other inorganics detected include arsenic, barium, beryllium, chromium, iron, manganese, nickel, strontium, vanadium, calcium, cadmium, copper, mercury, lead, magnesium, potassium, zinc, and nitrate/nitrites. Radionuclides detected include gross alpha; gross beta; tritium; uranium 233, 234; uranium 238; plutonium 239, 240; and americium 241. Table C-5 (Appendix C) summarizes the organics, metals, inorganics, and radionuclides detected. Figure 2.1-7 reports the sampling locations of analytes detected.

No upgradient or downgradient analytical groundwater data are known to have been collected.

2.1.5 S&W Contractor Storage Yard (IHSS 176)

The following discussion is summarized primarily from the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b).

2.1.5.1 Location and History

The S&W Contractor Storage Yard (IHSS 176) is located approximately 50 ft east of the Solar Evaporation Ponds in the vicinity of Building 964 (Figures 2.1-8 and 2.1-9). This yard has been used for storage of contractor materials for use in various projects at the RFP. IHSS 176 is approximately 290 by 390 ft in size according to the IAG (DOE 1991). The actual area of IHSS 176 used for storage appears to be considerably larger based on inspection of aerial photographs.

The S&W Contractor Storage Yard has been used for storage since 1970. This area was not intended to be used for the storage of hazardous waste. Drum storage began at this site in 1970 and continued until 1985. Containers were stored in numerous areas of the S&W Contractor Storage Yard throughout time. The total amount of waste stored at the S&W Contractor Storage Yard is unknown. In 1985, materials were identified in several areas of the S&W Contractor Storage Yard that qualified as hazardous waste. These containers had been placed directly on the ground surface or on pallets. The contents of the containers were sampled in 1985 and qualitatively analyzed. Components of the drummed waste were determined to be primarily

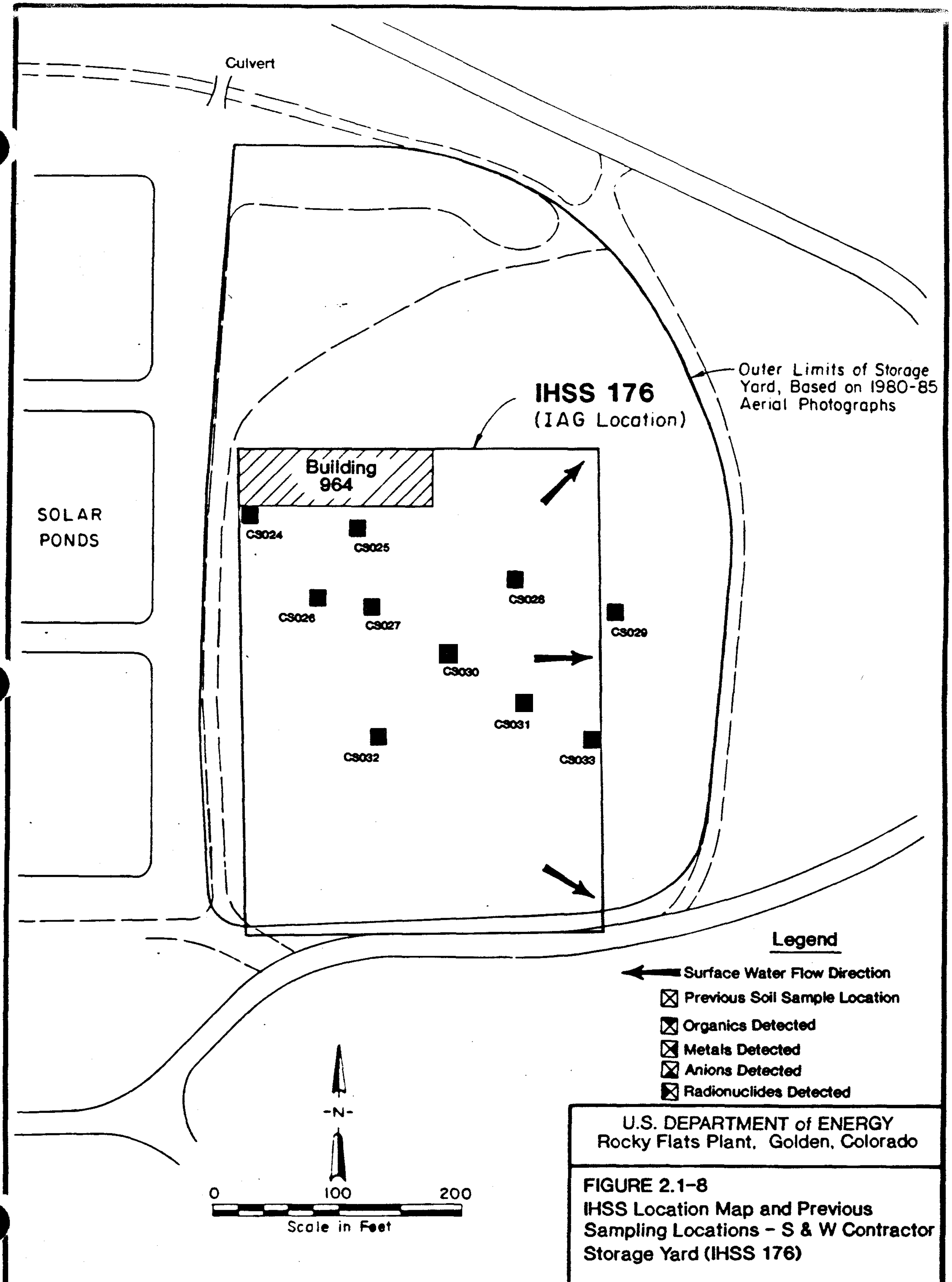
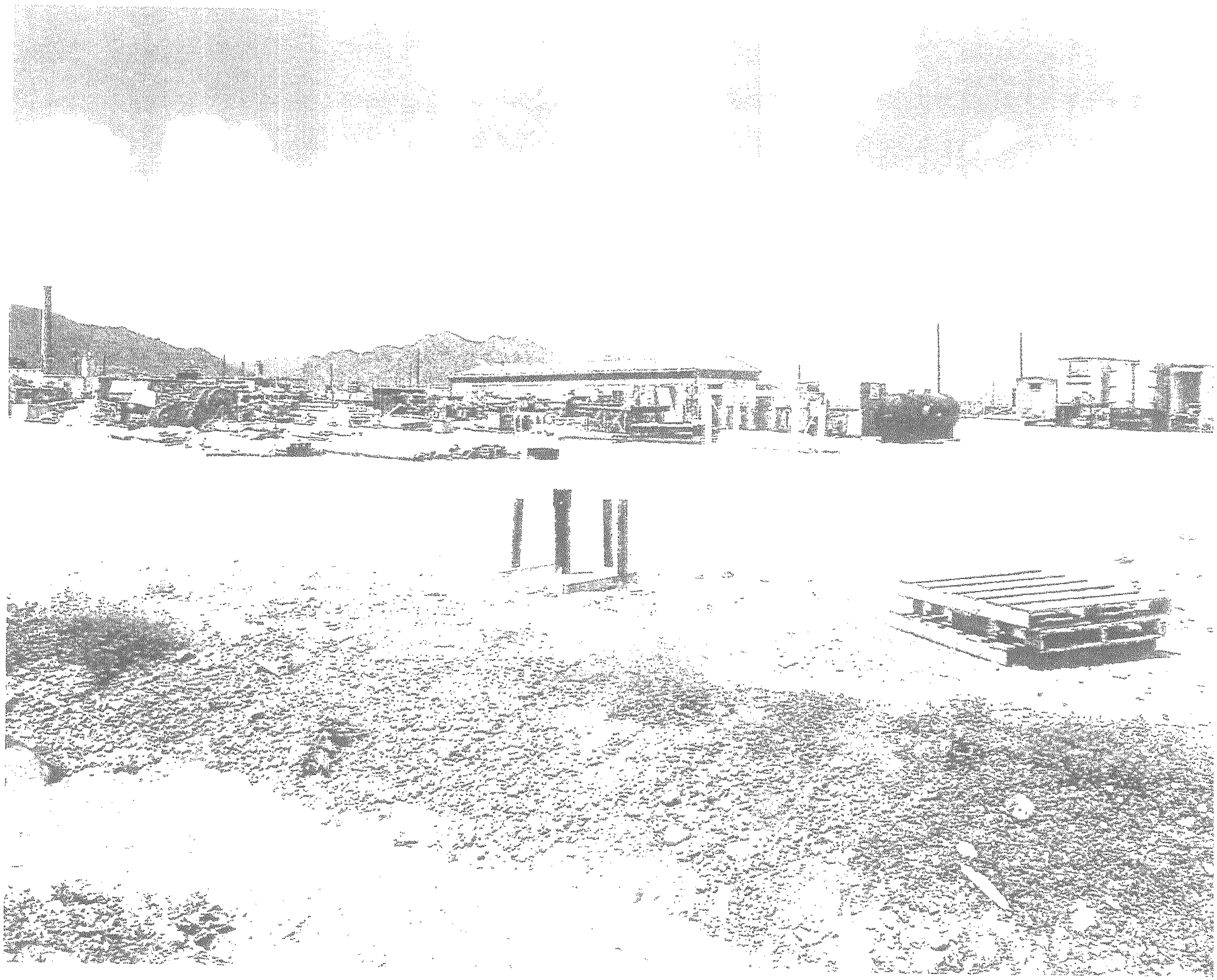


FIGURE 2.1-8
IHSS Location Map and Previous Sampling Locations – S & W Contractor Storage Yard (IHSS 176)



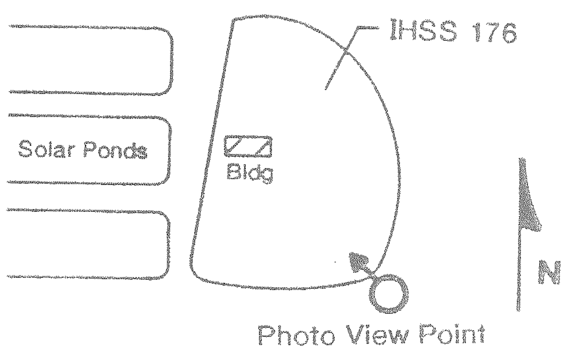


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FIGURE 2.1– 9
S & W Contractor Storage Yard
(IHSS 176) Site Photo

mineral spirits, water, waste oil, volatile organics, and metals. The containers were subsequently removed and disposed as hazardous waste. Most of the S&W Contractor Storage Yard area has been used for storage of surplus or raw materials for use by contractors in construction or maintenance projects rather than for drum storage or accumulation.

A site visit in May 1990 indicated that use of the S&W Contractor Storage Yard is diminishing. Air photos from 1967 to 1985 indicate that a larger area than the actual boundaries of IHSS 176 was used as a storage yard.

2.1.5.2 Previous Investigations

An initial soil characterization program to determine the nature and extent of soil contamination was specified for the S&W Contractor Storage Yard in the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b). Subsequent to submittal of the Closure Plan, soil samples were obtained in 1988 from the approximate ten locations shown in Figure 2.1-8 (Weston 1988). One sample location was based on ground staining, five sample locations were based on historical use of the area, and four sample locations were based on the presence of hazardous waste in 1985. The soil samples were collected from 1 ft deep excavations and were composited over the 1 ft deep interval except for VOA samples, which were grab samples from a depth of 1 ft. Analysis of soil samples included HSL VOAs, HSL BNAs, HSL metals, inorganics, and radionuclides.

Prior to soil sampling, a visual and a direct radiation survey using a FIDLER probe were also conducted to identify areas of potential contamination. The FIDLER survey was conducted on October 19, 1988. Background was determined to be 500 cpm. All FIDLER readings were below background. Since no areas exceeded background, no additional soil samples were collected (Weston 1988).

2.1.5.3 Physical Characteristics

The ground surface gently slopes to the northeast - east at IHSS 176 (Plate 1). Approximately 15 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 176. The alluvium observed in Well 2886 located 100 ft north of IHSS 176 consisted of a thin cobble layer resting atop claystone of the Arapahoe Formation which was overlain by approximately 8 ft of mixed gravel and clay (Appendix B). The groundwater flows to the northeast, and the depth to groundwater is estimated to be approximately 5 ft below the ground surface.

2.1.5.4 Nature and Extent of Contamination

Analysis of soil samples taken from borings in the area indicate levels above the detection limit for methylene chloride, and acetone (which were also present in some of the sample blanks). Table C-6 (Appendix C) lists the organics, metals, inorganics, and radionuclides detected. Metals and other inorganics detected include aluminum, arsenic, barium, beryllium, chromium, sodium, thallium, calcium, cadmium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, vanadium, zinc, strontium, and nitrate/nitrite. Radionuclides detected include gross alpha; gross beta; tritium; americium 241; plutonium 239, 240; uranium 238; and uranium 233, 234. Figure 2.1-8 illustrates the sampling locations of the analytes detected.

Upgradient data from Well P207689 indicates detections for the metals and inorganics aluminum, beryllium, calcium, lead, magnesium, sodium, cyanide, and sulfate. Table C-7 (Appendix C) lists the metals and other inorganics detected. Radionuclides detected include americium 241; plutonium 239; tritium; and uranium 233, 234. Table C-7 lists the radionuclides detected.

Analysis of groundwater samples taken from Well 0460 within IHSS 176 indicates detections for the inorganics and metals calcium, cobalt, magnesium, mercury, potassium, sodium, zinc, carbonate, and sulfate. Table C-8 (Appendix C) lists the metals and other inorganics.

Radionuclides detected include americium 241; gross alpha; plutonium 239; strontium 90; tritium; and uranium 233, 234. Table C-8 lists the radionuclides detected.

Metals and other inorganics located in the groundwater beneath IHSS 176 that were not detected in upgradient samples are cobalt, mercury, potassium, zinc, and carbonate. Radionuclides located beneath IHSS 176 that were not detected in upgradient samples include gross alpha and strontium 90. This may indicate that IHSS 176 is the source of these contaminants mentioned above but more information is needed from the proposed soil borings and wells at this site.

2.1.6 Building 885 Drum Storage Area (IHSS 177)

The following discussion is summarized from the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b) and the Draft Historical Release Report (DOE 1992).

2.1.6.1 Location and History

The Building 885 Drum Storage Area (IHSS 177) consists of the eastern and western sections of Building 885 (Figures 2.1-10 and 2.1-11). While the central section of Building 885 is completely enclosed, the eastern and western Drum Storage Areas are covered by a roof and are enclosed on two and three sides, respectively. The floors of the Drum Storage Areas are constructed of concrete. Each of the two Drum Storage Areas are approximately 10 by 20 ft in size.

IHSS 177 has been used for drum storage since 1953. The Drum Storage Areas have been used from 1986 to the present as a 90-day accumulation area and as a satellite collection station. The west section of Building 885 was used for storage of unused and waste oils, while the east section stored unused and waste paint and paint solvents. Waste material also contained low-level radioactive wastes. A maximum of ten to twenty 55-gallon drums were stored on pallets

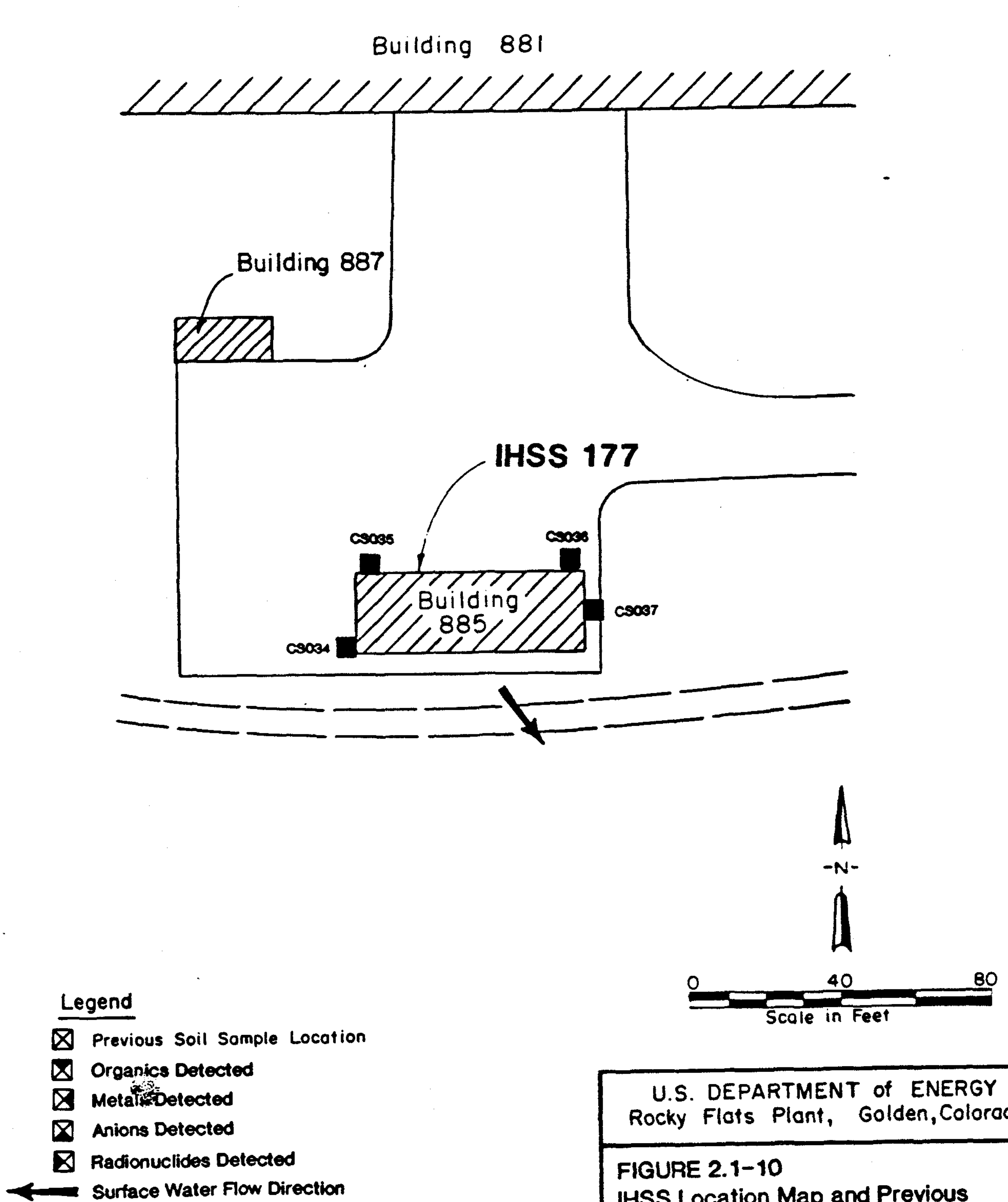

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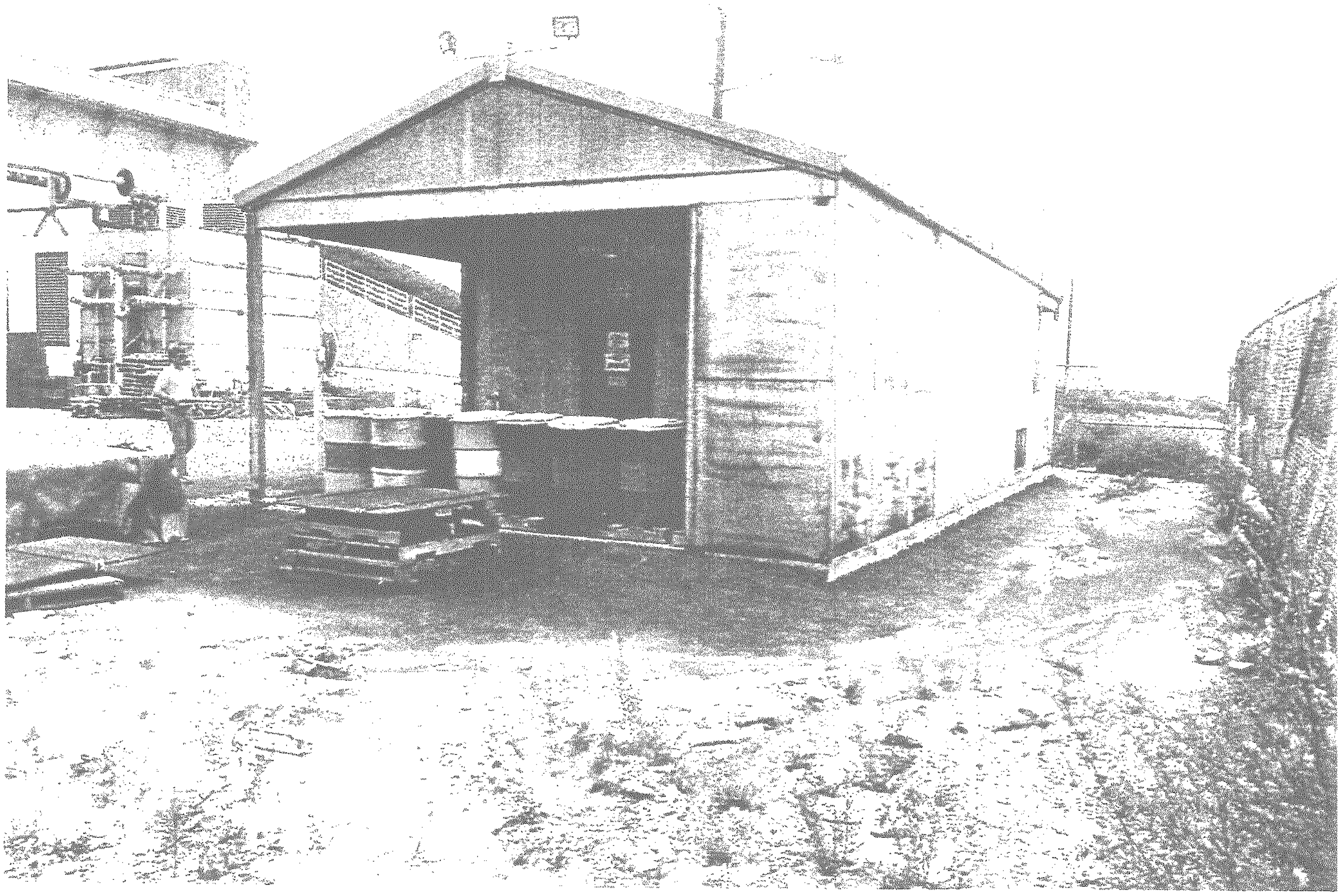
FIGURE 2.1-10
IHSS Location Map and Previous Sampling Locations - Building 885 Drum Storage Area (IHSS 177)



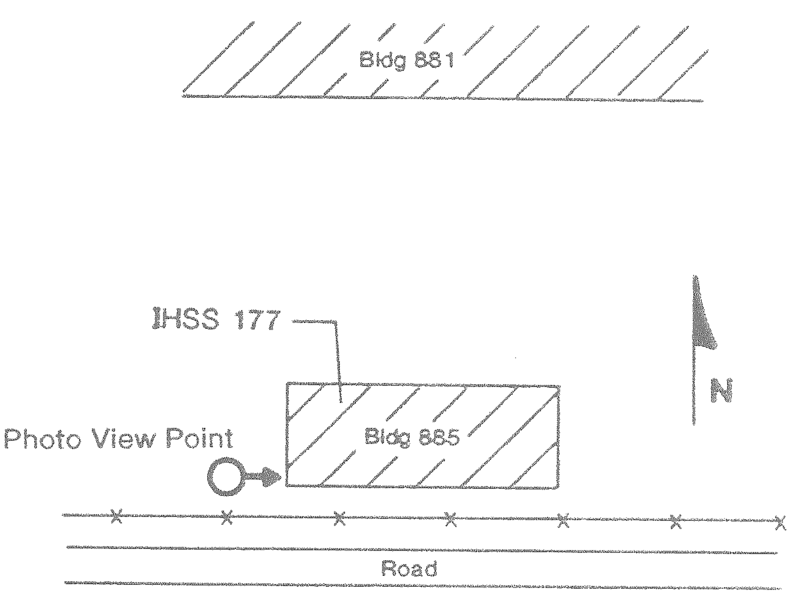


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FIGURE 2.1- 11
Building 885 Drum Storage Area
(IHSS 177) Site Photo

on the concrete floors in each area. There are no berms around the storage areas. Only one drum in each section was used for waste storage; the remaining drums contained unused oils and solvents. The total container storage capacity was 110 gallons, assuming only one drum in each of the two areas contained waste material. There have been no documented spills or leaks in this area.

2.1.6.2 Previous Investigations

An initial soil characterization program to determine the nature and extent of soil contamination was specified for IHSS 177 in the Closure Plan for the Container Storage Facilities (Rockwell International et al. 1988b). Subsequent to submittal of the closure plan, four soil samples were collected from IHSS 177 and analyzed in 1988. The approximate sampling locations are shown in Figure 2.1-10 (Weston 1988). These samples were collected from 1-ft-deep test pits located below a 6-inch-thick asphalt layer. Samples were composited over the test pit depth except for VOA samples, which were grab samples from a depth of 1 ft. Analysis of soil samples included HSL VOAs, HSL BNAs, HSL metals, inorganics, and radionuclides. Prior to soil sampling, a visual survey was conducted to identify areas of potential contamination.

A FIDLER survey was proposed in the Soil Characterization Plan but was never conducted. Information was obtained from the 800 area health physics department of FIDLER surveys conducted prior to the asphalt being laid down and after the asphalt was in place. Both prior FIDLER surveys did not detect gamma activity over a background of 250 cpm. Based on this information, no additional samples were collected (Weston 1988).

A recent visual survey of IHSS 177 indicated that the area was still in use for drum storage; however, no ground staining was observed. However, ground staining was noted during an earlier visual survey in 1986.

2.1.6.3 Physical Characteristics

The area around IHSS 177 gently slopes to the south and east (Plate 1). Approximately 12 ft of alluvium overlie the bedrock in the vicinity of IHSS 177. The alluvium, as described in Well 5187, located approximately 20 ft from the northwest corner of IHSS 177, consist of sandy, gravelly clay. The groundwater flows to the south and the depth to groundwater is estimated to be approximately 10 ft below the ground surface.

2.1.6.4 Nature and Extent of Contamination

Analysis of soil samples taken from borings surrounding IHSS 177 indicate detections of organics which include acetone, 2-butanone, and trans-1, 2-dichloroethene. Metals and inorganics detected include aluminum, arsenic, beryllium, chromium, strontium, manganese, barium, calcium, cadmium, copper, lead, iron, magnesium, mercury, vanadium, zinc, potassium, and nitrate/nitrite. Radionuclides detected include gross alpha; gross beta; tritium; uranium 238; uranium 233, 234; plutonium 239, 240; and americium 241. Table C-9 (Appendix C) lists the organics, metals, inorganics, and radionuclides detected. Figure 2.1-10 illustrates the sampling locations of the analytes detected.

Analysis of groundwater samples taken from upgradient Well 5287 indicates detections for metals and other inorganics including aluminum, calcium, copper, magnesium, manganese, nickel, sodium, zinc, and sulfate. Table C-10 (Appendix C) lists metals and other inorganics detected. Radionuclides detected include americium 241; gross alpha; plutonium 239; uranium 233, 234; uranium 238; and tritium. Table C-10 lists the radionuclides detected.

Downgradient data from Well 5387 indicates detections for the metals and other inorganics including calcium, copper, magnesium, nickel, sodium, zinc, and sulfate. Table C-11 (Appendix C) lists the metals and other inorganics detected. The radionuclides detected include uranium 233, 234. Table C-11 lists the radionuclides detected.

2.1.7 Building 334 Cargo Container Area (IHSS 181)

The following discussion is summarized from the closure plan for the Container Storage Facilities (Rockwell International et al. 1988b).

2.1.7.1 Location and History

IHSS 181 is the site of a former cargo container area. The cargo container was an 8- by 20- by 8-ft steel container and was used to store 55-gallon drums. The cargo container was located in the parking lot north of Building 334 (Figure 2.1-12). A maximum of eighteen 55-gallon drums could be stored in the cargo container; however, seven drums were the maximum stored there. The maximum storage capacity was, therefore, 385 gallons. The cargo container was located on an asphalt pad, and a collection pan was located in the bottom of the cargo container for secondary containment.

This area was used from the summer of 1984 to July 1986 for storage of drums containing waste machine oils, solvents, machine coolants and, possibly, low-level radioactive wastes. There is no documented or visual evidence of spills or leakage. The cargo container was moved to the Building 444/453 Drum Storage Area, IHSS 182 (Section 2.1.8).

2.1.7.2 Previous Investigations

No previous investigations of IHSS 181 have been conducted.

2.1.7.3 Physical Characteristics

The topography of IHSS 181 gently slopes to the east (Plate 1). The groundwater flows to the northeast and the depth to groundwater is approximately 10 ft below the ground surface. The closest well is located approximately 200 ft from the site; therefore, the data from well logs will not provide representative descriptions of geological materials at the IHSS. Approximately 20 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 181.

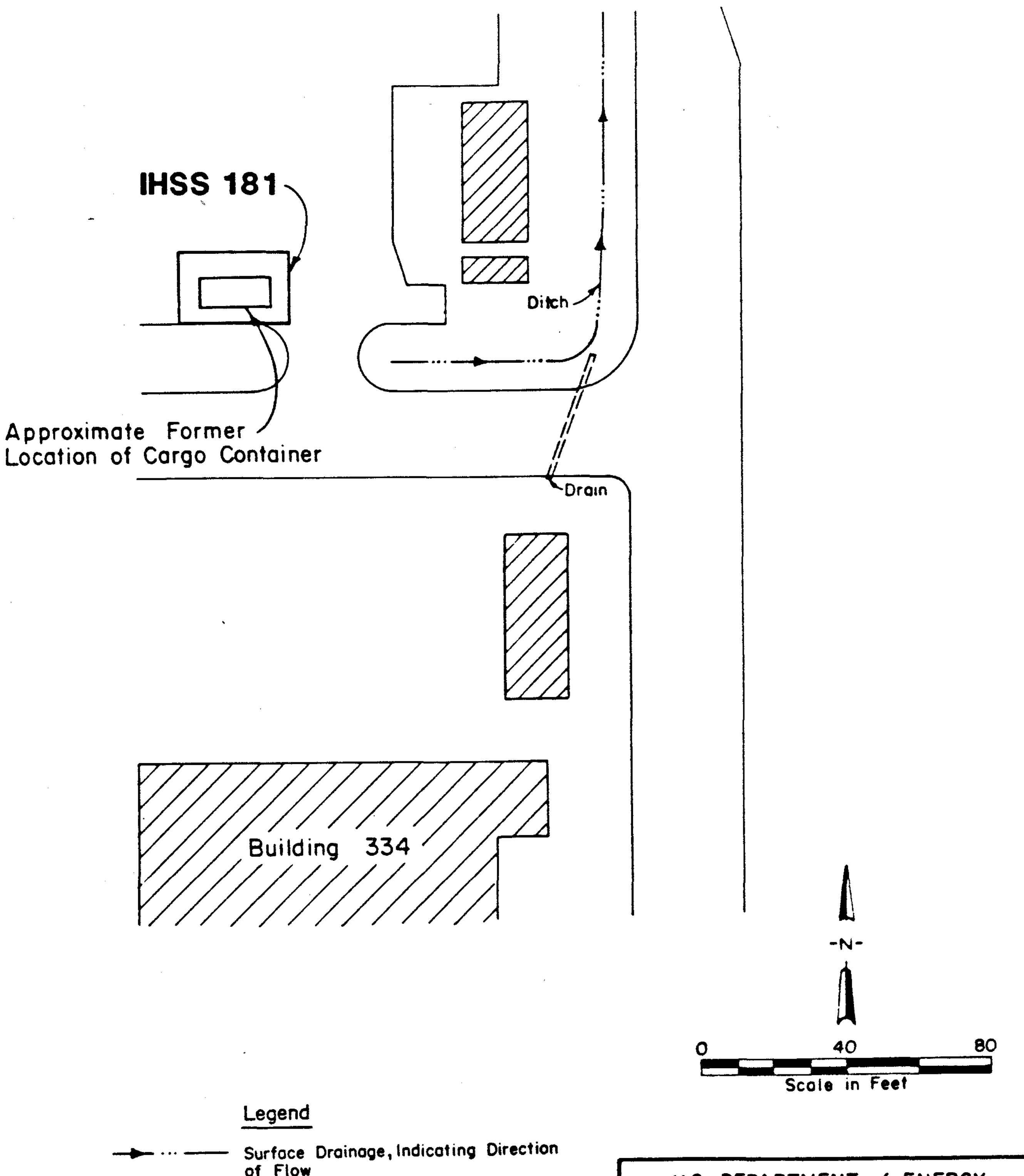

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FIGURE 2.1-12
Building 334 Cargo Container Area (IHSS 181) Location Map

2.1.7.4 Nature and Extent of Contamination

No analytical data on soil or water are available, so the extent of contamination in this area is unknown.

No upgradient or downgradient analytical groundwater data are available for this area.

2.1.8 Building 444/453 Drum Storage Area (IHSS 182)

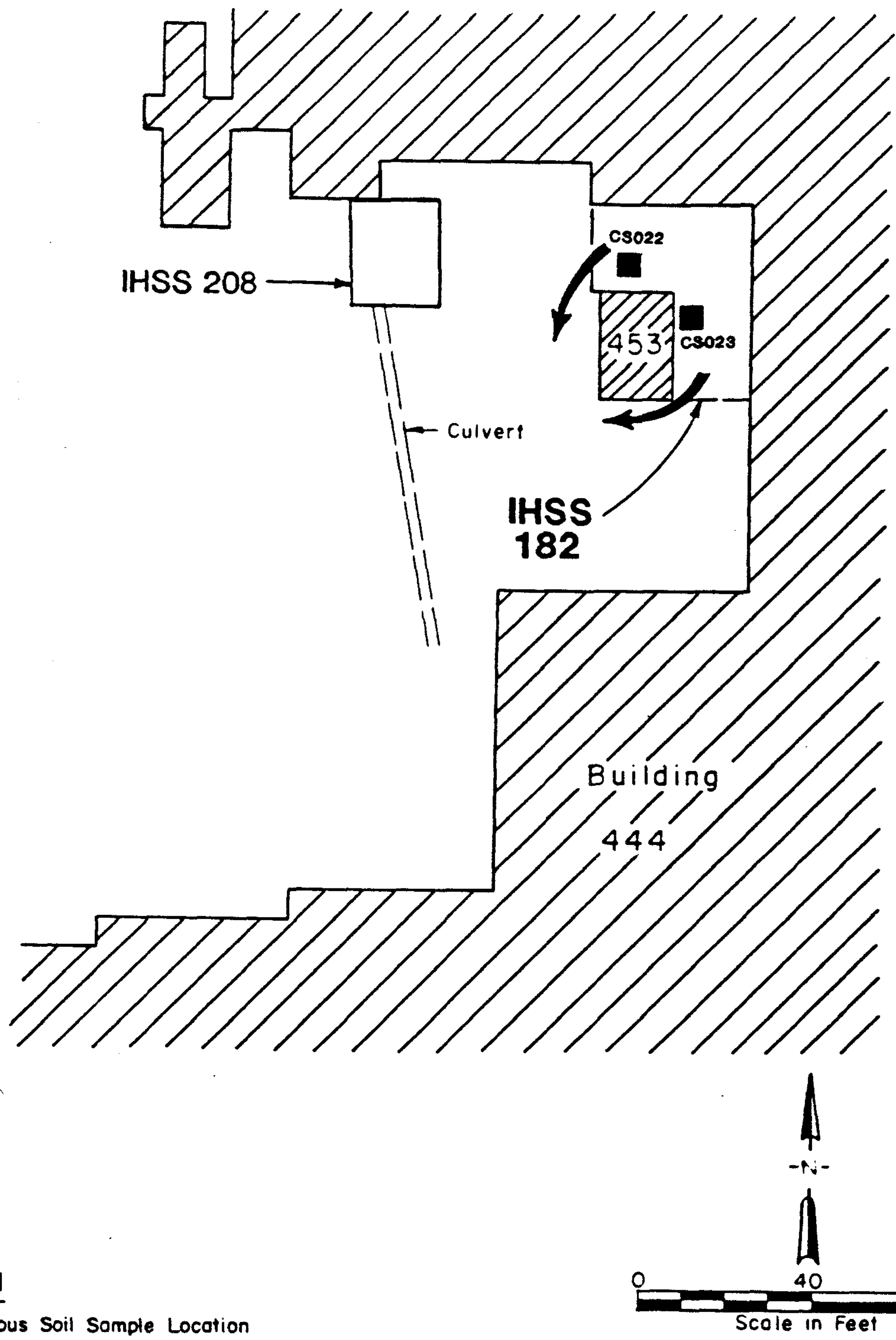
The following discussion is summarized from the closure plan for the Container Storage Facilities (Rockwell International et al. 1988b) and the Draft Historical Release Report (DOE 1992).

2.1.8.1 Location and History

IHSS 182 is located between Buildings 444 and 453 and covers an area of approximately 1,700 square ft (ft^2) (Figures 2.1-13, 2.1-14, and 2.1-15). In the mid-1970s, the area was covered with 4 inches of asphalt. There are no berms around the area.

IHSS 182 was first used as a storage area. In May 1957, it was noted that numerous drums of depleted uranium oxide were being stored in the "backyard" of Building 444. Originally, 55-gallon drums were placed directly on the ground surface. In the mid-1970s, the top 4 inches of soil in a portion of the Drum Storage Area was removed because it was believed to be contaminated. It was replaced with 4 inches of asphalt. However, drums were still stored on the soil in the remaining portion of the Drum Storage Area. It is unknown where the contaminated soil was moved or stored or whether contaminated soil samples were collected and analyzed.

The maximum number of drums ever stored at one time was approximately 200; however, some of these drums contained unused oil. The exact number of drums containing contaminated waste oils or solvents is unknown. Based on storage of two hundred 55-gallon drums, the total container storage capacity at any given time was 11,000 gallons. Waste hydraulic oils and



Legend

- Previous Soil Sample Location
- Organics Detected
- Metals Detected
- Anions Detected
- Radionuclides Detected
- Surface Water Flow Direction

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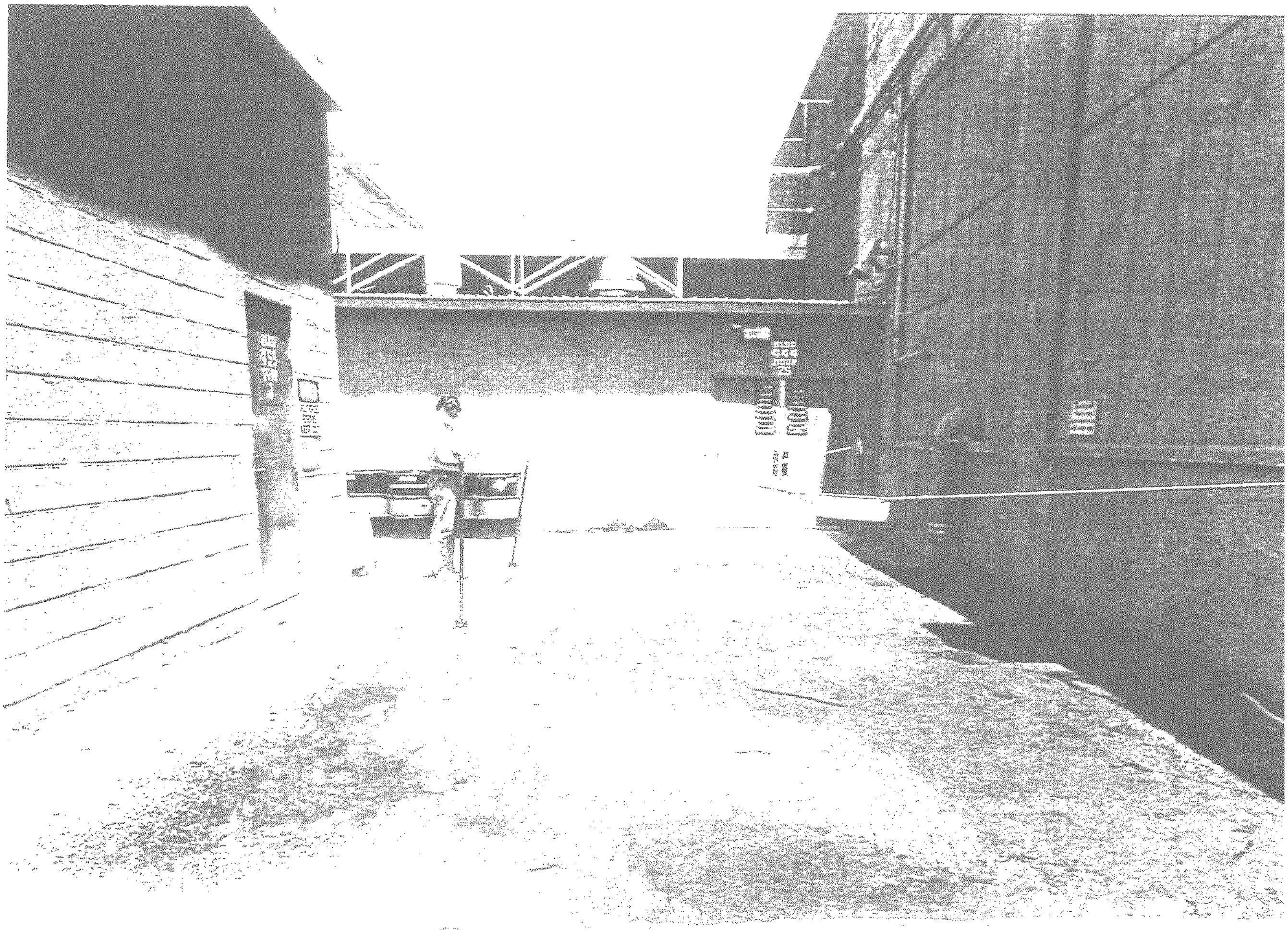
FIGURE 2.1-13
IHSS Location Map and Previous Sampling Locations – Building 444/453 Drum Storage Area (IHSS 182)



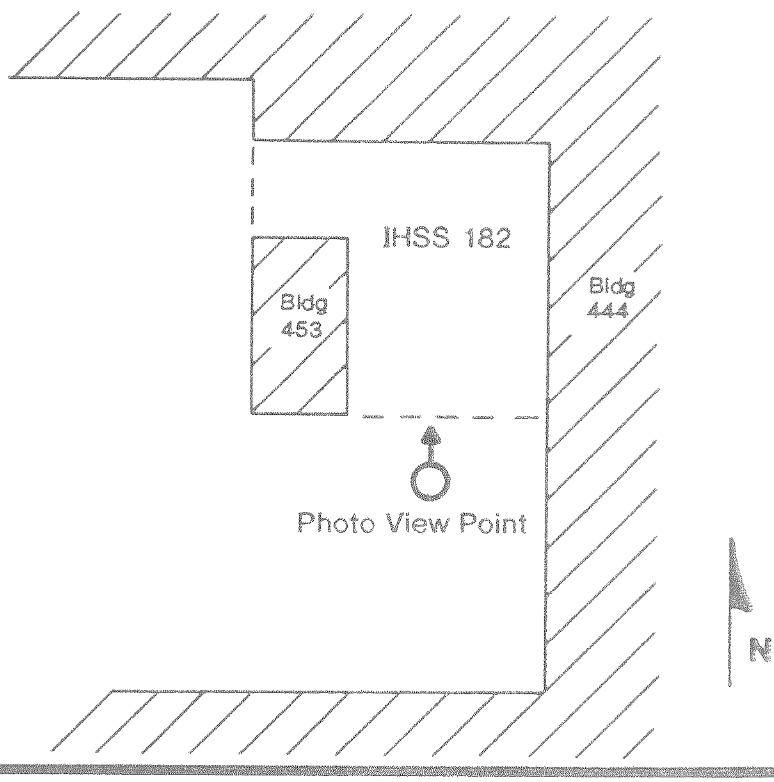


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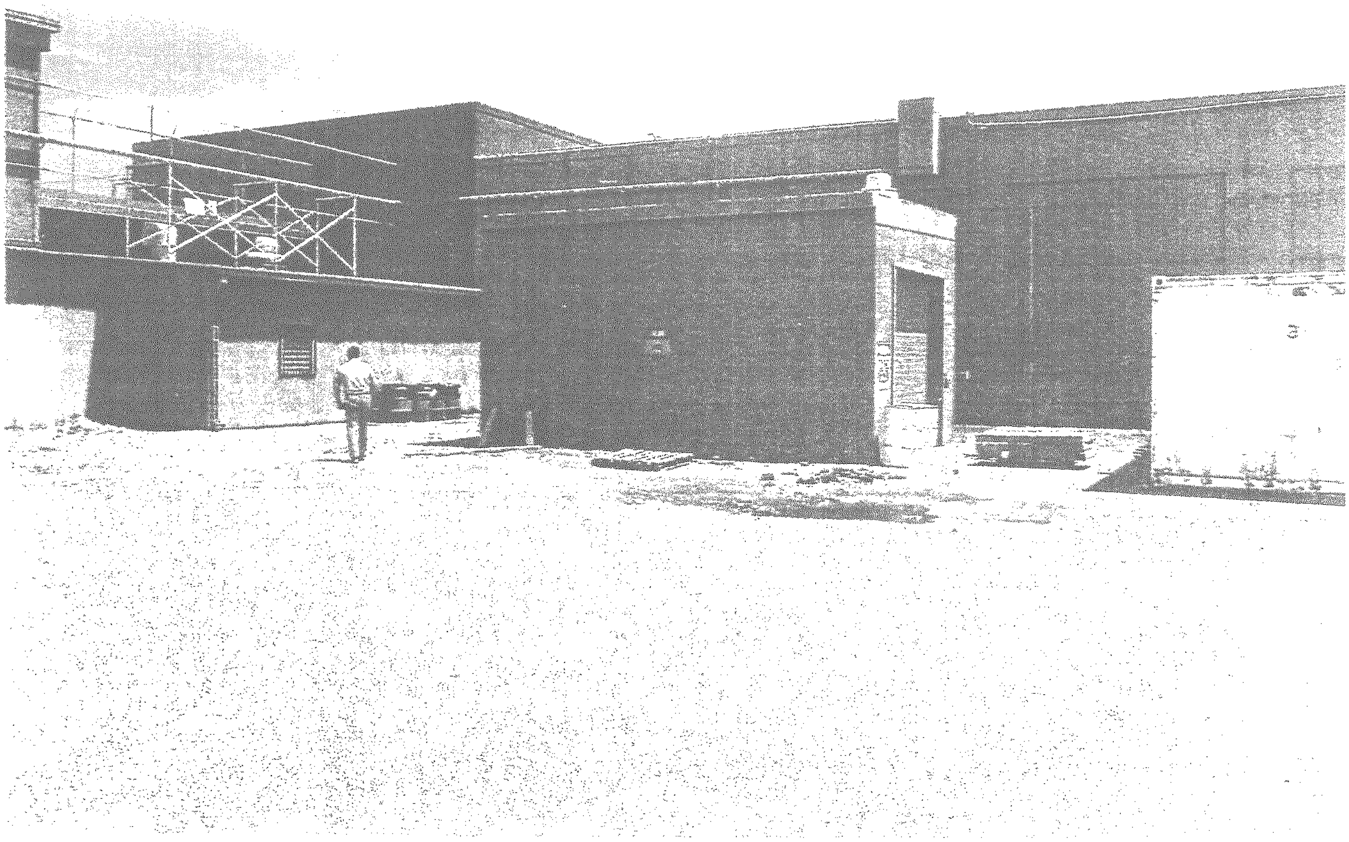
FIGURE 2.1-14
Building 444/453 Drum Storage Are
(IHSS 182) Site Photo



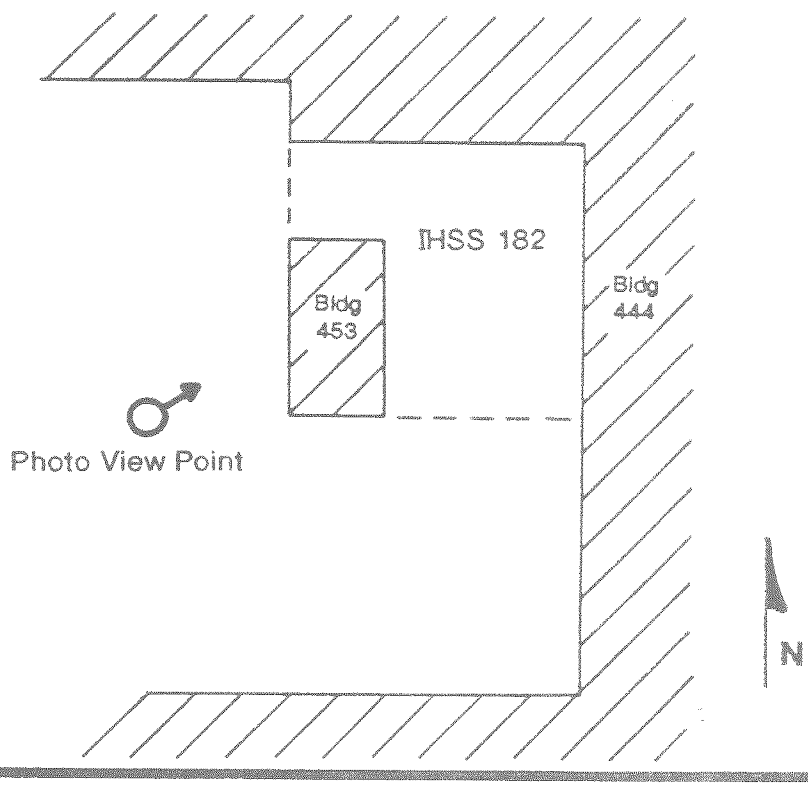


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FIGURE 2.1-15
Building 444/453 Drum Storage Are
(IHSS 182) Site Photo

chlorinated solvents were stored in the 55-gallon drums. Beryllium and low-level uranium contamination were sometimes present in the waste. IHSS 182 is roped off and is generally empty, although trash, such as wood, is sometimes temporarily placed in the roped off area.

Building 453 was used as an oil storage area. In July 1983, high groundwater lifted oil that had been spilled over the years to the surface of the soil forming pools of oil near the building. At this time, 25 barrels of used oil were stored outside the building.

The Building 334 Cargo Container was moved and relocated adjacent to IHSS 182 in fall 1986. This cargo container was moved out of IHSS 182 to the main hazardous waste storage area identified as Unit #1 in the RCRA Part B permit application (Rockwell International et al. 1988b).

During a site visit in May 1990, no drums of waste oil or solvents were observed in IHSS 182. Soil staining, apparently due to spillage of oils, was generally present throughout IHSS 182. Aerial photographs taken in 1982 reveal dark stains around Building 453 and along the western side of Building 444.

2.1.8.2 Previous Investigations

An initial soil characterization program to determine the nature and extent of soil contamination was specified for IHSS 182 in the closure plan for the Container Storage Facilities (Rockwell International et al. 1988b). Subsequent to submittal of the closure plan, soil samples were obtained in 1988 from the approximate locations shown in Figure 2.1-13 (Weston 1988). These samples were collected from 1-ft-deep excavations below the concrete sidewalk and were composited over the 1-ft-deep interval except for VOA samples, which were grab samples from a depth of 1 ft. The soil samples were reportedly analyzed for HSL VOAs, BNAs, HSL metals, inorganics, and radionuclides. Section 2.1.8.4 presents the results of this sampling.

Prior to soil sampling, visual and direct radiation surveys using a FIDLER probe were also conducted to identify areas of potential contamination. The FIDLER survey was conducted on October 24, 1988. Background was determined to be 250 cpm. The survey on the asphalt areas revealed above background readings ranging from 500 to 2500 cpm. Additionally, areas along the buildings and the cracks between the concrete and asphalt ranged from 750 to 1000 cpm. The survey conducted on the concrete was at the background limit of 250 cpm (Weston 1988).

2.1.8.3 Physical Characteristics

The land surface at IHSS 182 is nearly flat. A small depression where surface water collects is located near the southwest corner of the site. The geologic materials in the vicinity of IHSS 182 consist of Rocky Flats Alluvium, fill, and Arapahoe Formation deposits.

The topography gently slopes to the east and south (Plate 1). Approximately 25 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 182. The groundwater flows to the east and the depth to groundwater is approximately 20 ft below the ground surface.

2.1.8.4 Nature and Extent of Contamination

Analysis of soil samples taken from borings in the area indicate detections of organics which include acetone, 1,1,1-trichloroethane, toluene, ethylbenzene, total xylenes, naphthalene, phenanthrene, fluoranthene, and pyrene. Table C-12 (Appendix C) lists the organics, metals, and radionuclides detected. Metals detected include aluminum, barium, beryllium, calcium, chromium, lead, cadmium, copper, iron, mercury, potassium, magnesium, manganese, nickel, vanadium, zinc, and nitrate/nitrite. Radionuclides detected include gross alpha; gross beta; tritium; uranium 233, 234; uranium 238; plutonium 239, 240; and americium 241. Figure 2.1-13 illustrates the sampling locations of the analytes detected.

No representative upgradient or downgradient analytical groundwater data are available for this area.

2.1.9 Building 460 Sump #3 Acid Side (IHSS 205)

The following discussion is summarized from the closure plan for the Building 460 Acid and Solvent Dumpsters (Advanced Sciences, Inc. 1988).

2.1.9.1 Location and History

The dumpsters (portable cylindrical vessels) are located outside Building 460 along the southeast corner of the building (Figures 2.1-16 and 2.1-17). (Figure 2.1-16 varies slightly from the CAD drawing given in the HRR which incorrectly shows this IHSS completely inside Building 460.) These 460 dumpsters had been operated as interim status units in the 1986/1987 time frame, and were identified in the November 1986 RCRA Part A and Part B permit applications. The acid dumpsters are still in use, but as a 90-day accumulation area rather than an interim status unit. These changes from interim status were reflected in the Revised RCRA Part A and Part B Permits submitted to CDH and EPA on December 15, 1987. Interim status usage of the dumpsters ceased on March 24, 1988.

Lines run from the waste generators to a sump or holding tank (the acid sump is located in Room 156B), after which lines run from these holding tanks through the concrete wall to the dumpsters, where they are attached by quick connect couplings to the dumpsters.

The acid dumpsters are 3/16-inch thick, 394L stainless steel, 250-gallon cylinders, lined with Kynar polyvinyledine fluoride (as specified by SM-122, Section 6, ASME). Each dumpster contains an 18-inch-diameter manhole on the top and a 1-inch-diameter drain fitted with a ball-valve in the bottom. The paired dumpsters are used in a manner such that one dumpster of the pair can receive wastes while the other dumpster is being emptied.

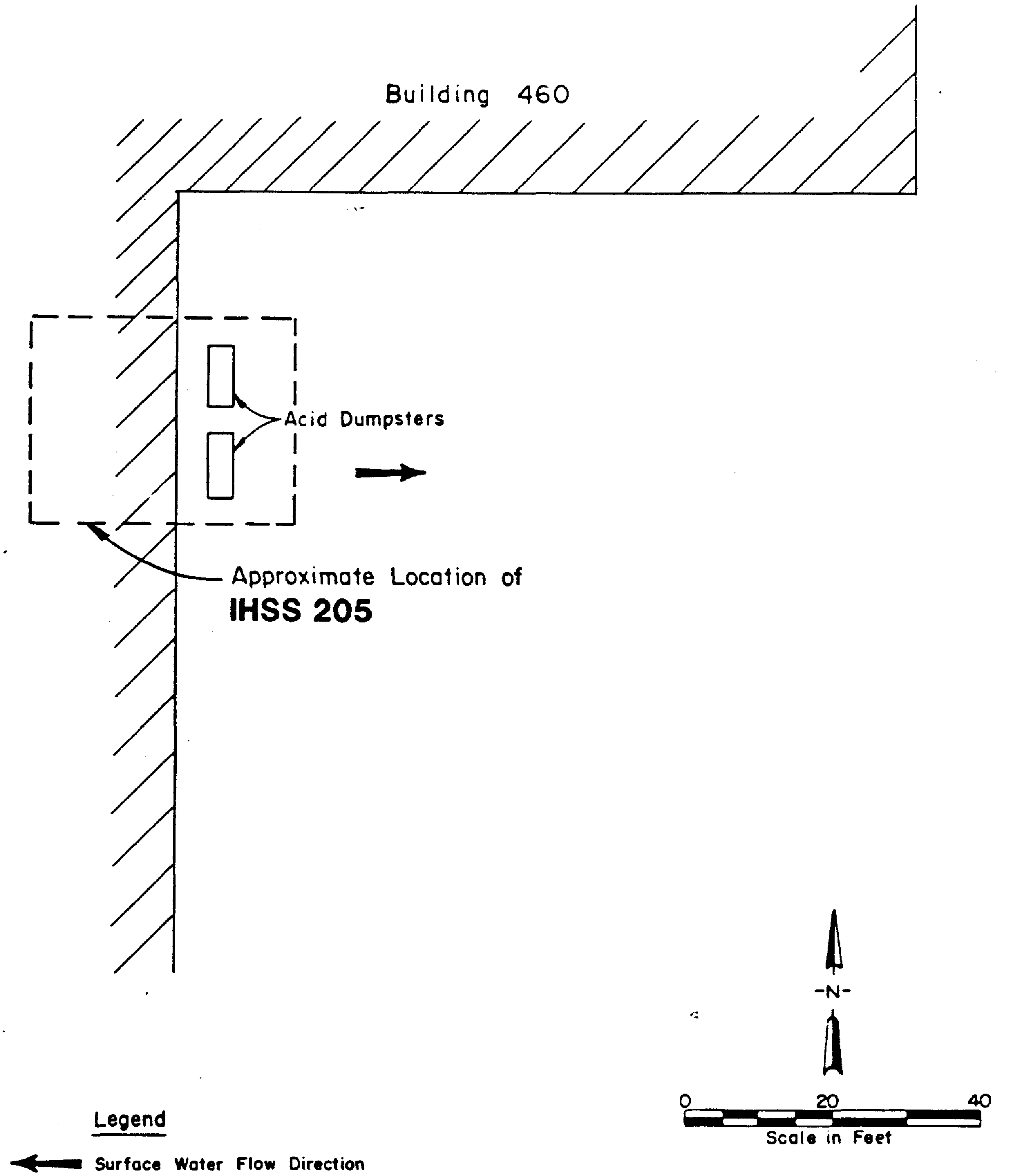

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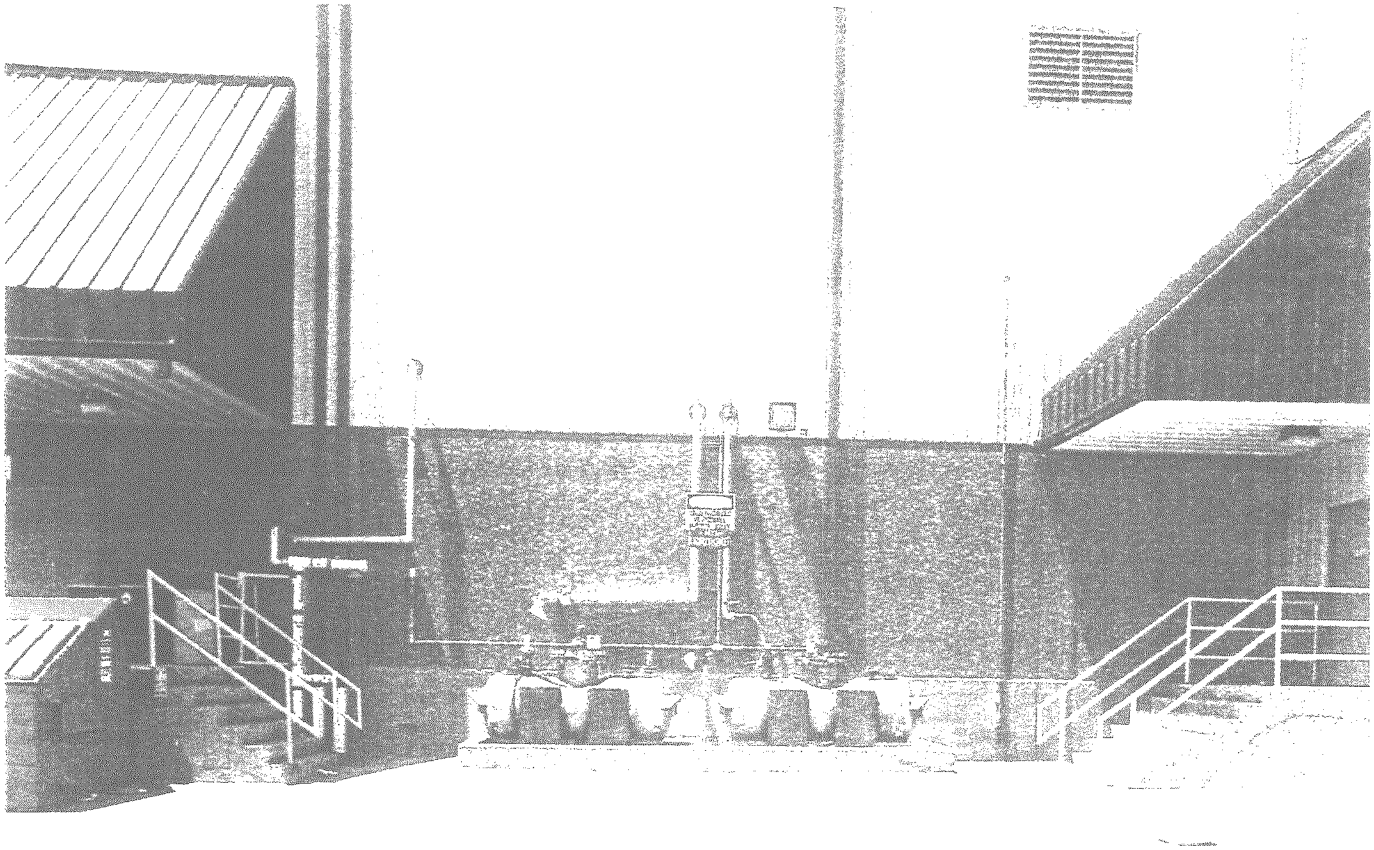
FIGURE 2.1-16
Building 460 Sump #3 Acid Side (IHSS 205) Location Map



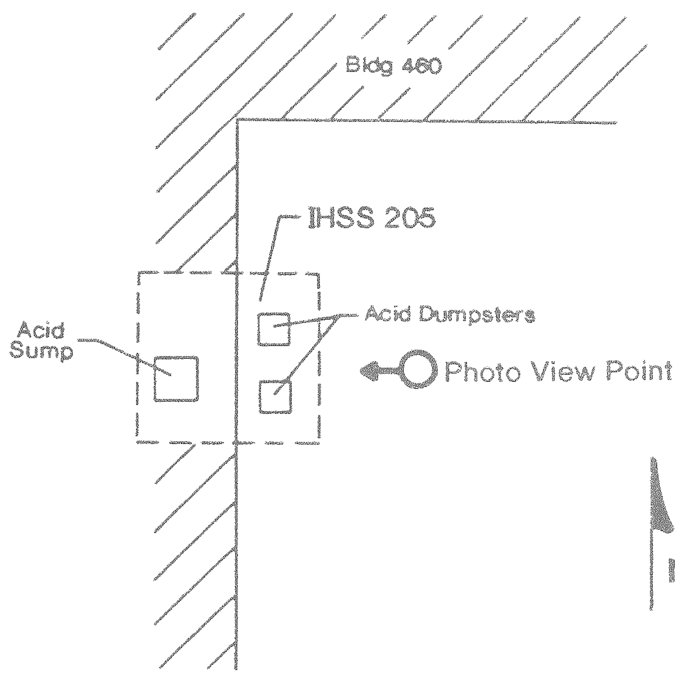


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FIGURE 2.1- 17
Building 460 Sump #3 Acid Side (IHSS 205) Site Photo

The acid dumpsters have a storage capacity of 250 gallons each or a combined total of 500 gallons; however, they are used one at a time. Therefore, the capacity for storage is normally somewhat less than 250 gallons. An additional small amount of storage is available in an acid sump, a fiberglass tank located inside Building 460 (Room 156B) where acid wastes are transferred to the acid waste dumpsters through permanent piping.

A level sensor is mounted in a 2-1/2-inch-diameter, stainless steel pipe near the end of each dumpster. An up-to-the-minute log of the volume in the tank is maintained and visually checked with the sensor weekly to determine when dumpster changeover was necessary, generally when the liquid level reached about 1 ft from the top of the dumpster.

The dumpsters are contained within a concrete-bermed area, with a concrete divider separating each dumpster (Figure 2.1-17). Each bermed area measures 4 ft, 6-1/2 inches wide by 8 ft, 6 inches long, and 12 inches deep. Each bermed area has a 286-gallon capacity.

The containment areas cannot be drained into one another, e.g., each area represents a distinct basin separated by the dividing berm(s). Each basin, however, can be partially drained to the area outside of containment through a drain hole located 1-1/2 inches above the basin floor. It is unknown if these drain holes were ever opened, but they are currently plugged.

No cracks are present in the concrete containment pad under the acid dumpsters, and no spills from the dumpsters have ever escaped the secondary containment system. No stains from dumpster spillage are present. Stain from rainwater and snowmelt accumulation, however, is present.

The acid dumpsters are connected to an acid sump (a fiberglass tank in the wall of Building 460) with quick-disconnects to facilitate exchanging dumpsters. A pump transfers waste acids from the sump through a dedicated pipe system to the acid waste dumpster. The acid sump is connected to the Building 460 dedicated drainage system (exclusively acids).

When it is necessary to empty one of the dumpsters, it is either transported by the Trucking group directly to Building 374 or 774, or moved by forklift to an adjacent, bermed location for transfer to drums. Acid wastes are transferred from the dumpsters to steel drums with poly liners, using a 1/2-hp pump and 1-inch-diameter Tygon tubing. Filled acid drums are then stored in the Building 460 Drum Storage Area.

Waste materials handled by the Acid Dumpster were a mixture of approximately 80 percent water and 20 percent acid. The acids were primarily nitric acid and Nitradd, a combination of hydrofluoric acid and ammonium salts.

Building 460, the Consolidated Non-Nuclear Manufacturing Building, contains 25 major functions/operations:

Electric Discharge Machining	Copper Cleaning
Acid Cleaning - Automated line	Aqueous Cleaning
Acid Cleaning - Internal line	Inspection
Electro-Chemical Machining	R and D Lab
Final Step-Cleaning	Machinery
Nondestructive Testing	Assembly Machining
Hardware Machining	Assembly
R and D Shop	Maintenance Paint Shop (2)
Maintenance Machine Shop	Maintenance Pipe Shop
Crush Grinding Operation	Lube Oil Storage
Maintenance Sheet Metal Shop	Production Testing Cells
Maintenance Carpenter Shop	Metallography Lab

2.1.9.2 Previous Investigations

Previous soil sampling investigations have not been conducted at this site.

2.1.9.3 Physical Characteristics

The area around IHSS 205 is paved and flat lying. The geologic materials in the vicinity consist of Rocky Flats Alluvium, fill, and Arapahoe Formation deposits.

Approximately 25 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 205. The closest well is located approximately 500 ft from the site; therefore, detailed bore logs do not provide representative information on geologic materials in IHSS 205. The topography gently slopes to the east and south (Plate 1). The groundwater flows to the east and the depth to groundwater is approximately 20 ft below the ground surface.

2.1.9.4 Nature and Extent of Contamination

No samples were collected in this area for analysis, so the presence/absence of contamination is unknown.

No upgradient or downgradient analytical groundwater data are available for this area.

2.1.10 Inactive D-836 Hazardous Waste Tank (IHSS 206)

The following discussion is summarized from the RCRA Part B Permit Application (Rockwell International 1987) and the Draft Historical Release Report (DOE 1992).

2.1.10.1 Location and History

IHSS 206 was previously identified in the RCRA Part B permit application (Rockwell International 1987) as Unit # 41.14, a portion of the Building 374 Waste Treatment Facility (Unit #42). Although the D-836 Hazardous Waste Tank was mobile, after consulting the Building Manager, the area considered for the scope of this work plan is the area outside Building 374 where this tank was connected to the building (Figures 2.1-18 and 2.1-19). The

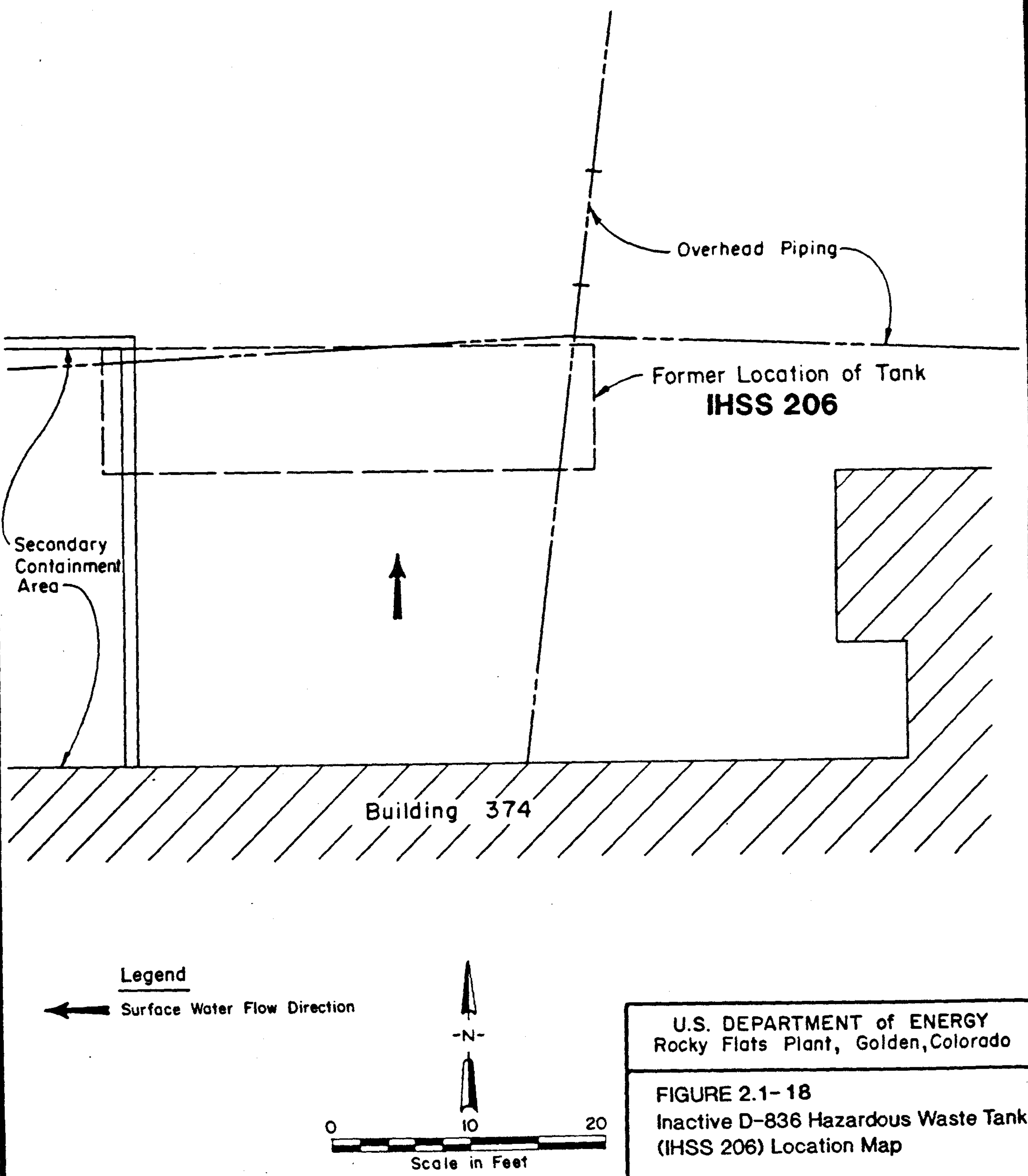

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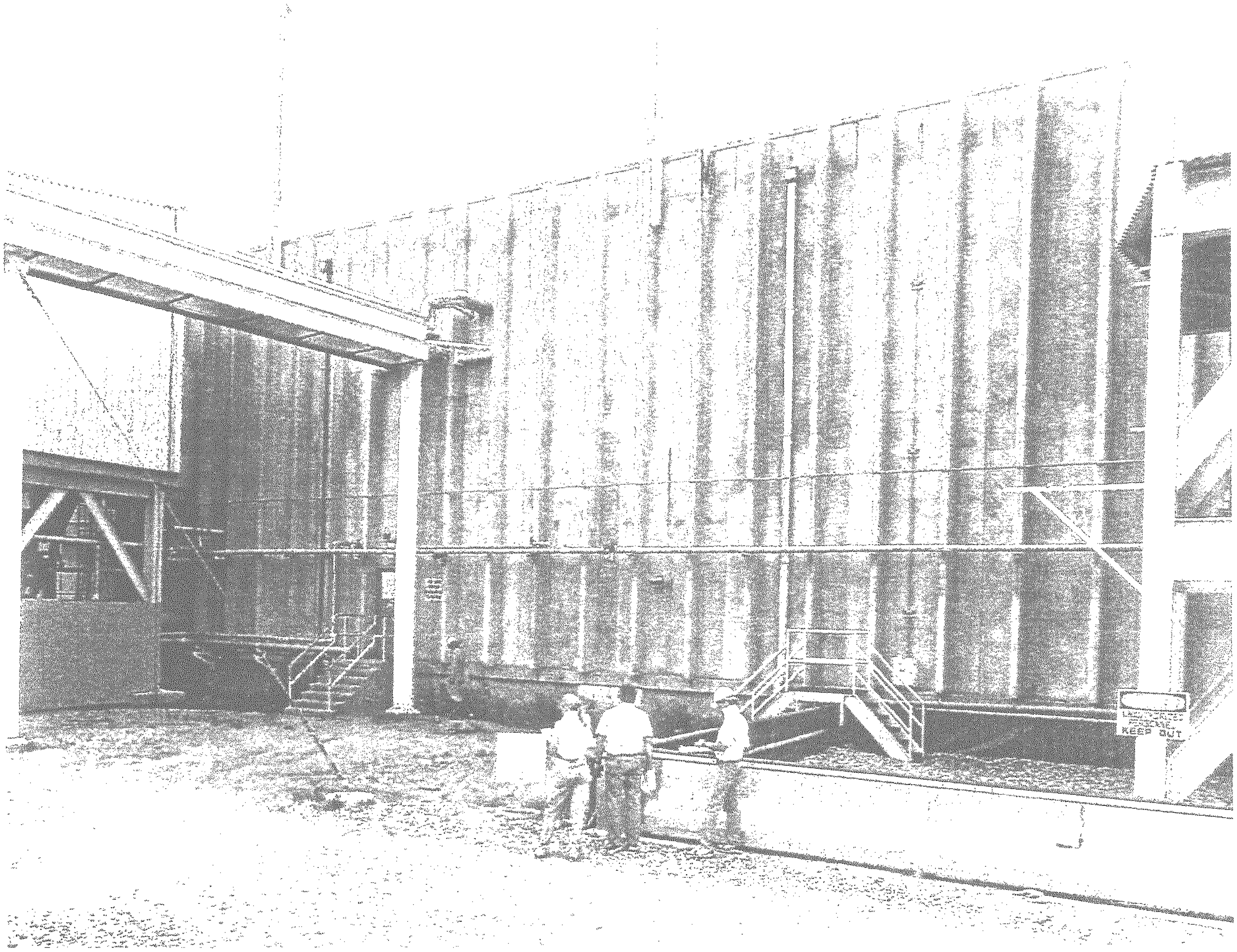
FIGURE 2.1-18
Inactive D-836 Hazardous Waste Tank (IHSS 206) Location Map



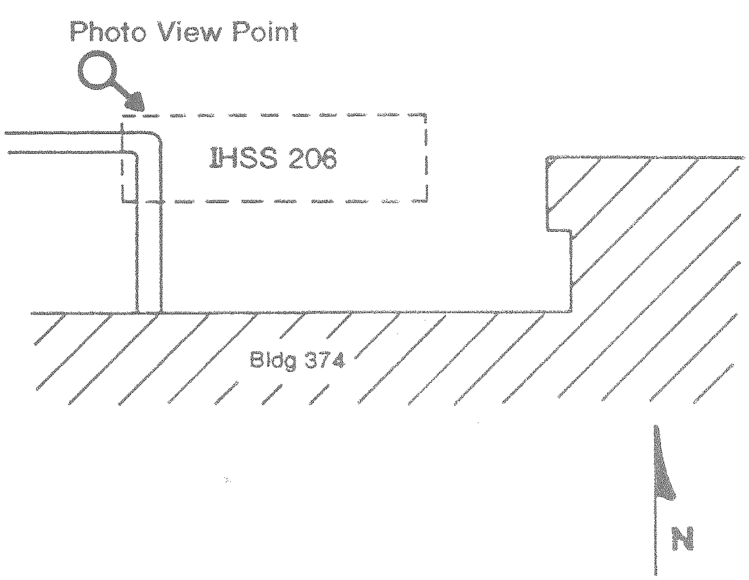


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FIGURE 2.1-19
Inactive D-836 Hazardous Waste Ta
(IHSS 206) Site Photo

tank is constructed of carbon steel and is 8 ft in diameter and 49.5 ft in length, with a total storage capacity of 19,000 gallons.

The Inactive D-836 Hazardous Waste Tank was a 19,000-gallon, carbon steel tank constructed in 1962. Prior to 1975, it was probably used to store U.S. Air Force fuel at another location. From 1975 to 1987, the tank was used to store off-specification Building 374 product water (water too high in conductivity).

In February 1980, a spill of condensate water containing low concentrations of tritium occurred when a line from the evaporator to the tank was disconnected. The tank was located over compacted soil outside of Building 374 and was not secondarily contained.

2.1.10.2 Previous Investigations

Previous soil sampling investigations have not been conducted at this site.

2.1.10.3 Physical Characteristics

The topography of IHSS 206 gently slopes to the north - northeast (Plate 1). The geologic materials in the vicinity consist of Rocky Flats Alluvium, fill, and Arapahoe Formation deposits.

Approximately 5 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 206. The closest well is located approximately 750 ft from the site; therefore, detailed bore logs will not be useful for detailed information on geologic materials at the IHSS. The groundwater flows to the northeast and the depth to groundwater is approximately 15 ft below the ground surface.

2.1.10.4 Nature and Extent of Contamination

No soil sampling investigations have been conducted at this site, so the nature and extent of contamination is not known.

No upgradient or downgradient analytical groundwater data are available for this area.

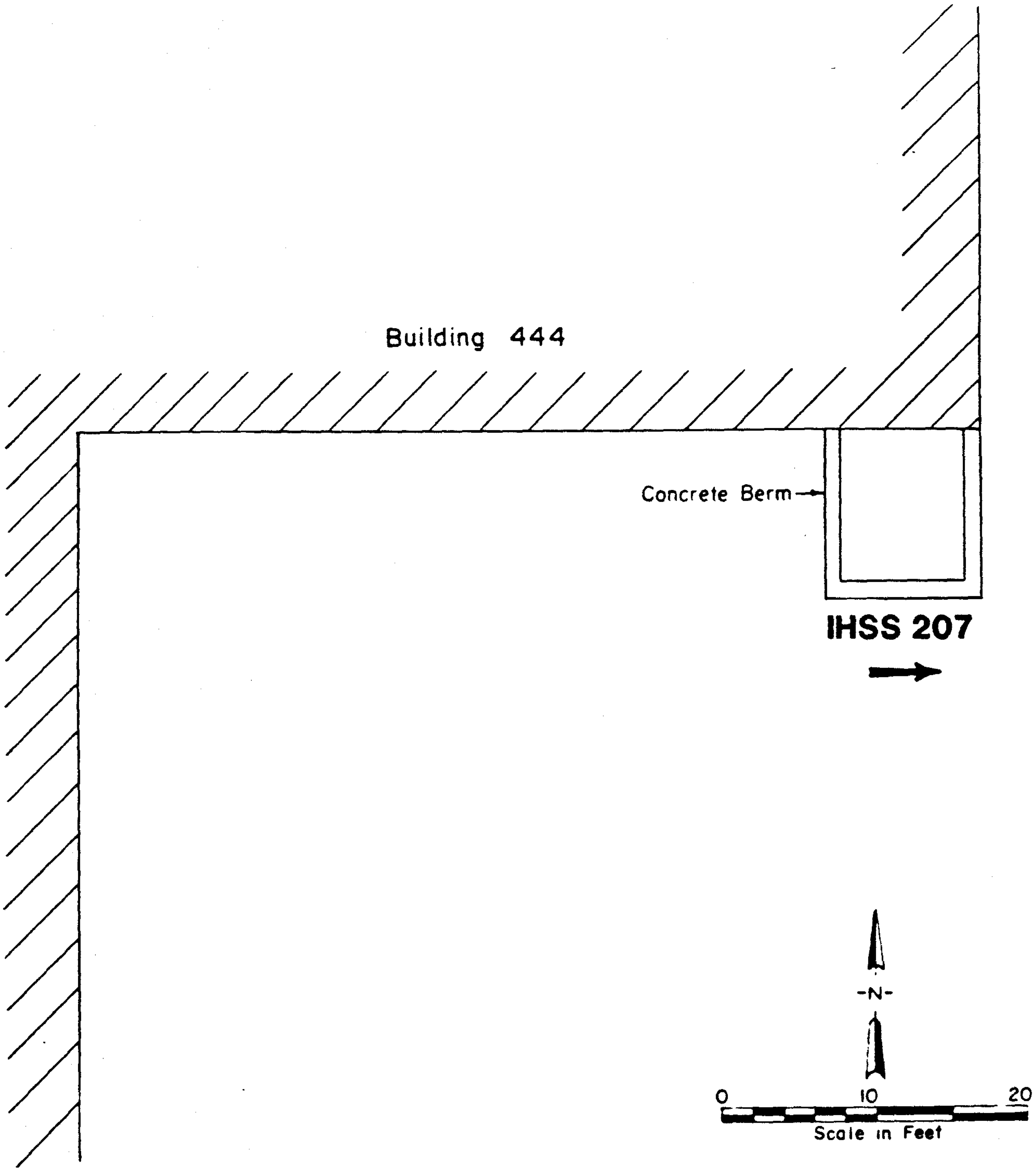
2.1.11 Inactive Building 444 Acid Dumpsters (IHSS 207)

The following discussion is summarized from the closure plan for Building 444 Acid Dumpsters (Rockwell International et al. 1988c) and the Draft Historical Release Report (DOE 1992).

2.1.11.1 Location and History

IHSS 207 is the site of former Building 444 Acid Dumpsters which were located outside and to the east of Building 444 (Figures 2.1-20 and 2.1-21). (Figure 2.1-20 gives a more accurate depiction of IHSS 207 than the one given by the HRR CAD drawing which shows the IHSS in the street.) Each dumpster had the capacity to handle 500 gallons of waste. Only one dumpster was filled at a time. The dumpster receiving waste was placed within an asphalt bermed area with inner dimensions measuring 9-1/2 ft by 9 ft by 1 ft and a capacity to contain 640 gallons.

The acid dumpsters were used to store acidic wastes from Building 444 and operated from 1980 through 1987. When one dumpster was full it was transported to Building 374 or 774 for treatment and the other dumpster was subsequently used for waste storage. The waste consisted of acidic waste from the chemical milling of beryllium and electropolishing solution from chemical milling. The raw milling acid consisted of a mixture of 75 percent phosphoric acid, 3 percent sulfuric acid, and chromium trioxide. The electropolishing solution consisted of phosphoric acid. The spent acid was drained into a sump and then into the acid dumpsters. The bermed area was inspected frequently. In January 1981, radiation monitoring detected uranium-contaminated process waste that had leaked into the catch basin due to a missing gasket within the quick disconnect assembly. The spill was cleaned up. The acid dumpsters and associated piping were decontaminated and moved to another process area during 1987. During a site visit in May 1990, it was noted that although the bermed area was still intact, some concrete degradation had occurred.



Legend

Surface Water Flow Direction

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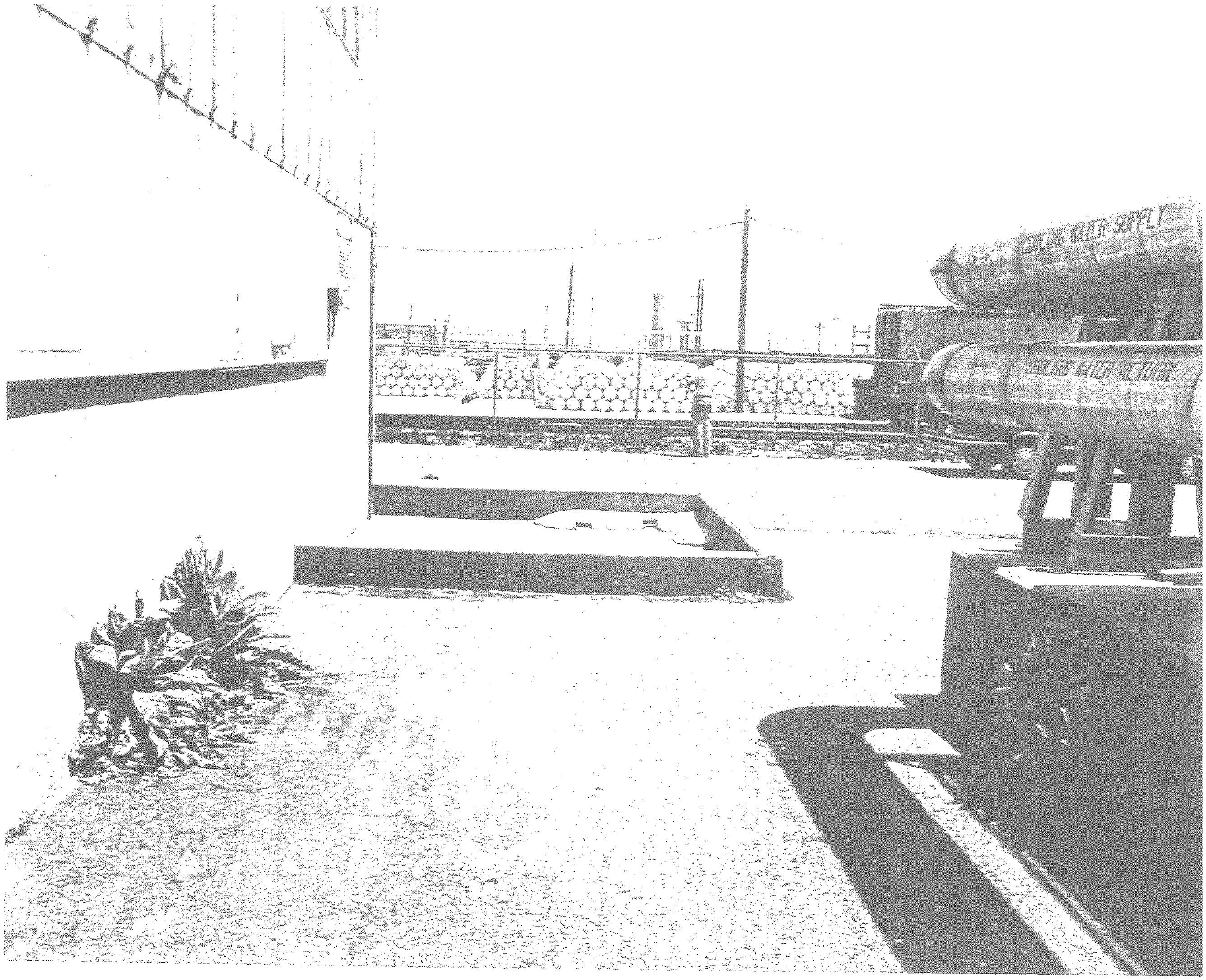
FIGURE 2.1-20
Inactive Building 444 Acid Dumpster (IHSS 207) Location Map



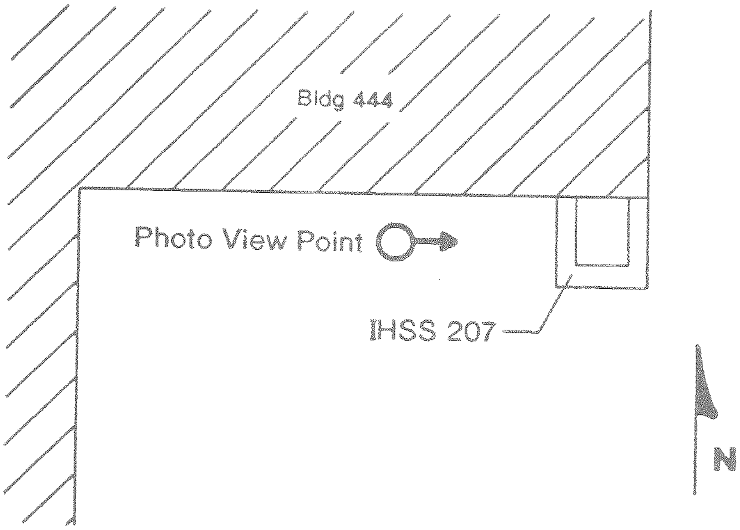


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FIGURE 2.1- 21
Inactive Building 444 Acid Dumpst
(IHSS 207) Site Photo

Additional contaminants of concern found in the acid waste stream of Building 444 include the metals cadmium, chromium, lead, and silver, and the radionuclides uranium 233, 234, uranium 238, americium 241, and tritium (Rockwell International et al. 1988c). These contaminants have no IHSS associated with actual storage. There is a possibility some of these waste acids could have been stored at IHSS 207.

2.1.11.2 Previous Investigations

No previous soil or water sampling investigations have been performed. The bermed area had been inspected on a frequent basis. No spills have been reported to date.

2.1.11.3 Physical Characteristics

The topography of IHSS 207 slopes to the east (Plate 1). The geologic materials in the vicinity consist of Rocky Flats Alluvium, fill, and Arapahoe Formation deposits.

Approximately 25 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 207. The closest well, in this case, is located approximately 200 ft south of the site. For a more detailed description of the geology, reference the bore log for Well P419689 found in Appendix B. The groundwater flows to the east and intercepts the Walnut Creek drainage. The depth to groundwater is approximately 25 ft below the ground surface.

2.1.11.4 Nature and Extent of Contamination

No analytical data are available, so extent of contamination is unknown.

No upgradient or downgradient analytical groundwater data are available for this area.

2.1.12 Inactive 444/447 Waste Storage Area (IHSS 208)

The following discussion is summarized from the RCRA Part B permit application (Rockwell International 1987).

2.1.12.1 Location and History

The Inactive 444/447 Waste Storage Area (IHSS 208) was previously identified in the RCRA Part B permit application (Rockwell International 1987) as Unit #3, and was located in the same area as IHSS 182 (Figures 2.1-22 and 2.1-23). This storage area consisted of a 20- by 8-ft cargo container with a maximum waste volume of 990 gallons. Similar to IHSS 206, this storage area was also mobile and is currently used to store hazardous waste at Unit #1 (Hazardous Storage Area) (Rockwell International 1987).

IHSS 208 was used from 1986 to 1987 at Unit #3, which was located at the same point as IHSS 182. This storage area was secondarily contained, and no leaks or spills were reported in this area. Typical stored wastes included a composite of nitric acid with silver, sodium fluoride, sodium fluoride solution, plating acids (hydrochloric acid, nitric acid, hydrofluoric acid) with concentrated chromium plating solution, concentrated cadmium cyanide solution, nickel sulfamate, and developer and fixer.

2.1.12.2 Previous Investigations

No previous soil sampling investigations have been performed at IHSS 208.

2.1.12.3 Physical Characteristics

The topography of IHSS 208 gently slopes to the east (Plate 1). The geologic materials in the vicinity consist of Rocky Flats Alluvium, fill, and Arapahoe Formation deposits. Approximately 25 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 208.

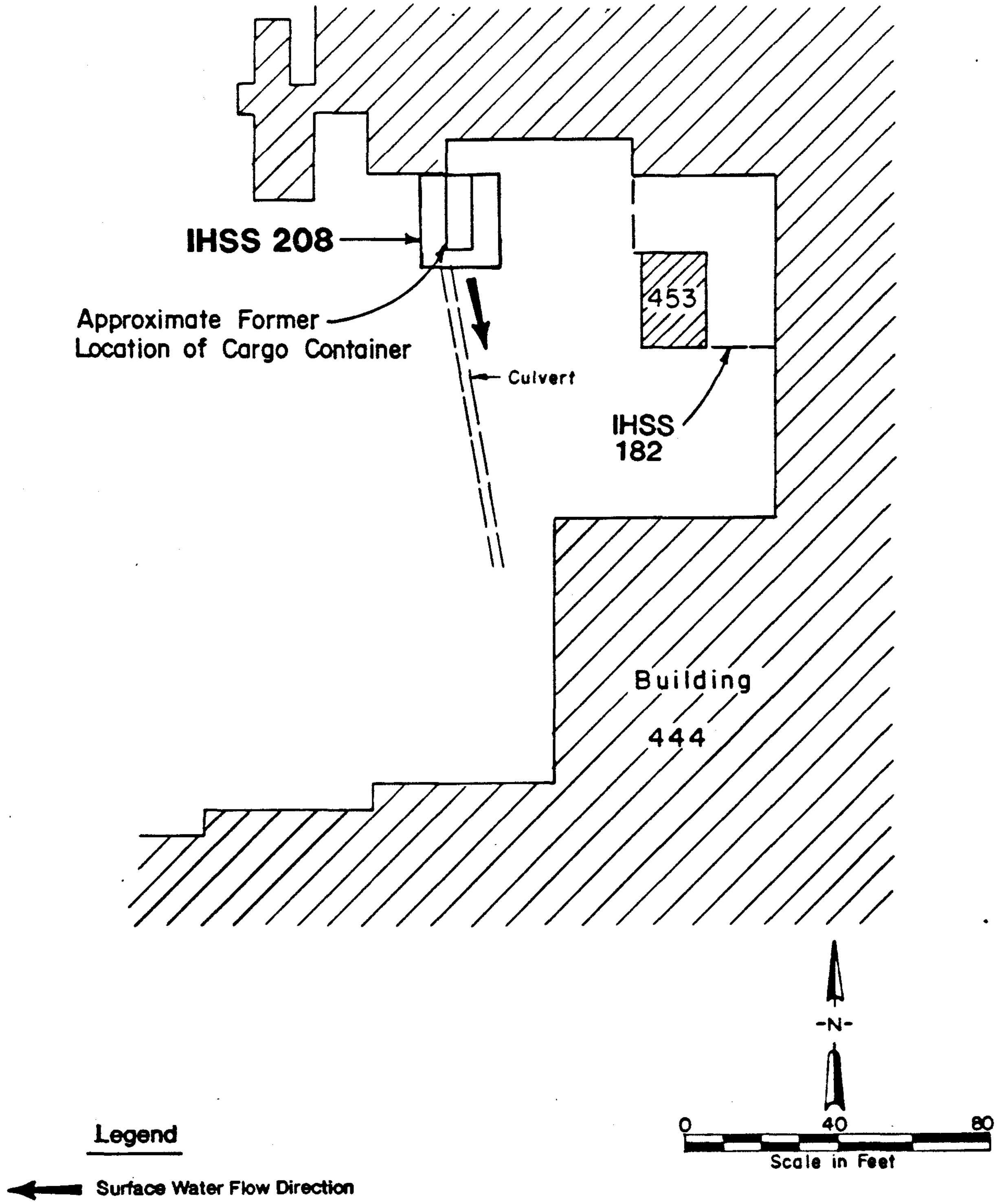

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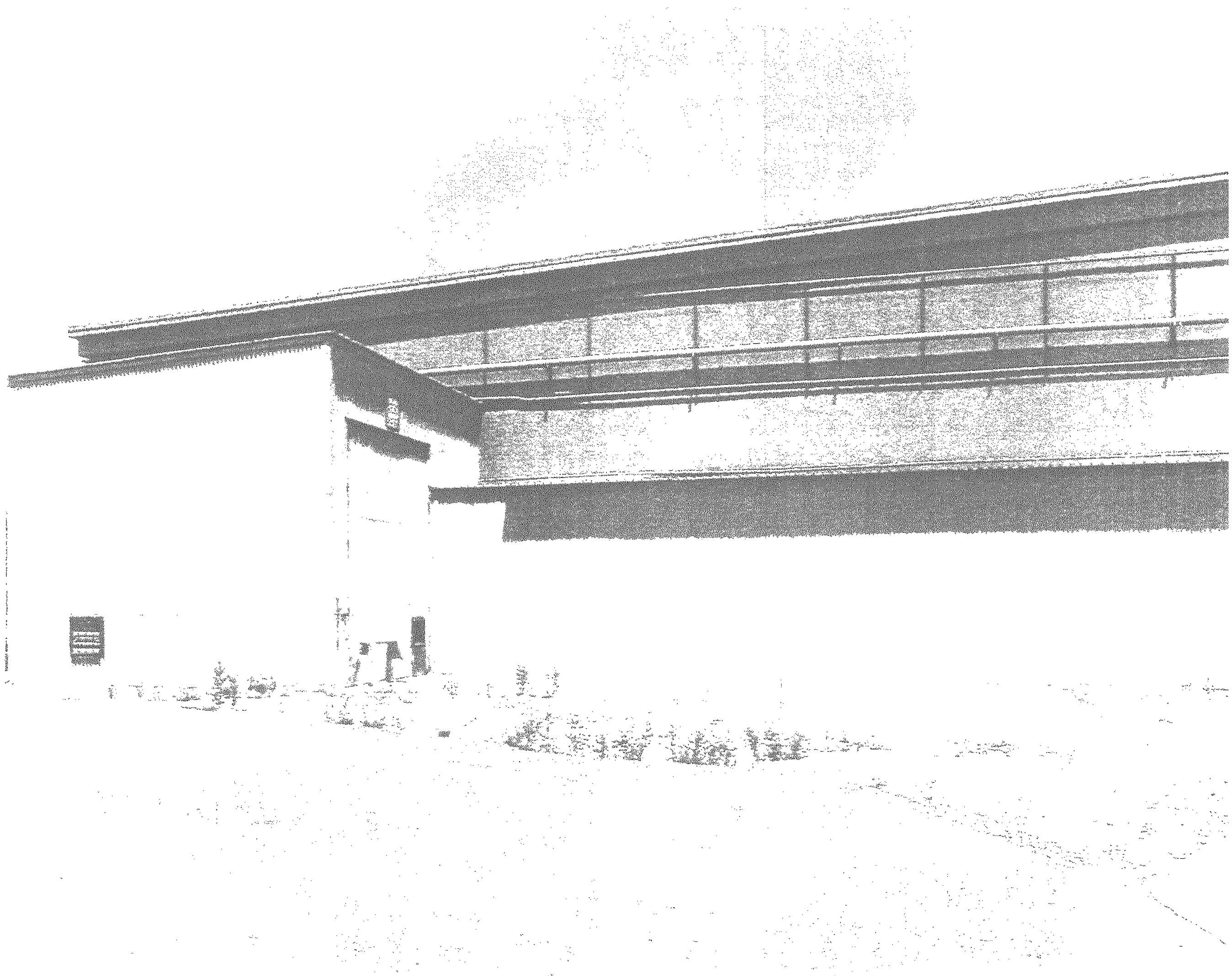
FIGURE 2.1- 22
Inactive 444/447 Waste Storage Area (IHSS 208) Location Map



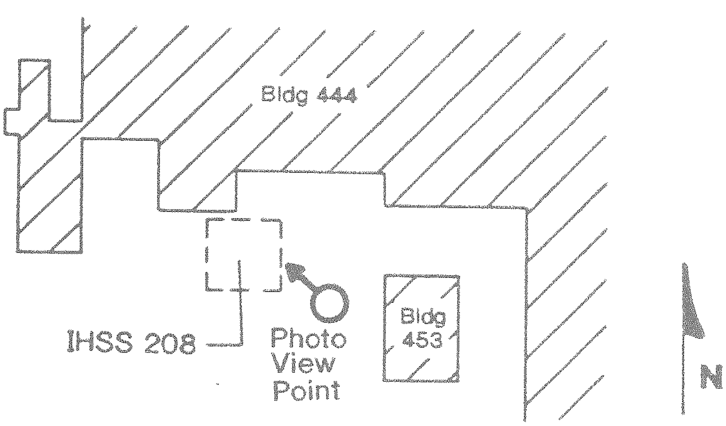


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FIGURE 2.1-23
Inactive 444/447 Waste Storage
Area (IHSS 208) Site Photo

The closest well is located approximately 750 ft from the site; therefore, detailed bore logs will not be useful for descriptions of geologic materials. The groundwater flows to the east and intercepts the south Walnut Creek drainage. The depth of groundwater is approximately 20 ft below the ground surface.

2.1.12.4 Nature and Extent of Contamination

No soil sampling investigations have been conducted at this site, so the nature and extent of contamination is not known.

No upgradient or downgradient analytical groundwater data are available for this area.

2.1.13 Unit 16, Building 980 Cargo Container (IHSS 210)

The following discussion is summarized in Rockwell International (1989b).

2.1.13.1 Location and History

IHSS 210 is located south of Spruce Avenue and east of 10th Street (Figure 2.1-24). Unit #16, an area located southeast of Building 980, provided solid and liquid waste drum storage for automotive oils, stoddard solvent, paints and paint thinner, paper and rags contaminated with oils, grease, gasoline, diesel fuel, solvents, metal scraps, and fiberglass resins and catalysts. IHSS 210 includes a steel cargo container and a roped area of ground adjacent and to the east of the container. The cargo container is approximately 20 ft long, 8 ft wide, and 8 ft high. The dimensions of the roped area are approximately 10 ft wide and 20 ft long.

IHSS 210 had been used for several years to store drummed hazardous waste generated from paint work, automotive work, and machine work performed in Building 980. On May 31, 1988, the IHSS 210 drum storage operation was terminated and the inventory removed. IHSS 210 is

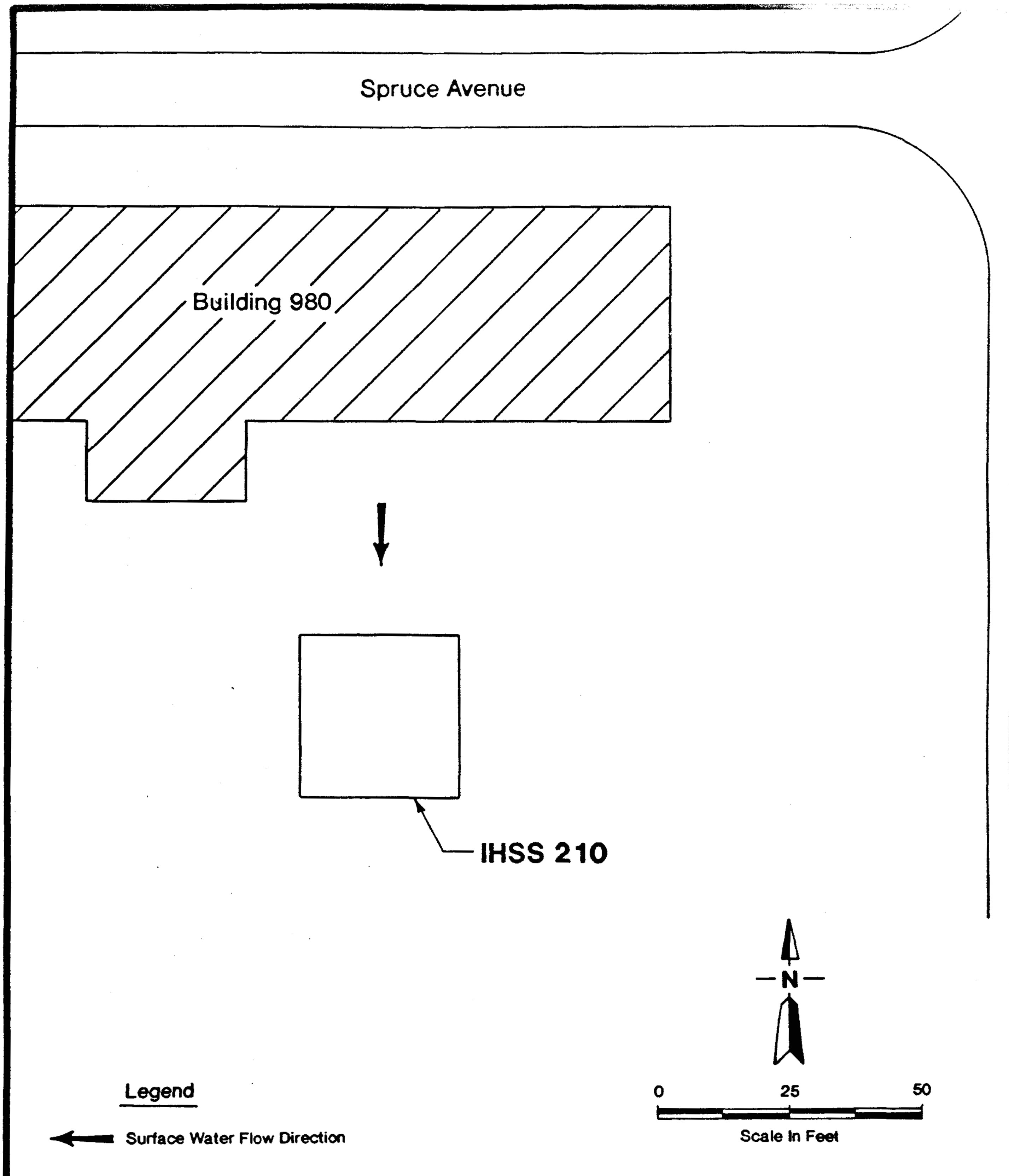

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FIGURE 2.1-24
Unit 16, Building 980 Cargo Container (IHSS 210) Location Map

currently being used in a 90-day storage unit. As of May 31, 1988, all hazardous waste was removed from IHSS 210.

2.1.13.2 Previous Investigations

Periodic container inspections were performed by RFP personnel. These inspections consisted of visually assessing the structural integrity of the drums and checking for leaks and corrosion.

2.1.13.3 Physical Characteristics

The topography of IHSS 210 gently slopes to the northeast and east (Plate 1). The geologic materials in the vicinity of IHSS 210 consist of Rocky Flats Alluvium, fill, and Arapahoe Formation deposits.

Less than 10 ft of alluvium and fill overlie the bedrock in the vicinity of IHSS 210. The closest well is located approximately 200 ft northeast of the site. For a more detailed description of the geology, reference the bore log for Well 3887 found in Appendix B. The groundwater flows to the southeast intercepting the south Walnut Creek drainage. The depth of groundwater is approximately 10 ft below the ground surface.

2.1.13.4 Nature and Extent of Contamination

No analytical data are available, so the extent of contamination is unknown. No upgradient or downgradient analytical groundwater data are available for this area.

2.1.14 Unit 15, 904 Pad Pondcrete Storage (IHSS 213)

The following discussion is summarized from the closure plan for Unit 15, Storage Pad 904 (Rockwell International 1989c).

2.1.14.1 Location and History

The Unit 15, 904 Pad Pondcrete Storage is located in the southeastern portion of the RFP production area and occupies a 129,505-ft^2 rectangular area, measuring 439 ft north-south and 295 ft east-west (Figures 2.1-25 and 2.1-26).

The 904 Pad is used for the storage of pondcrete, a low-level mixed waste resulting from the solidification of Solar Evaporation Ponds sludge or sediment with Portland cement. The material is placed in polyethylene-lined 3/4-inch plywood boxes measuring 4 by 2-1/2 by 7 ft. Metal boxes measuring 4 by 4 by 7 ft are also used. Boxes are stacked three high on the 904 Pad. Saltcrete, a material similar in nature to pondcrete, is treated and stored in the same fashion as pondcrete. Saltcrete results from evaporation of liquid process water. Pondcrete and saltcrete are stored within the berm area of the 904 Pad.

The maximum pondcrete and saltcrete storage capacity of the 904 Pad is 6,136 wooden and 102 metal boxes of waste, accounting for approximately 103,464 ft^3 of waste (5,000 tons, assuming a density of 100 pounds per ft^3). Pad 904 is currently at maximum capacity. All wastes will be removed from the 904 Pad before sampling for the RFI/RI begins.

The 904 Pad was constructed in August 1987 of 3-inch-thick hot bituminous pavement placed over 6 inches of Class 6 coarse aggregate. The aggregate had been placed on regraded native soil. The 904 Pad was located adjacent to the 903 Pad, a documented source of plutonium release to the environment at the RFP. Prior to construction, soil samples taken at a depth of approximately 2 inches were collected and analyzed. Plutonium 239 concentrations were generally above background levels, indicating some plutonium contamination was present at the 904 Pad location prior to construction. The area was resampled when the top 6 to 12 inches of soil was removed after grading for the 904 Pad construction. Plutonium 239 concentrations were found to be more than an order of magnitude higher than the previous shallow samples.

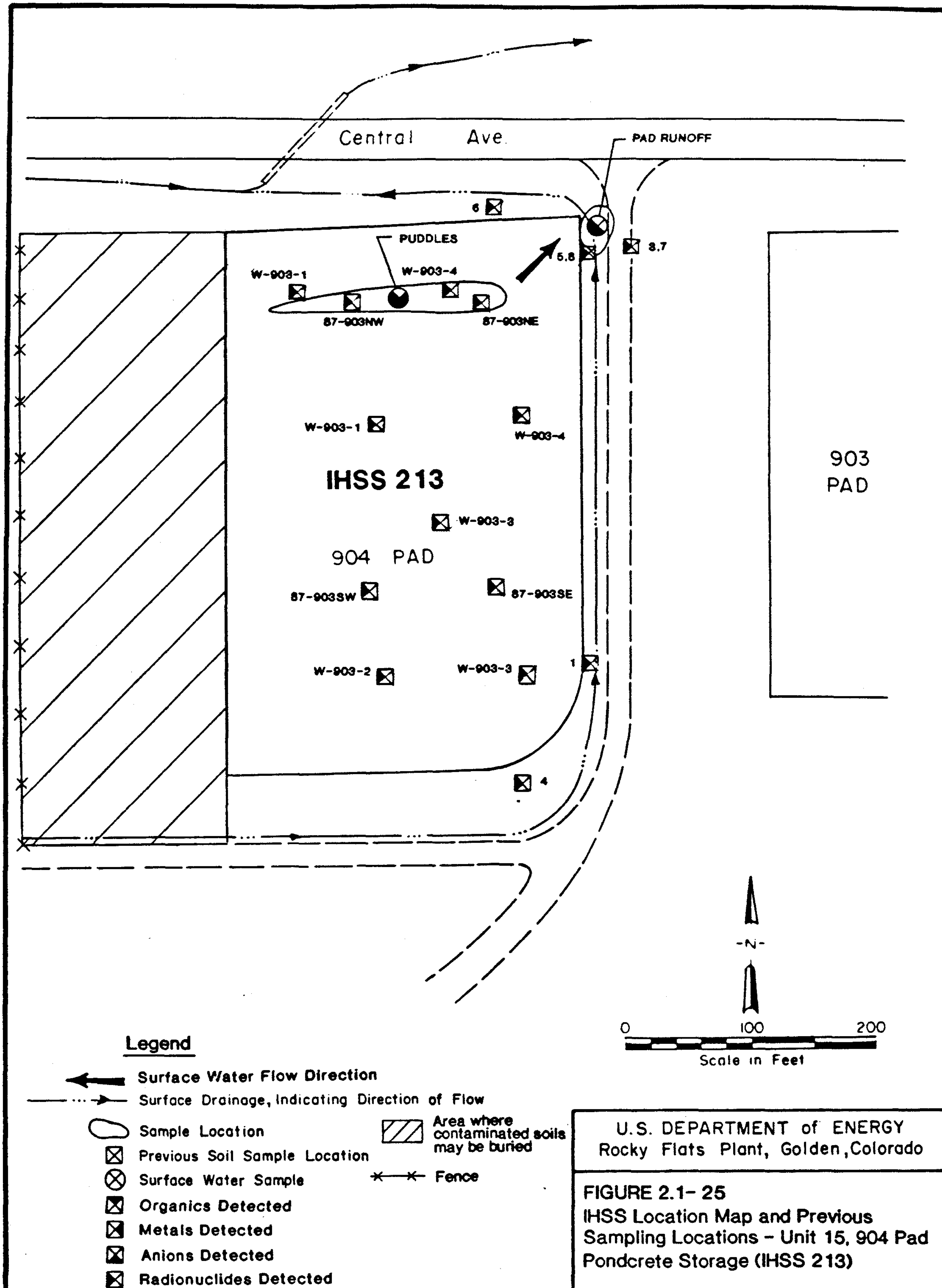
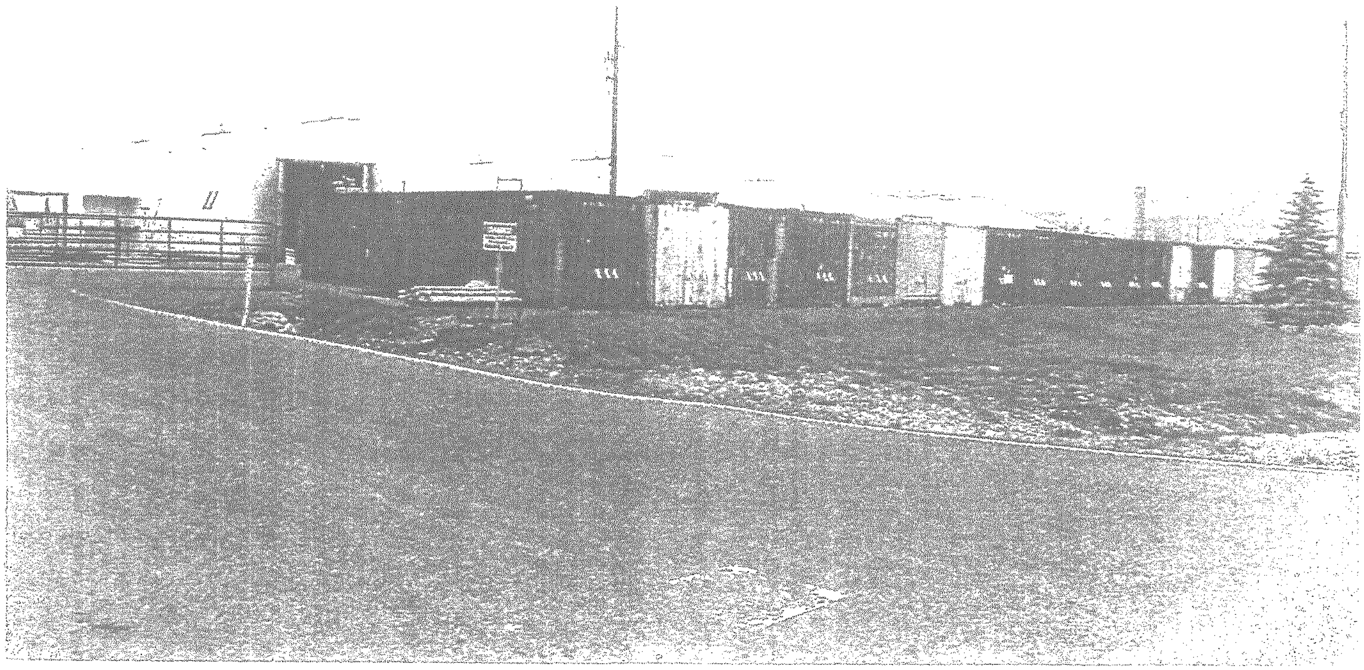


FIGURE 2.1-25
IHSS Location Map and Previous Sampling Locations - Unit 15, 904 Pad Pondcrete Storage (IHSS 213)



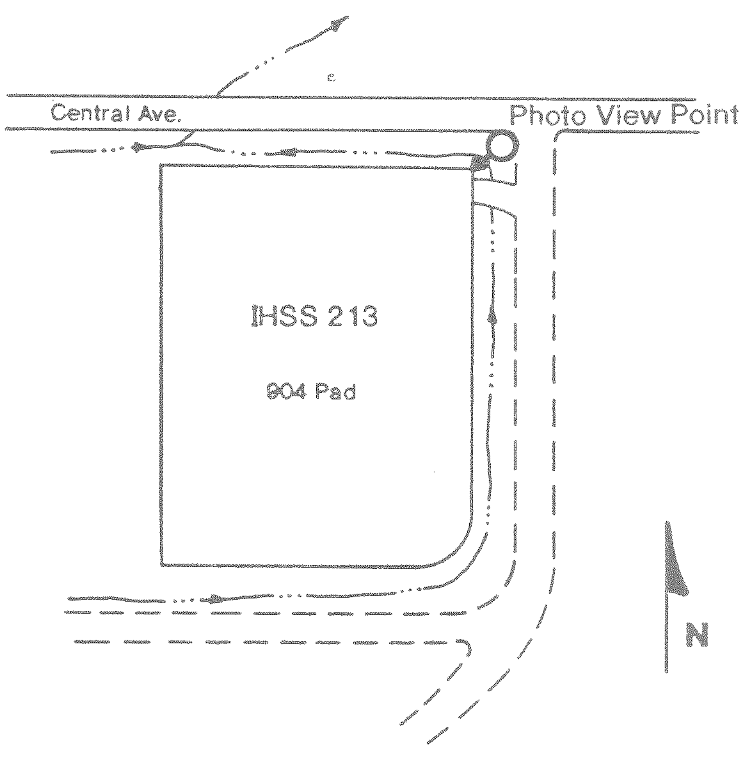


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FIGURE 2.1- 26
Unit 15, 904 Pad Pondcrete Storage (IHSS 213) Site Photo

These sampling results indicated that relatively clean soil material has been laid down over previously contaminated soil material in the area of the 904 Pad. Covering plutonium-contaminated soils with clean soils was a practice at the RFP during the late 1960s and early 1970s. Excavated contaminated material was stockpiled along the west border of the 904 Pad, covered with clean soil, and vegetated to prevent wind dispersal (Figure 2.1-25).

The 904 Pad began receiving waste during October 1987. The initial pad was not constructed with a containment berm. Pondcrete accumulation was temporarily halted in May 1988 as the result of a spill. On June 6, 1988, a 6-inch-high asphalt berm was constructed around the west, north, and east perimeter of the 904 Pad in an attempt to collect surface water runoff samples. Spills and leakage of both pondcrete and saltcrete have been a recurrent problem at the 904 Pad. A number of incidences are related to the incomplete solidification of the waste material which results in failure of the container and in releases to the pad surface. Spills of pondcrete are cleaned using water and brooms to scrub the pad surface. The brooms are used to remove contaminants from the crevices in the asphalt. Water is collected using a wet vacuum cleaner. The cleaning process is continued until radiation levels are below the detection limit for the monitoring instrument. Saltcrete spills tend to be composed of dry material which is cleaned by vacuuming the surface until radiation levels are below the detection limit for the monitoring instrument. Portable air monitors are moved to the pad shortly after spill incidence. Based on these monitors, there have been no releases that exceed the RFP Screening Guide for plutonium in air of 0.01 picocuries per cubic meter (pCi/m^3).

2.1.14.2 Previous Investigations

Soil sampling prior to and during grading activities associated with the 904 Pad construction have documented pre-existing radioactive contamination. Samples of runoff water from the 904 Pad taken after spills have detected gross alpha and beta concentrations above drinking water standards. Seepage of runoff water below the asphalt berm has been reported as very common by RFP employees. Analysis of runoff data indicates 41 percent of all runoff samples equal or exceed the gross alpha drinking water standard of 15 pCi/L and 37 percent of all runoff samples are equal to or exceed the gross beta drinking water standards of 50 pCi/L. The surface water background value for gross alpha is 177 pCi/L and for gross beta is 163 pCi/L. Analysis of existing data indicates that runoff from the 904 Pad may be contributing to the elevated analyte concentrations in the South Walnut Creek water. South Walnut Creek is diverted into Pond B-4 which intermittently discharges to Pond B-5, the last control point on the South Walnut Creek drainage (Plate 1). Pond B-5 discharges must meet the RFP NPDES permit.

A memo dated January 26, 1989, 89-RF-0332, addresses the possible impact of runoff from Pad 904 and Pad 750. The runoff may result in chronic low levels of contaminants being released into Pond B-5 that discharge from the pond would violate the NPDES permit. Therefore, the potential for contamination exists along the path from Pad 904 to Pond B-5.

2.1.14.3 Physical Characteristics

Approximately 10 to 20 ft of Rocky Flats Alluvium overlies the Arapahoe Formation in the vicinity of the 904 Pad. It appears to maintain a thickness of 10 to 20 ft east to west and is completely eroded approximately 150 and 900 ft north of the 904 Pad, where surface drainages exist. South of the 904 Pad, the Rocky Flats Alluvium attains a maximum thickness of approximately 25 ft, and then rapidly thins as it enters the north flank of the Woman Creek Valley (see EG&G 1992, Plate I). The Arapahoe Formation consists of subcropping claystones and discontinuous subcropping sandstones.

In Well 10-87, which is located in IHSS 213, the marker sandstone bed at the base of the Arapahoe Formation occurs at a depth of 27 ft. It is part of a 12-ft-thick, fining-upward sequence with medium-grained, well-rounded, frosted quartz sandstone at the base and very fine-grained quartz sandstone at the top. The Arapahoe Formation conformably overlies silty, fine-grained sandstones and claystones of the upper Laramie Formation, and is unconformably overlain by 15 ft of gravels of the Rocky Flats Alluvium. Sandstone beds in the Arapahoe and Laramie Formation dip approximately 1 to 2 degrees east (EG&G 1992). For more detail on the geology, see the bore log for Well 10-87 found in Appendix B.

The topography and drainage of the 904 Pad is approximately 0.7 percent to the northeast (Plate 1). Because of this slope, water tends to accumulate along the north berm, and in the northeast corner of the pad adjacent to the berm. Any runoff or berm overflow is intercepted by a ditch sloped to drain to the northeast to intercept the South Walnut Creek drainage. The ditch is located east of the 904 Pad. The west, north, and east perimeters of the 904 Pad are enclosed by a 6-inch-high berm, added approximately 1 year after storage operations began. The berm was designed to collect surface water runoff samples from the 904 Pad, and additionally to minimize runon. The bedrock aquifer potentiometric surface slopes away from the 904 Pad to the east, roughly consistent with the dip of the sandstone units of the Arapahoe Formation. This results in groundwater movement towards the north, east, and south.

Groundwater flow in the alluvial aquifer below the 904 Pad appears to be strongly influenced by the east-northeast sloping topography and the configuration of the base of weathering in the Arapahoe Formation. In addition, the alluvial aquifer potentiometric surface slopes away from the 904 Pad toward the north, east, and south, thus groundwater flows radially in those three directions. After examining data from logs of Well 10-87, which is an alluvial well on the site, the depth of groundwater was determined to be approximately 12 ft as of December 1988.

Analyses of potentiometric data for the alluvium indicates that water in the alluvial aquifer in the vicinity of the 904 Pad flows toward the south and southeast at a rate of about 5.26×10^{-3} feet per day (ft/day) (based on a saturated hydraulic conductivity of 1.36×10^{-2} ft/day, an assumed effective porosity of 0.1, and a gradient of 0.039 foot/foot [ft/ft]) and toward the northeast at a rate of about 2.72 x 10^{-3} ft/day (based on a saturated hydraulic conductivity of 1.36 x 10^{-2} ft/day, an assumed effective porosity of 0.1, and a gradient of 0.020 ft/ft) (Rockwell International 1989c).

Analysis of bedrock aquifer potentiometric data indicates that groundwater in the bedrock aquifer, which is assumed to occur predominately in the fine-grained sandstone/siltstone units of the upper Laramie Formation in the vicinity of the 904 Pad, flows toward the south at a rate of 1.92 x 10^{-3} ft/day under a gradient of 0.170 ft/ft, toward the east at a rate of 1.15 x 10^{-3} ft/day under a gradient of 0.102 ft/ft, and toward the northeast at a rate of 1.38 x 10^{-3} ft/day under a gradient of 0.122 ft/ft. These groundwater flow rates assume an effective porosity of 0.1 and a sandstone-saturated hydraulic conductivity of 1.13 x 10^{-3} ft/day. The hydraulic conductivity values used are based on slug and packer test data (Rockwell International 1989c).

2.1.14.4 Nature and Extent of Contamination

Analysis of soil samples taken from borings in the area indicate the presence of gross alpha, gross beta, total plutonium, total uranium, uranium 234, unranium 238, americium 241, and plutonium 239. Table C-13 (Appendix C) presents the radionuclides detected.

In addition, analysis of surface water samples taken in the area of IHSS 213 indicate the presence of gross alpha, gross beta, nitrate, cyanide, and cadmium. Table C-14 (Appendix C) presents the metals and other inorganics detected.

The sampling locations of the analytes detected are illustrated in Figure 2.1-25.

Analysis of groundwater samples taken from upgradient Well 1087 indicates detections for the metals and other inorganics, barium, calcium, iron, magnesium, manganese, nickel, sodium, zinc, and sulfate. Radionuclides detected above background include americium 241 and uranium 233, 234. Table C-15 (Appendix C) presents the metals, inorganics, and radionuclides detected.

No downgradient groundwater analytical data are known to have been collected. In order to assess the possibility of groundwater contamination from IHSS 213, further data are needed.

2.1.15 Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214)

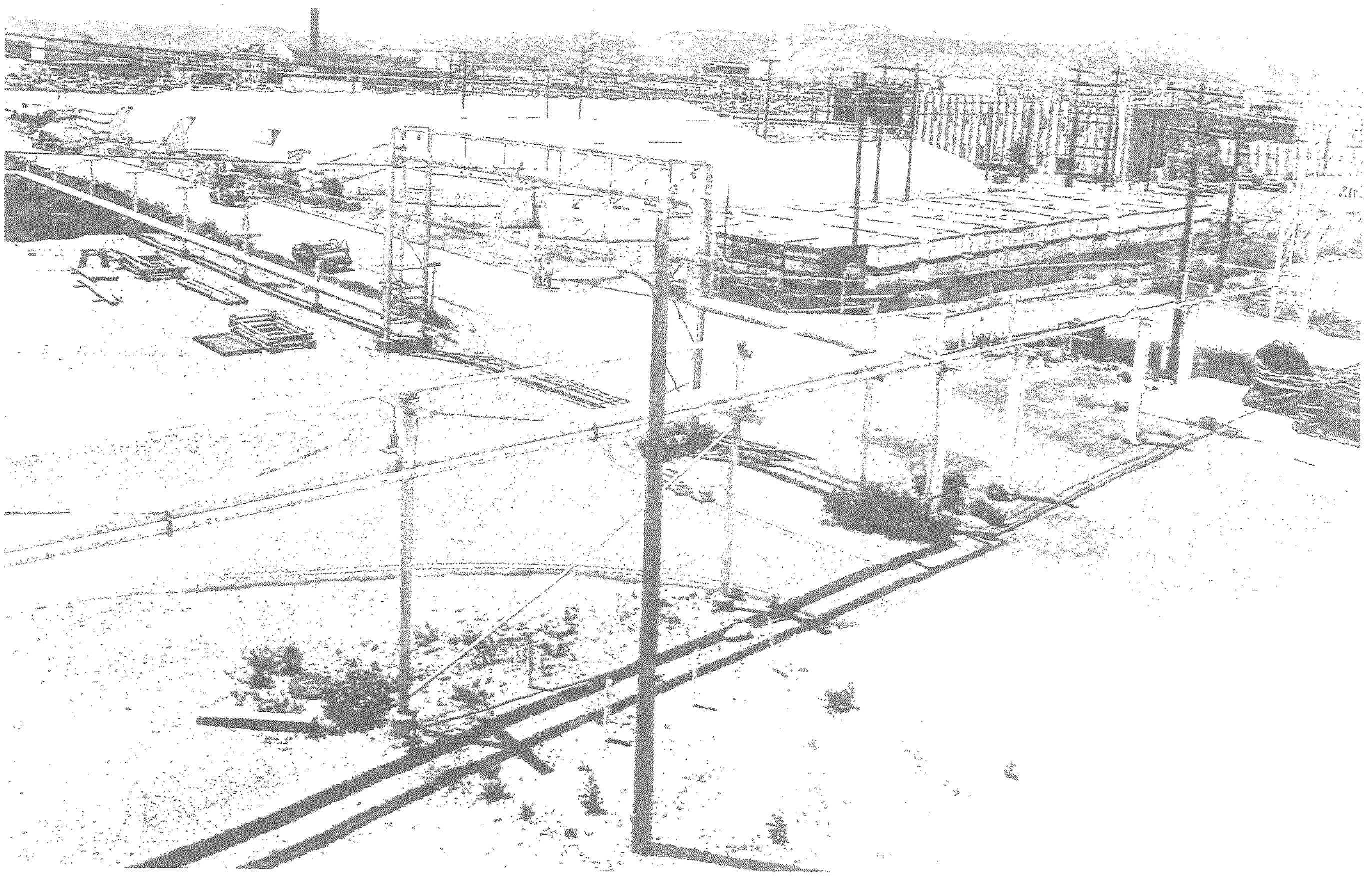
The following discussion is summarized primarily from the closure plan for Unit 25, Storage Pad 750 (Rockwell International 1989d).

2.1.15.1 Location and History

The Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214) was initially constructed as a parking lot for Building 750 (Figures 2.1-27 and 2.1-28). One hundred forty-two thousand ft^2 of the original 220,000 ft^2 surface are used for storage. The boundaries of the pad as depicted in Figure 2.1-27 are the latest boundaries of the present pad.

The 750 Pad is used for the storage of pondcrete, a low-level mixed waste resulting from the solidification of Solar Pond sludge or sediment with Portland cement. The material is placed in polyethylene-lined, 3/4-inch plywood boxes measuring 4 ft by 2.5 ft by 7 ft. Boxes are stacked three high on the pad. Metal boxes measuring 4 ft by 4 ft by 7 ft are also used. Saltcrete, a material similar in nature to pondcrete resulting from evaporation of liquid process waste, is treated and stored in the same fashion as pondcrete on the pad. Pondcrete and saltcrete are stored within the berm area of the 750 Pad.

The maximum waste storage inventory of the 750 Pad is 12,168 boxes of waste, accounting for approximately 183,000 ft^3 of waste (9,000 tons, assuming a density of 100 pounds/ft^3). The



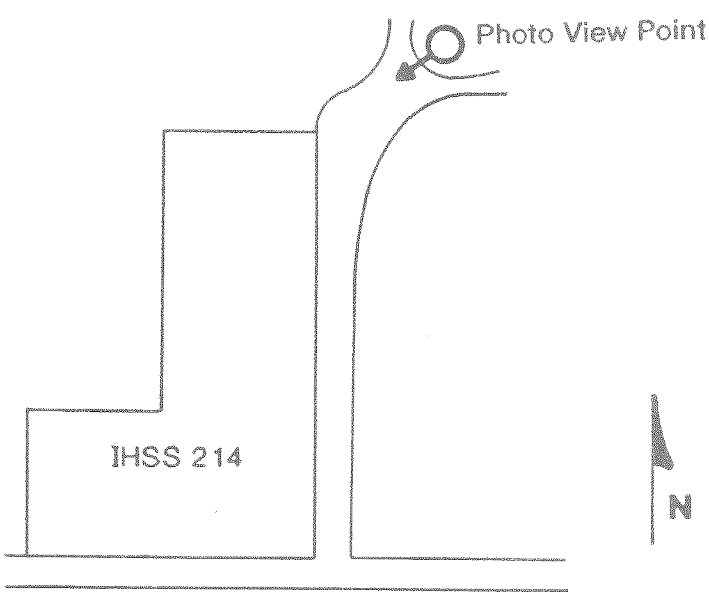


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FIGURE 2.1- 28
Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214)
Site Photo

inventory as of September 30, 1989, consisted of 8,881 wooden boxes of pondcrete, 157 metal boxes of pondcrete, and 855 wooden boxes of saltcrete.

The 750 Pad was initially constructed as a 220,000-ft^2 parking lot for Building 750 in 1969. The 750 Pad was constructed with a 6-inch-thick aggregate overlain by a 2-inch-thick asphaltic concrete. In 1986, prior to the storage of waste, 142,000 ft^2 of the 750 Pad was overlaid with Petromat and 3 inches of asphalt. Eight-inch-high asphalt berms were constructed along the east and portions of the north and south sides. Waste storage began on November 18, 1986. Production of pondcrete ceased on May 23, 1988, in response to spills on the 904 Pad. A detailed inspection of waste stored on the 750 Pad identified approximately 5 percent (440) of pondcrete boxes were of poor quality (i.e., containing unhardened pondcrete). Severely deformed boxes of waste were transferred to metal boxes or to Building 788 to await reprocessing. Storage of pondcrete resumed in November 1986 and continues to the present.

From November 18, 1986, to September 1, 1989, two spills of pondcrete occurred. The spills, totaling approximately 0.5 ft^3, were released to the asphalt pad. Both spills consisted of unhardened Solar Evaporation Pond sludge and cement. Following each incident, the entire contents of the failed container and spilled pondcrete were transferred to metal boxes. The spill locations were then cleaned by using water and brooms to scrub the 750 Pad surface. The brooms are used to remove pondcrete from the crevices in the asphalt. Water was collected using wet vacuums. Cleaning continued until radiation levels were below detection limits for the instruments being used.

Routine inspections of the 750 Pad on November 1, 1988, and April 7, 1989, identified deformed and leaking boxes of saltcrete. All saltcrete spills have consisted of a fine, dry, powder. From November 1, 1988, through July 25, 1989, a total of 64 leaking boxes were identified that had released approximately 113 pounds of saltcrete to the 750 Pad. The location of spills were cleaned by vacuuming until radiation levels were below detection limits of the instruments being used. Analytical results from samplers S-2 and S-17 located upwind from the 750 Pad identified no total long-lived alpha activity above plant standards. No soil monitoring has been conducted at the 750 Pad to confirm if precipitation migrated contaminants to the soil (Rockwell International 1989d). Berms 8 inches in height existed on the south, north, and east sides of the pad, so surface runoff would have been minimized. The quantity of saltcrete that was retrieved is unknown.

A site visit in May 1990 observed wet, severely deformed cardboard boxes being transported into storage tents. Torn boxes with exposed plastic inner liners were also observed. There is a high probability that leakage of material will continue until all materials are removed.

Portable air monitors were moved to the 750 Pad shortly after the spill incidences. Based on these air monitors, there have been no releases that exceed the RFP Screening Guide for plutonium (0.01 pCi/m^3).

2.1.15.2 Previous Investigations

Soil and surface water samples were taken at the 750 Pad puddle and the culvert outlet. Section 2.1.15.4 discusses the analytes detected.

2.1.15.3 Physical Characteristics

The asphalt pad at IHSS 214 is located approximately at grade, sloped 2 percent to the east. Prior to storage of waste material, an overlay was installed consisting of 3 inches of asphalt underlain by Petromat, a rubberized material intended to prevent permeation through the 750 Pad. An 8-inch-high asphalt berm was added to the east and portions of the north and south sides to minimize runon and provide runoff water samples from the 750 Pad. Runoff from the 750 Pad is collected in seven stormwater inlets between 10th Street and the 750 Pad. All runoff water storage behind the 8-inch berm occurs in the immediate vicinity of the stormwater inlets. Calculated storage potential behind the berm is approximately 500 ft^3. Any precipitation event that exceeds approximately 0.03 inch will cause overlapping of the berms. The stormwater inlets are directly piped to a culvert that drains to South Walnut Creek.

Approximately 5 to 10 ft of Rocky Flats Alluvium overlies the Arapahoe Formation in the vicinity of IHSS 214. The alluvium has been completely eroded approximately 250 ft east of Pad 750, in the South Walnut Creek drainage. The Arapahoe Formation consists of subcropping claystones and discontinuous subcropping siltstones and very fine grained sandstones.

The medium-grained to conglomeratic marker sandstone bed at the base of the Arapahoe Formation occurs at a depth of 25 to 35 ft, north of IHSS 214 in the Solar Ponds area, south of IHSS 214 in the vicinity of IHSS 213, and east of IHSS 214 in the Mound area. However, none of the wells adjacent to IHSS 214 intersected the marker sandstone bed. Isopach maps of the Arapahoe sandstone show a channel in the vicinity of IHSS 214, which suggests that the wells adjacent to IHSS 214 are in fine-grained channel margin sandstone or interchannel claystone deposits, or have not been drilled deep enough to reach the medium-grained to conglomeratic marker bed. The Arapahoe Formation conformably overlies silty, fine-grained sandstones and claystones of the upper Laramie Formation. Sandstone beds in the Arapahoe and Laramie Formations dip 1 to 2 degrees east (EG&G 1992). For a more detailed description of the geology, see the bore log for Well P207489 found in Appendix B. Well P207489 is located north of IHSS 214.

The alluvial aquifer potentiometric surface slopes away from IHSS 214 primarily to the east. Groundwater flow in the alluvial aquifer appears to be strongly influenced by the topography and the configuration of the base of weathering in the Arapahoe Formation (Rockwell International 1989d).

Depth of groundwater is approximately 5 ft below the ground surface. Groundwater elevation information for alluvial wells suggests that groundwater levels have remained relatively stable in Wells 4-87, 10-87, 15-87, 26-86, and 61-86 (with a variance between 1 and 6 ft), and have dropped below the lowest screened interval during most of the period of record in Wells 24-86 and 44-87 causing a variance of approximately 1 to 2 ft thus producing dry wells. Alluvial aquifer potentiometric maps for the first through fourth quarters of 1988 (Rockwell International 1989d) indicate that alluvial aquifer flow directions and gradients remain fairly constant throughout the year. Areas of unsaturated surficial materials are present north of IHSS 214 near Well 38-87, and east of Pad 750 near Well 33-86. These unsaturated surficial materials may represent areas where bedrock is very near the surface causing no flow boundaries or where building footing drains dewater the local alluvial aquifer. Groundwater flowing east from IHSS 214 will most likely be discharged to the headwaters of South Walnut Creek.

Analyses of potentiometric data for the alluvium indicate that water in the alluvial aquifer in the vicinity of the 750 Pad flows to the east at a rate of about 2.45×10^{-3} ft/day (based on a saturated hydraulic conductivity of 1.36×10^{-2} ft/day, an assumed effective porosity of 0.1, and a gradient of 0.018 ft/ft) and toward the northeast at a rate of about 2.72×10^{-3} ft/day (based on a saturated hydraulic conductivity of 1.36×10^{-2} ft/day, an assumed effective porosity of 0.1, and a gradient of 0.020 ft/ft). Hydraulic conductivity estimates for the alluvial aquifer are based on slug test data (Rockwell International 1989d).

Groundwater elevation information for bedrock wells suggests that groundwater levels have remained relatively stable in Wells 5-87BR, 9-87BR, and 45-87BR (with a variance between 1 and 3 ft), moderately stable in Wells 16-87BR, and 23-86BR (with a variance between 15 and 30 ft), and relatively unstable in Well 25-86 (with a variance of approximately 60 ft). Bedrock aquifer potentiometric maps for the first through fourth quarters of 1988 (Rockwell International 1989d) indicate that bedrock aquifer flow directions and gradients remain fairly constant throughout the year. Groundwater flowing north from IHSS 214 may be monitored using information collected from Well 23-86BR; and groundwater flowing east from IHSS 214 may be monitored using information collected from Well 22-87BR.

Analysis of bedrock aquifer potentiometric data indicate that groundwater in the bedrock aquifer, which is assumed to occur predominately in the fine-grained sandstone/siltstone units of the upper Laramie Formation in the vicinity of IHSS 214, flow toward the northeast at a rate of 1.03 x 10^{-3} ft/day under a gradient of 0.091 ft/ft. This assumes an effective porosity of 0.10 and a sandstone saturated hydraulic conductivity of 1.13 x 10^{-3} ft/day. The hydraulic conductivity values used are based on slug and packer test data (Rockwell International 1989d).

2.1.15.4 Nature and Extent of Contamination

Radionuclide analysis of soil samples taken in the area indicate the presence of gross alpha and gross beta. Table C-16 (Appendix C) lists the radionuclides detected in the soil. Analysis of surface water samples taken in the area of IHSS 214 indicate presence of gross alpha, gross beta, nitrate, cyanide, and cadmium. Table C-17 (Appendix C) lists the metals and other inorganics detected in the surface water.

Figure 2.1-27 illustrates the sampling locations of the analytes detected.

Analysis of groundwater samples taken from upgradient Well P207489 indicates detections of metals and other inorganics including calcium, magnesium, manganese, and sulfate. Table C-18 (Appendix C) presents the metals and other inorganics detected. Radionuclides detected include americium 241; tritium; uranium 233, 235; and uranium 235, 236. Table C-18 presents the metals, inorganics, and radionuclides detected.

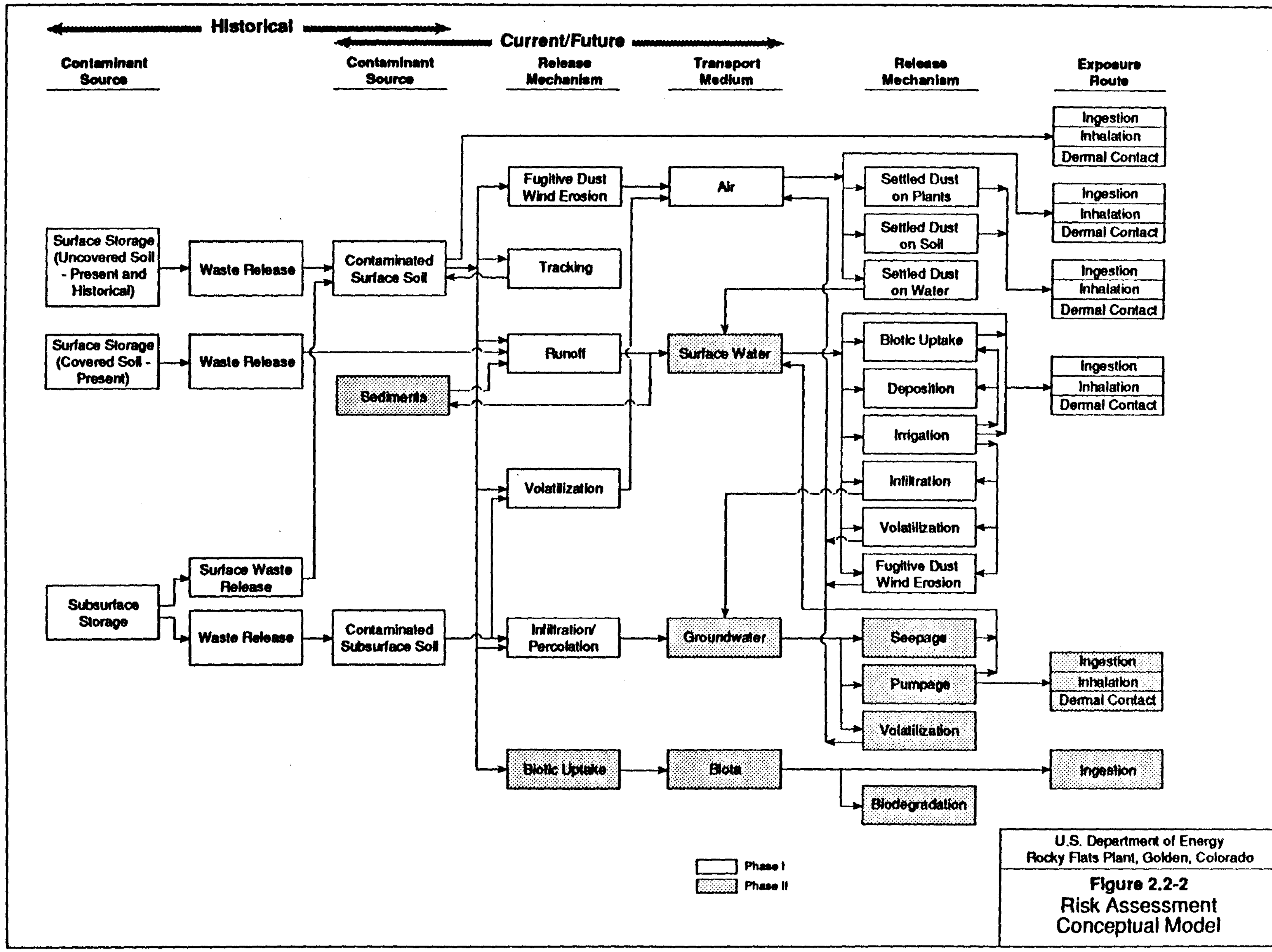
No downgradient analytical data are available. In order to assess the possibility of groundwater contamination from IHSS 214, further data are needed.

2.2 SITE CONCEPTUAL MODEL

The primary purpose of the conceptual model is to aid in identifying exposure pathways by which human and biotic receptors may be exposed to contaminants. The conceptual model provides a contaminant source characterization and an overview of all the potential pathways that may form releases from and into each transport medium. The primary objective of the pathway screening process is to identify those exposure pathways that are or may be "complete" under current conditions or under reasonable assumptions about future conditions. An exposure pathway is considered to be complete if a linkage can be shown between one or more contaminant sources, through one or more environmental fate and transport processes to an exposure point where human or ecological receptors are present. The identification of potentially complete pathways is a qualitative judgment, and the identification of a complete exposure pathway does not necessarily indicate that adverse effects will occur; it indicates that the effort to quantify exposures is worthwhile from the standpoint of protecting human health and the environment.

The following discussion contains a generalized discussion of contaminant sources, release mechanisms, contaminant migration, pathways and potential receptors, and is followed by a detailed discussion of the same for each IHSS grouping. Figures 2.2-1 and 2.2-2 are idealized conceptual models for OU10.

In the OU10 conceptual model, the IHSSs have been grouped together into three groups based on similar characteristics. These groupings include subsurface storage (IHSS 129); surface storage with a covered surface (IHSSs 177, 181, 182, 205, 207, 208, 213, and 214); and surface storage with an uncovered surface (IHSSs 170, 174, 175, 176, 206, and 210).



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Rocky Flats Plant, Golden, Colorado

Figure 2.2-2
Risk Assessment Conceptual Model

IHSSs 182 and 213 were covered at later dates after use, therefore, the surface storage with an uncovered surface model would apply before the addition of surface covering and the covered surface model would apply after surface covering was added. IHSSs 182 and 213 have been grouped into the covered storage site model since this model presently applies to these sites. Above ground tanks have been grouped into either the covered or uncovered storage yards, pads, and cargo container areas since the models are similar (i.e., the point of release is on the surface).

2.2.1 Generalized Site Conceptual Model

2.2.1.1 Sources of Contamination

Historical sources include surface and subsurface storage, and the surface and subsurface soil and liquid contaminated as a result of waste releases from storage. Current sources include existing storage, and soils and liquid contaminated as a result of waste releases.

2.2.1.2 Types of Contamination

Types of contamination include organic compounds, inorganic compounds and radionuclides. The characteristics of RFP contaminants and movement through the environment vary depending on the waste composition and the environmental conditions.

2.2.1.3 Release Mechanisms

Release mechanisms are physical and/or chemical processes by which contaminants are released from the source. The conceptual model identifies historical mechanisms which released contaminants directly from the historical sources (in this case, leaks, spills, and overflows), and current release mechanisms which release contaminants from current contaminant sources or transport media. Release mechanisms include fugitive dust, wind erosion, runoff, volatilization, infiltration/percolation, biotic uptake, and tracking. Soil is the initial receiving medium for waste discharges except in the case of covered surface storage where waste either adsorbs to the cover material or is released by wind, volatilization, tracking, or runoff.

2.2.1.4 Contaminant Migration Pathways

Contaminant migration pathways include transport media and exposure routes. Transport media are the environmental media into which contaminants are released from the source and from which contaminants are in turn released to a receptor (or to another transport medium). Potential transport media from OU10 include air, surface water, groundwater, and biota.

Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor. Exposure routes for receptors are inhalation, ingestion, and dermal contact.

2.2.1.5 Receptors

Receptors are human or environmental populations that are affected by the contamination released from a site. Human receptors for OU10 may include RFP workers and visitors. Environmental receptors include the limited biota (both flora and fauna) indigenous to the OU10 environs.

2.2.2 <u>Underground Storage</u>

IHSS 129 is the only OU10 IHSS characterized by this conceptual model.

2.2.2.1 Sources of Contamination

Historical sources of contamination include spills from tanks or leaks from associated pipelines. Spills or leakage related to Tank No. 4 and its five associated pipelines are the historical sources of contamination at IHSS 129. The possible current sources of contamination include joints or corners of underground tanks and associated pipelines and the soils beneath these structures.

2.2.2.2 Types of Contamination

The type of contamination possibly existing at IHSS 129 are organic compounds, including free product, and inorganic compounds.

2.2.2.3 Release Mechanisms

Releases of contamination associated with tanks and pipes are most likely to occur at the following locations:

- Tank openings (e.g., overflows and spills)
- Tank/pipe connections
- The base of the tank where residual waste collects, and where underground tanks may be in contact with groundwater
- Cold joints along the walls of concrete tanks
- Structural seams which could be affected by differential settlement of the tank bedding or supports
- Sections of pipeline broken or corroded
- Elbows, joints, and intersection of piping

Potential releases from contaminated soils could occur through leaching and infiltration. Soil contamination due to spills at the ground surface could result in other types of releases shown in Figure 2.2-2. However, fugitive dust is not expected to be released at IHSS 129 because the site has been covered with gravel.

2.2.2.4 Contaminant Migration Pathways

The contaminant migration pathways for underground tanks and associated pipes, which are illustrated in Figure 2.2-2, include air from volatilization and dust from possible surface spills. Surface water and biota are also transport media for possible surface spillage. Groundwater possibly transports contaminants that may have leached through the soil column or directly transports contaminants from tanks that are in contact with groundwater.

2.2.2.5 Receptors

Potential receptors may include humans and terrestrial biota through inhalation and ingestion of windblown dust and through dermal contact with contaminated soils, surface water and sediment. Depending on future land use scenarios that will be developed in a separate technical memorandum, potential receptors of contaminated groundwater may include humans through dermal contact, ingestion, and inhalation of vapors volatilized from contaminated groundwater. Surface water and sediments contaminated by groundwater recharge could impact humans and terrestrial or aquatic biota through ingestion.

2.2.3 Surface Storage With A Covered Surface

IHSSs 177, 181, 182, 205, 207, 208, 213, and 214 are characterized in this conceptual model.

2.2.3.1 Sources of Contamination

The historical sources of contamination include possible leaks or spills from drums or containers (IHSSs 177, 181, 182, and 208); spills from drums or containers (IHSSs 177, 181, 182, and 208); spills or leaks of acid waste from failing dumpsters or piping (IHSSs 205 and 207); spills or leaks from pondcrete or saltcrete storage (IHSSs 213 and 214). The current sources of contamination at these sites include the cover material on the site and the soils surrounding the site where runoff or wind has transported the contaminants. The soils underneath IHSSs 182 and 213 may be a source of possible contamination, since the sites were covered after a period of use.

2.2.3.2 Types of Contamination

The types of contamination include oils, coolants, solvents, and low level radioactive waste stored in drums (IHSSs 177, 181, and 182). Acid wastes are the types of contamination associated with IHSSs 205, 207, and 208. Low level mixed wastes (pondcrete and saltcrete) are associated with IHSSs 213 and 214.

2.2.3.3 Release Mechanisms

The most probable release mechanisms for sites with surface storage and a covered surface releasing contaminants from the surface cover and surrounding soils are runoff, wind erosion and volatilization. Wind dispersion of contaminants at IHSSs 213 and 214 may be particularly important because of pondcrete and saltcrete powders.

Other release mechanisms include tracking, and biotic uptake of materials on the surface cover and surrounding soils or water. Infiltration/percolation applies to the soils around the covered sites but a cover most likely prevents infiltration/percolation of contaminants directly under the cover. Infiltration/percolation directly under the cover may have occurred at IHSSs 182 and 213 where possible contamination of the soils occurred before installation of a surface cover.

2.2.3.4 Contaminant Migration Pathways

The primary migration pathways for wastes would be flow of liquid wastes off the cover or transport by wind or surface water off the cover. From this point, if the waste is carried by wind, the contaminants may settle on plants, soil or surface water. If the waste migrates in groundwater it may be pumped, recharge surface water, or volatilize. The waste possibly transported by surface water would eventually be deposited or reach humans or biota.

2.2.3.5 Receptors

Potential receptors may include humans and terrestrial biota through inhalation of windblown dust or volatilization and through dermal contact with contaminated surface cover, surrounding soils, surface water, and sediment. Potential receptors of contaminated groundwater may include humans through dermal contact and ingestion from pumpage and/or inhalation of vapors volatilized from contaminated groundwater. Surface water and sediments contaminated by groundwater recharge could impact humans, terrestrial or aquatic biota.

2.2.4 Surface Storage without a Covered Surface

IHSSs 170, 174, 175, 176, 206, and 210 are characterized in this conceptual model.

2.2.4.1 Sources of Contamination

The historical sources of contaminants include possible leaks or spills from drums or containers (IHSSs 175, 176, and 210). Other sources include the above mentioned sources plus dumpsters, spent batteries, and miscellaneous wastes (IHSSs 170 and 174). Sources also include tanks and piping (IHSS 206). Current sources include soils on and around the site. Some of the low level radioactive wastes may have been transported by wind and did not originate from the actual sites where the radioactivity has been detected.

2.2.4.2 Types of Contamination

The types of contamination include oils, coolants, solvents, metals and low level radioactive wastes (IHSSs 170, 174, 175, 176, and 210). IHSS 206 may possibly have nitrates from off-specification water and, therefore, is much different than the other sites with respect to the types of contaminants existing at the sites.

2.2.4.3 Release Mechanisms

The most probable release mechanisms for sites with surface storage and uncovered surface are direct infiltration/percolation, volatilization, runoff, and fugitive dust wind erosion. Other release mechanisms include tracking and biotic uptake. The main difference between these uncovered sites and the covered sites is the possibility of direct infiltration/percolation due to contaminants leaking or spilling directly on the soil.

2.2.4.4 Contaminant Migration Pathways

The primary migration pathways would be infiltration of wastes, groundwater transport, or migration by wind or surface water. The possible wastes in groundwater could volatilize, migrate to surface water or be pumped out of the ground. The possible wastes transported by wind may settle on plants, soil, or surface water. The possible waste transported by surface water would eventually be deposited or reach humans or biota.

2.2.4.5 Receptors

Potential receptors include humans and terrestrial biota through inhalation of windblown dust or volatilization and through contact with contaminated soil, surface water, and sediment. Potential receptors of contaminated groundwater include humans through dermal contact and ingestion from pumpage and/or inhalation of vapors volatilized from contaminated groundwater. Surface water and sediments contaminated by groundwater recharge could impact humans, terrestrial or aquatic biota.

3.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section provides a preliminary identification of potential ARARs for OU10. The summary of potential sitewide ARARs presented is based on current federal and state health and environmental statutes and regulations. The chemical-specific ARARs presented are not specific to OU10 because insufficient validated data exist to justify inclusion or exclusion of specific constituents. The preliminary identification and examination of potential ARARs will provide for the use of appropriate analytical detection limits during the RFI/RI. As data become available during the Phase I RFI/RI, chemical-specific ARARs will be proposed for OU10. Location-specific ARARs will be addressed in the RFI/RI report. The CMS/FS report will further address chemical-specific ARARs as well as action- and location-specific ARARs in the development and evaluation of remedial alternatives.

This section also addresses the development of risk-based Preliminary Remediation Goals (PRGs), which are required for contaminants of concern for which ARARs are not available. PRGs are generally prepared early in the RFI/RI process if existing data are available. Such data are not currently available for OU10, and the development of PRGs will be possible only after the results of the first field screening task (Section 7.0) are obtained. Once developed, the PRGs will be modified based on the environmental pathway analysis in the Baseline Risk Assessment (BRA).

3.1 THE ARAR BASIS

Section 121(d) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that Superfund-financed enforcement, and federal facility remedial actions comply with federal ARARs or more stringent promulgated state requirements. CDH Water Quality Control Commission (WQCC) groundwater standards became effective on April 30, 1991, and are therefore considered in the process for developing potential sitewide ARARs for RFP.

Potential ARARs are identified in this work plan.

3.2 ARAR DEFINITIONS

"Applicable requirements," as defined in 40 CFR 300.5, are "those standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable." "Relevant and appropriate requirements," also defined in 40 CFR 300.5 are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws, that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate." The most stringent promulgated standards are applied as ARARs (Preamble to NCP, 55 FR 8741). According to the NCP [40 FR 300.400(g)(4)], the term "promulgated" means that standards are of general applicability and are legally enforceable. ARARs are mandatory and must be complied with, unless a waiver or variance is issued.

3.3 TBC DEFINITION

In addition to ARARs, advisories, criteria, or guidance may be identified as information to be considered (TBCs) for a particular release. As defined in 40 CFR 300.400(g)(3), the TBC category consists of advisories, criteria, or guidance developed by EPA, other federal agencies, or states that may be useful in developing remedies. Use of the TBCs is discretionary rather than mandatory.

3.4 ARAR CATEGORIES

In general, there are three categories of ARARs:

- Contaminant or chemical-specific requirements
- Location-specific requirements
- Performance, design, or other action-specific requirements.

ARARs are generally considered to be dynamic in nature in that they evolve from general to very specific in the CERCLA site cleanup process. Initially, during the RFI/RI work plan stage, probable chemical-specific ARARs may be identified, usually on the basis of limited data. Chemical-specific ARARs at this point have meaning only in that they can be used to ensure that appropriate detection limits have been established so that data collected in the RFI/RI will be amenable for comparison to ARAR standards. It can also be appropriate to conduct a preliminary identification of location-specific ARARs early in the RFI/RI process so that information can be gathered to determine whether restrictions can be placed on the concentrations of hazardous substances or on the conduct of an activity solely because it occurs in a special location. As discussed in the introductory paragraph of this section, detailed, location-specific ARARs will be proposed in the RFI/RI report. Identification of action-specific ARARs and remediation goals is part of the feasibility study process and will be addressed in the CMS/FS report. Chemical-specific ARARs may be deleted if they are found to be inappropriate at any time in the RFI/RI process. Deletion of chemical-specified ARARs will be based on analytical information obtained from sampling at OU10.

PRGs are developed in the early phases of the RFI/RI process, and are later modified once the BRA is complete. Section 3.8 discusses PRGs in more detail.

Chemical-specific ARARs do not currently exist for soils; however, some chemical-related, *action-specific* requirements do exist, such as Colorado's construction standard for plutonium in soils. At this time, with respect to establishing analytical detection limits for soil, use of method detection limits provided in GRRASP (EG&G 1991), which are Contract Laboratory Program (CLP) required quantitation limits, should enable meaningful interpretation of soil sample results.

For appropriate management of investigation-derived wastes, as required in the IAG (Attachment 2, Statement of Work, Section IV), DOE has developed standard operating procedures (SOPs) for field investigation activities. All waste generated by the various investigations conducted at RFP will follow SOPs approved by EPA and CDH. The SOPs satisfy the IAG requirement to comply with ARARs as they relate to investigation activities. This approach is consistent with EPA policy as provided in the Draft Guide to Management of Investigation-Derived Waste (EPA 1991a).

3.5 CHEMICAL-SPECIFIC ARARs

The groundwater and surface water chemical-specific ARARs primarily apply to media that will be investigated in Phase II of the RFI/RI, however, they are presented here as well (Tables 3-1 to 3-4). Potential chemical-specific benchmarks, which essentially fall within the TBC category, have been developed on a sitewide basis. A screening and analysis process will be used to determine which of the potential benchmarks will serve as ARARs for OU10. The analysis will address compliance with chemical-, location-, and action-specific ARARs in accordance with the National Contingency Plan (NCP). The screening process will consider relevant and appropriate requirements in the same manner as applicable requirements. When more than one ARARs is identified, the more stringent of the applicable ARARs will be used.

The first step in identifying potential ARARs will occur after the initial scoping and site characterization and will involve analysis of the chemicals present at the site and any location-specific characteristics at the site. After the chemicals have been identified, the presence or absence of chemical-specific ARARs will be determined. Chemical-specific ARARs will be derived primarily from federal and state health and environmental statutes and regulations, including the following:

- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) applicable to both surface water and groundwater
- Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC) potentially applicable to surface water and alluvial groundwater
- RCRA, Part 264, Subpart F, Ground Water Concentration Limits (40 CFR 264.94) applicable to ground water
- WQCC Surface Water Standards for Woman Creek and Walnut Creek (5 CCR 1002-8, Section 3.8.29, effective March 30, 1990) applicable to surface water
- WQCC Basic Standards for Ground Water (5 CCR 1002-8, Section 3.11.0, amended September 1990) potentially applicable to groundwater
- WQCC Classifications and Water Quality Standards for Ground Water (5 CCR 1002-8, Section 3.12.0, effective April 30, 1991) potentially applicable to groundwater

A summary of chemical-specific standards or potential benchmarks (based on the above regulations and contaminants that may be found potentially sitewide) is presented in Table 3-1, Ground Water Quality Standards, Table 3-2, Federal Surface Water Quality Standards, and Table 3-3, Statewide and Basinwide (CDH/CWQCC) Surface Water Quality Standards, and Table 3-4, Stream Segment (CDH/CWQCC) Surface Water Quality Standards. These potential chemical-specific benchmarks and accompanying regulations will be screened to determine their jurisdictional requirements and applicability to OU10. If the requirements are not applicable, they will be further screened to determine whether they are relevant and appropriate to the particular site-specific conditions at OU10. Where benchmarks do not exist for a particular chemical, or where existing benchmarks are not protective of human health and the environment, other TBC criteria (such as guidance, proposed standards, and advisories developed by EPA, other federal agencies, or states) will be evaluated for use. Where benchmarks or other TBC criteria are not available or are less than laboratory practical quantitation limits (PQLs), PQLs will be used. For any parameters to be analyzed in groundwater, surface water, or soil, for which no benchmarks or other TBCs were found, use of the methods that achieve the detection limits provided in the GRRASP (EG&G 1991), which are quantitation limits required by the CLP, should enable meaningful interpretation of sample results. In addition, whenever a potential standard is below the GRRASP-derived detection limit, the detection limit will be used as the standard. Risk-based concentrations will be used in establishing the remediation goals for the parameters for which no potential ARARs could be identified, thus ensuring protectiveness of human health and the environment.

3.6 LOCATION-SPECIFIC ARARs

Potential location-specific ARARs include the following:

- Endangered Species Act; 16 USC Sections 1531 et seq.
- Executive Orders and Regulations Pertaining to Floodplain Management [44 Fed. Reg. 43239; 40 CFR 6; 40 CFR 257.3.1(a)]
- Executive Order 11988, Floodplain Management
- Standards Pertaining to RCRA Regulated Waste Management Units [44 FR 43239, 40 CFR 6, 40 CFR 257.3.1(a)]
- State of Colorado Hazardous Waste Management Act Siting Standards
- Fish and Wildlife Coordination Act, including Protection of Aquatic Life During Stream Modification (16 USC 661 et seq.)
- Migratory Bird Treaty Act (16 USC 703 et seq.)
- Bald Eagle Protection Act (16 USC 688 et seq.)
- Requirement Pertaining to Protection of Wetlands (40 CFR 6)
- Executive Order 11990, Protection of Wetlands
- Army Corps of Engineers Permit Program Regulations (33 CFR 320-330)
- Proposed Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11, 17.12)
- National Historic Preservation Act and Regulations (40 CFR 800), including Colorado's delegated responsibilities

No sites of historic interest will be affected. Sites of archaeological interest are not likely because most of the areas of concern have already been excavated and developed.

An environmental evaluation is already underway for species of concern which include all threatened and endangered species protected by the Endangered Species Act.

3.7 REMEDIAL ACTION

CERCLA Section 121 specifically requires attainment of all ARARs. Moreover, a remedial action that complies with the most stringent requirement is likely to ensure attainment of similar but less stringent ARARs dealing with the same subject. Furthermore, CERCLA requires that the remedies selected attain ARARs and be protective of human health and the environment. Remediation goals will be based on the BRA to be conducted for protection of human health and the environment.

3.8 PRELIMINARY REMEDIATION GOALS

PRGs consist of initial cleanup goals that are protective of human health and the environment. They are described in the recently released EPA guidance document, Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual, Part B (EPA 1991b). PRGs developed early in the RFI/RI process and later modified to reflect the results of the pathway analysis peformed during the BRA, are used to screen remedial alternatives during the RFI/RI and CMS/FS. PRGs are TBCs calculated for contaminants without ARARs, which will result in residual risks that fully satisfy NCP.

Chemical-specific PRGs consist of concentrations based on risk assessment. The risk assessment sets concentration limits using toxicity values under specific exposure conditions. Development of PRGs requires the following site-specific data:

- Media of potential concern
- Chemicals of potential concern

- Probable future land use

PRGs will be calculated for those chemicals being analyzed for this work plan that do not have ARARs associated with them. These PRGs will be refined in the RFI/RI stage and reported in a technical memorandum developed early in the FS process. In order to calculate PRGs, industrial land use will be assumed for the future, although other land use scenarios such as off-site resident will also be considered. Section 8.0 discusses details of the risk assessment process.

Once the BRA is completed, remediation goals will be developed based on the environmental pathway analysis provided in the BRA. Levels to which contaminants will be remediated will be decided during the CMS/FS process.

EPA guidance (EPA 1991b) provides standardized default exposure equations and parameters used to calculate PRGs for radioactive materials and chemicals. The guidance also indicates that an uncertainty assessment may be applicable to the development of PRGs and can serve as a basis for recommending further modifications to the PRGs prior to setting final remediation goals. An uncertainty assessment for the PRGs would be similar to that conducted during the BRA.

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

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

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL: RFP	PQL MDL: CDH	Method (6)	FEDERAL STANDARDS: SDWA Maximum Contaminant Level (a)	FEDERAL STANDARDS: SDWA Maximum Contaminant Level (b)	FEDERAL STANDARDS: SDWA Maximum Contaminant Level Goals (a)	FEDERAL STANDARDS: SDWA Maximum Contaminant Level Goals (b)	FEDERAL STANDARDS: RCRA Subpart F Limit (c)	STATE STANDARDS: CDH CWQCC Groundwater Quality Standards (d): Statewide: Table A (d) (7)	STATE STANDARDS: CDH CWQCC Groundwater Quality Standards (d): Site-Specific (g): Table 1 Human Health	Site-Specific (g): Table 2 Secondary Drinking	Site-Specific (g): Table 3 Agriculture	Site-Specific (g): Table 4 TDS	Site-Specific (g): Table 5 Chronic	Site-Specific (g): Table 6 Radionuclides: Woman Creek	Site-Specific (g): Table 6 Radionuclides: Walnut Creek
Arsenic V	M																
Barium	M	200		CT	1,000	2,000 (e)		2,000 (e)	1,000		1,000						
Beryllium	M	5		CT									100				
Cadmium	M	5		CT	10	5		5	10		10		10				
Calcium	M	5,000		CT													
Cesium	M	1,000		NC													
Chromium	M	10		CT	50	100		100	50		50		100				
Chromium III	M	5		SW8467196													
Chromium VI	M	10		E218.5													
Cobalt	M	50		CT									50				
Copper	M	25		CT	1,000 *			1,300 (f)				1,000	200				
Cyanide	M	10		CT							200						
Iron	M	100		CT	300 *							300	5,000				
Lead	M	5		CT	50			0 (f)	50		50		100				
Lithium	M	100		NC									2,500				
Magnesium	M	5000		CT													
Manganese	M	15		CT	50 *							50	200				
Mercury	M	0.2		CT	2	2		2	2		2		10				
Molybdenum	M	200		NC													
Nickel	M	40		CT									200				
Potassium	M	5000		CT													
Selenium	M	5		CT	10	50		50	10		10		20				
Silver	M	10		CT	50	100 *			50		50						
Sodium	M	5000		CT													
Strontium	M	200		NC													
Thallium	M	10		CT													
Tin	M	200		NC													

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Titanium	M	10		E6010													
Tungsten	M	10		E6010													
Vanadium	M	50		CT									100				
Zinc	M	20		CT	5,000 *							5,000	2,000				
2,4,5-TP Silvex	P		0.5	d	10	50		50	10	50							
2,4-Dichlorophenoxyacetic Acid (2,4-D)	P		1	d	100	70		70	100	70							
	P																
Acrolein	P		10														
Aldicarb	P		10			3 (e)		1 (e)		10							
Aldrin	P	0.05	0.1	CP						0.002					0.000074		
Bromacil	P																
Carbofuran	P			d		40		40		36							
Chloranil	P																
Chlordane (Alpha)	P	0.5	1	CP		2		0		0.03					0.00046		
Chlordane (Gamma)	P	0.5	1	CP		2		0		0.03					0.00046		
Chlorpyrifos	P			E619													
DDT	P	0.1	0.1	CP						0.1					0.000024		
DDT Metabolite (DDD)	P	0.1		CP													
DDT Metabolite (DDE)	P	0.1	0.1	CP						0.1							
Demeton	P																
Diazinon	P																
Dieldrin	P	0.1	0.1	CP						0.002					0.000071		
Endosulfan I	P	0.05		CP													
Endosulfan II	P	0.1		CP													
Endosulfan sulfate	P	0.1		CP													
Endrin	P	0.1	0.1	CP	0.2				0.2	0.2							

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Endrin Aldehyde	P		0.1							0.2							
Endrin Ketone	P	0.1		CP													
Guthion	P																
Heptachlor	P	0.05	0.05	CP		0.4		0		0.008					0.00028		
Heptachlor Epoxide	P	0.05	0.05	CP		0.2		0		0.09							
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP						0.006					0.0092		
Hexachlorocyclohexane, Beta	P	0.05	0.1(9)	CP											0.0163		
Hexachlorocyclohexane, BHC	P		0.05														
Hexachlorocyclohexane, Delta	P	0.05		CP													
Hexachlorocyclohexane, Tech	P		0.5(9)	f											0.0123		
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	4	0.2		0.2	4.0	0.2					0.0186		
Malathion	P																
Methoxychlor	P	0.5	0.5	CP	100	40		40	100	40	100						
Mirex	P																
Parathion	P																
PCBs	P	0.5	1	CP		0.5		0		0.005					0.000079		
Simazine	P			e											4		
Toxaphene	P	1	5	CP		3		0	5.0	0.03	5						
Vaponite 2	P																
Aroclor 1016	PP	0.5		CP													
Aroclor 1221	PP	0.5		CP													
Aroclor 1232	PP	0.5		CP													
Aroclor 1242	PP	0.5		CP													
Aroclor 1248	PP	0.5		CP													
Aroclor 1254	PP	1		CP													
Aroclor 1260	PP	1		CP													
Atrazine	PP		1 (9)	e		3		3							3		

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

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

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
2,4-Dichlorophenol	SV	10	50	CS						21							
2,4-Dimethylphenol	SV	10		CS													
2,4-Dinitrophenol	SV	50	50	CS						14							
2,4-Dinitrotoluene	SV	10		CS													
2,6-Dinitrotoluene	SV	10		CS													
2-Chloronaphthalene	SV	10		CS													
2-Chlorophenol	SV	10		CS													
2-Methylnaphthalene	SV	10		CS													
2-Methylphenol	SV	10		CS													
2-Nitroaniline	SV	50		CS													
2-Nitrophenol	SV	10		CS													
3,3-Dichlorobenzidine	SV	20		CS													
3-Nitroaniline	SV	50		CS													
4,6-Dinitro-2-methylphenol	SV	50		CS													
4-Bromophenyl Phenylether	SV	10		CS													
4-Chloroaniline	SV	10		CS													
4-Chlorophenyl Phenyl Ether	SV	10		CS													
4-Chloro-3-methylphenol	SV	10		CS													
4-Methylphenol	SV	10		CS													
4-Nitroaniline	SV	50		CS													
4-Nitrophenol	SV	50		CS													
Acenaphthene	SV	10		CS													
Anthracene	SV	10		CS													
Benzidine	SV		10	d						0.0002	0.1				0.00012		
Benzoic Acid	SV	50		CS													
Benzo(a)anthracene	SV	10		CS													
Benzo(a)pyrene	SV	10		CS													

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Benzo(b)fluoranthene	SV	10		CS													
Benzo(g,h,i)perylene	SV	10		CS													
Benzo(k)fluoranthene	SV	10		CS													
Benzyl Alcohol	SV	10		CS													
bis(2-Chloroethoxy)methane	SV	10		CS													
bis(2-Chloroethyl)ether	SV	10		CS						0.03					0.0000037		
bis(2-Chloroisopropyl)ether	SV	10		CS													
bis(2-Ethylhexyl)phthalate	SV	10		CS													
Butadiene	SV																
Butylbenzylphthalate	SV	10		CS													
Chlorinated Ethers	SV																
Chlorinated Napthalenes	SV																
Chloroalkylethers	SV	10		CS													
Chlorophenol	SV										1						
Chrysene	SV	10		CS													
Dibenzofuran	SV	10		CS													
Dibenz(a,h)anthracene	SV	10		CS													
Dichlorobenzenes	SV																
Dichlorobenzidine	SV	20	10(9)	CS											0.01		
Diethylphthalate	SV	10		CS													
Dimethylphthalate	SV	10		CS													
Di-n-butylphthalate	SV	10		CS													
Di-n-octylphthalate	SV	10		CS													
Ethylene Glycol	SV			d						7,000							
Fluoranthene	SV	10		CS													
Fluorene	SV	10		CS													
Formaldehyde	SV																

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Haloethers	SV																
Hexachlorobenzene	SV	10	10	CS						6					0.00072		
Hexachlorobutadiene	SV	10	10	CS						1					0.45		
Hexachlorocyclopentadiene	SV	10		CS						49							
Hexachloroethane	SV	10		CS											1.9		
Hydrazine	SV																
Indeno(1,2,3-cd)pyrene	SV	10		CS													
Isophorone	SV	10	10	CS						1,050							
Naphthalene	SV	10		CS													
Nitrobenzene	SV	10	10	CS						3.5							
Nitrophenols	SV																
Nitrosamines	SV		10														
Nitrosodibutylamine	SV			b											0.0064		
Nitrosodiethylamine	SV		10	b											0.0008		
Nitrosodimethylamine	SV		10	b											0.0014		
Nitrosopyrrolidine	SV		10	b											0.016		
N-Nitrosodiphenylamine	SV	10	10(9)	CSb											4.9		
N-Nitroso-di-n-dipropylamine	SV	10		CSb													
Pentachlorinated Ethanes	SV			b													
Pentachlorobenzene	SV		10	b						6 (7)							
Pentachlorophenol	SV	50	50	CS		1 (e)		0 (e)		200							
Phenanthrene	SV	10		CS													
Phenol	SV	10		CS							1						
Phthalate Esters	SV																
Polynuclear Aromatic Hydrocarb	SV		1 (9)	b											0.0028		
Vinyl Chloride	SV	10	2	CV	2		0			2							

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Statewide	Site-Specific (g)						
										Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
1,1,1-Trichloroethane	V	5	1	CV	200		200			200							
1,1,2,2-Tetrachloroethane	V	5	1 (9)	CV											0.17		
1,1,2-Trichloroethane	V	5	1	CV						3					0.6		
1,1-Dichloroethane	V	5		CV													
1,1-Dichloroethene	V	5	1	CV	7		7			7							
1,2-Dichloroethane	V	5	1	CV	5		0			0.4							
1,2-Dichloroethene (cis)	V		1	a		70		70		70							
1,2-Dichloroethene (total)	V	5		CV													
1,2-Dichloroethene (trans)	V		1	a		100		100		100							
1,2-Dichloropropane	V	5	1	CV		5		0		0.56							
1,3-Dichloropropene (cis)	V	5		CV													
1,3-Dichloropropene (trans)	V	5		CV													
2-Butanone	V	10		CV													
2-Hexanone	V	10		CV													
4-Methyl-2-pentanone	V	10		CV													
Acetone	V	10		CV													
Acrylonitrile	V		15(9)	c											0.058		
Benzene	V	5	1	CV	5		0			1							
Bromodichloromethane	V	5	1	CV						0.3							
Bromoform	V	5	1	CV						4							
Bromomethane	V	10		CV													
Carbon Disulfide	V	5		CV													
Carbon Tetrachloride	V	5	1	CV	5		0			0.3							
Chlorinated Benzenes	V	10		CV/CS													
Chlorobenzene	V	5	1	CV/CS		100		100		100							
Chloroethane	V	10		CV													
Chloroform	V	5	1	CV	Tot THM					6					0.19		

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) GROUND WATER QUALITY STANDARDS (ug/l)

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

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

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

EXPLANATION OF TABLE

* = secondary maximum contaminant level

** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

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

(1) TDS standard - see Table 4 in (d); standard is 400 mg/l or 1.25 times the background level, whichever is least restrictive
(2) radionuclide standards - see sec. 3.11.5(c)2 in (d)
(3) If both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(4) MDL for Radium 226 is 0.5; MDL for radium 228 is 1
(5) type abbreviations are: A=anion; B=bacteria; C=cation; D=dioxin; E=element; FP=field parameter; I=indicator; M=metal; P=pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile

TABLE 3-1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

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

(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV;
d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.

(7) Where standard is below (more stringent than) PQL (CDH), PQL is standard.

(8) Value for gross alpha excludes uranium.

(9) Value is CDH detection level (PQL not available)

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

(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526; 1/30/1991)

(c) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, August 1988, 40 CFR 264.94.

(d) CDH/Colorado Water Quality Control Commission, The Basic Standards for Ground Water, 3.11.0 (5 CCR 1002-8) 1/5/1987 amended 11/30/1991; statewide radioactive standards listed in 3.11.5(c)(2).

(e) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective January 1, 1993 (56 FR 30266; 7/1/1991)

(f) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/91) effective 12/7/92.

(g) CDH/Colorado Water Quality Control Commission, Classifications and Water Quality Standards for Ground Water, 3.12.0 (9/19/1991).

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

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

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Beryllium	M	5		CT					130	5.3	.0068**	.117**	
Cadmium	M	5		CT	10	5		5	3.9 (3)	1.1 (3)	10		
Calcium	M	5,000		CT									
Cesium	M	1,000		NC									
Chromium	M	10		CT	50	100		100					
Chromium III	M	5		SW8467196					1,700	210	170,000	3,433,000	
Chromium VI	M	10		E218.5					16	11	50		
Cobalt	M	50		CT									
Copper	M	25		CT	1,000*			1,300 (g)	18 (3)	12 (3)			
Cyanide	M	10		CT					22	5.2	200		
Iron	M	100		CT	300 *					1,000	300		
Lead	M	5		CT	50			0 (g)	82 (3)	3.2 (3)	50		
Lithium	M	100		NC									
Magnesium	M	5000		CT									
Manganese	M	15		CT	50 *						50	100	
Mercury	M	0.2		CT	2	2		2	2.4	0.012	0.144	0.146	
Molybdenum	M	200		NC									
Nickel	M	40		CT					1,400 (3)	160 (3)	13.4	100	
Potassium	M	5000		CT									
Selenium	M	5		CT	10	50		50	20 (d)	5 (d)	10		
Silver	M	10		CT	50	100 *			4.1 (3)	0.12	50		
Sodium	M	5000		CT									
Strontium	M	200		NC									
Thallium	M	10		CT					1,400 (1)	40 (1)	13	48	
Tin	M	200		NC									
Titanium	M	10		E6010									
Tungsten	M	10		E6010									
Vanadium	M	50		CT									

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Zinc	M	20		CT	5,000 *				120 (3)	110 (3)			
2,4,5-TP Silvex	P		0.5	d	10	50		50					
2,4-Dichlorophenoxyacetic Acid (2,4-D)	P		1	d	100	70		70					
Acrolein	P		10						68(1)	21(1)	320	780	
Aldicarb	P		10			3 (f)		1 (f)					
Aldrin	P	0.05	0.1	CP					3.0		0.000074	0.000079	
Bromacil	P												
Carbofuran	P			d		40		40					
Chloranil													
Chlordane (Alpha)	P	0.5	1	CP		2		0	2.4	0.0043	0.00046	0.00048	
Chlordane (Gamma)	P	0.5	1	CP		2		0	2.4	0.0043	0.00046	0.00048	
Chlorpyrifos	P		0.1	E619					0.063	0.041			
DDT	P	0.1	0.1	CP					1.1	0.0011	0.000024	0.000024	
DDT metabolite (DDD)	P	0.1	0.1	CP					0.06				
DDT metabolite (DDE)	P	0.1	0.1	CP					1,050				
Demeton	P		1							0.1			
Diazinon	P												
Dieldrin	P	0.1	0.1	CP					2.5	0.0019	0.00007	0.000076	
Endosulfan I	P	0.05	0.1	CP					0.22	0.056	74	159	
Endosulfan II	P	0.1	0.1	CP									
Endosulfan Sulfate	P	0.1	0.1	CP									
Endrin	P	0.1	0.1	CP	0.2				0.18	0.0023	1		
Endrin Aldehyde	P		0.1										
Endrin Ketone	P	0.1		CP									
Guthion	P		1.5							0.01			
Heptachlor	P	0.05	0.05	CP		0.4		0	0.52	0.0038	0.00028	0.00029	
Heptachlor Epoxide	P	0.05	0.05	CP		0.2		0					

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	Fish Consumption Only	NRC Effluent Standards Water pCi/L
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP							0.0092	0.031	
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP							0.0163	0.0547	
Hexachlorocyclohexane, BHC	P	0.05	0.05										
Hexachlorocyclohexane, Delta	P	0.05		CP									
Hexachlorocyclohexane, Technical	P		0.2	f							0.0123	0.0414	
Hexachlorocyclohexane, (Lindane) Gama	P	0.05	0.05	CP	4	0.2		0.2	2.0	0.08			
Malathion	P		0.2							0.01			
Methoxychlor	P	0.5	0.5	CP	100	40		40		0.03	100		
Mirex	P		0.1							0.001			
Parathion	P								0.065	0.013			
PCBs	P	0.5	1	CP		0.5		0	2.0	0.014	0.000079**	0.000079**	
Simazine	P			e									
Toxaphene	P	1	5	CP		3		0	0.73	0.0002	0.00071**	0.00073**	
Vaponite 2	P												
Aroclor 1016	PP	0.5		CP									
Aroclor 1221	PP	0.5		CP									
Aroclor 1232	PP	0.5		CP									
Aroclor 1242	PP	0.5		CP									
Aroclor 1248	PP	0.5		CP									
Aroclor 1254	PP	1		CP									
Aroclor 1260	PP	1		CP									
Atrazine	PP			e		3		3					
Americium (pCi/l)	R												20
Americium 241 (pCi/l)	R	0.01											900
Cesium 134 (pCi/l)	R	1											1000
Cesium 137 (pCi/l)	R	1											
Gross Alpha (pCi/l)	R	2			15 (10)							15	

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)								
Plutonium (pCi/l)	R												
Plutonium 238+239+240 (pCi/l)	R	0.01											20
Radium 226+228 (pCi/l)	R	0.5/0.1 (9)			5							5	60
Strontium 89+90 (pCi/l)	R	1											500
Strontium 90 (pCi/l)	R				8 (6)							8	500
Thorium 230+232 (pCi/l)	R												30
Tritium (pCi/l)	R				20,000 (6)								1000000
Uranium 233+234 (pCi/l)	R												300
Uranium 235 (pCi/l)	R	0.6											300
Uranium 238 (pCi/l)	R	0.6											300
Uranium (total) (pCi/l)	R												
1,2,4,5-Tetrachlorobenzene	SV		10	b							38	48	
1,2,4-Trichlorobenzene	SV	10		CS									
1,2-Dichlorobenzene (Ortho)	SV	10	10	CS		600		600					
1,2-Diphenylhydrazine	SV			b					270 (1)				
1,3-Dichlorobenzene (Meta)	SV	10	1	CS									
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75		75						
2,4,5-Trichlorophenol	SV	50		CS							2,800		
2,4,6-Trichlorophenol	SV	10	50	CS						970 (1)	1.2 **	3.6 **	
2,4-Dichlorophenol	SV	10	50	CS					2,020 (1)	365 (1)	3,090		
2,4-Dimethylphenol	SV	10	50	CS					2,120 (1)				
2,4-Dinitrophenol	SV	50	50	CS									
2,4-Dinitrotoluene	SV	10	10	CS							0.11 **	9.1 **	
2,6-Dinitrotoluene	SV	10	10	CS					330 (1)	230 (1)	70	14,300	
2-Chloronaphthalene	SV	10		CS									
2-Chlorophenol	SV	10	50	CS					4,360 (1)	2,000 (1)			

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL MDL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
2-Methylnaphthalene	SV	10		CS									
2-Methylphenol	SV	10		CS									
2-Nitroaniline	SV	50		CS									
2-Nitrophenol	SV	10		CS									
3,3-Dichlorobenzidine	SV	20	10	CS							0.01	0.02	
3-Nitroaniline	SV	50		CS									
4,6-Dinitro-2-methylphenol	SV	50	50	CS									
4-Bromophenyl Phenylether	SV	10		CS									
4-Chloroaniline	SV	10		CS									
4-Chlorophenyl Phenyl Ether	SV	10		CS									
4-Chloro-3-methylphenol	SV	10	50	CS					30 (1)				
4-Methylphenol	SV	10		CS									
4-Nitroaniline	SV	50		CS									
4-Nitrophenol	SV	50		CS					230 (1)	150 (1)			
Acenaphthene	SV	10	10	CS					1,700 (1)	520 (1)			
Anthracene	SV	10	1	CS									
Benzidine	SV		1	d					2,500		0.00012	0.00053	
Benzoic Acid	SV	50		CS									
Benzo(a)anthracene	SV	10	10	CS									
Benzo(a)pyrene	SV	10	10	CS									
Benzo(b)fluoranthene	SV	10	10	CS									
Benzo(g,h,i)perylene	SV	10	10	CS									
Benzo(k)fluoranthene	SV	10	10	CS									
Benzyl Alcohol	SV	10		CS									
bis(2-Chloroethoxy)methane	SV	10		CS									
bis(2-Chloroethyl)ether	SV	10	10	CS							0.03**	1.36 **	
bis(2-Chloroisopropyl)ether	SV	10	10	CS							34.7	4,360	
bis(2-Ethylhexyl)phthalate	SV	10	10	CS							15,000	50,000	

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

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

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

		PQL			SDWA	SDWA	SDWA	SDWA	CWA AWQC for Protection of Aquatic Life (c)		CWA AWQC for Protection of Human Health (c)		NRC Effluent Standards
		MDL			Maximum Contaminant Levels (a)	Maximum Contaminant Levels (b)	Maximum Contaminant Level Goals (a)	Maximum Contaminant Level Goals (b)	Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only	Water pCi/L
Parameter	Type (7)	RFP	CDH	Method (8)									
Nitrobenzene	SV	10	10	CS					27,000 (1)		19,800		
Nitrophenols	SV								230 (1)	150 (1)			
Nitrosamines	SV								5,850 (1)				
Nitrosodibutylamine	SV		10	b							0.0064	0.587	
Nitrosodiethylamine	SV		10	b							0.0008	1.24	
Nitrosodimethylamine	SV		10	b							0.0014	16	
Nitrosopyrrolidine	SV		10	b							0.016	91.9	
N-Nitrosodiphenylamine	SV	10	10	b							4.9 **	16.1 **	
N-Nitroso-di-n-dipropylamine	SV	10	10	b									
Pentachlorinated Ethanes	SV			b					7,240 (1)	1,100 (1)			
Pentachlorobenzene	SV		10	b							74	85	
Pentachlorophenol	SV	50	50	CS		1 (f)		0 (f)	20 (4)	13 (4)	1,010		
Phenanthrene	SV	10	10	CS									
Phenol	SV	10	50	CS					10,200 (1)	2,560 (1)	3,500		
Phthalate Esters	SV			e					940 (1)	3 (1)			
Polynuclear Aromatic Hydrocarbons	SV		10	b							0.0028**	0.0311**	
Vinyl Chloride	SV	10	2	CV	2		0				2 **	525 **	
1,1,1-Trichloroethane	V	5	1	CV	200		200				18,400	1,030,000	
1,1,2,2-Tetrachloroethane	V	5	1	CV						2,400	0.17**	10.7 **	
1,1,2-Trichloroethane	V	5	1	CV						9,400	0.6**	41.8 **	
1,1-Dichloroethane	V	5		CV									
1,1-Dichloroethene	V	5	1	CV	7		7						
1,2-Dichloroethane	V	5	1	CV	5		0		118,000	20,000	0.94**	243 **	
1,2-Dichloroethene (cis)	V		1	a		70		70					
1,2-Dichloroethene (total)	V	5		CV									
1,2-Dichloroethene (trans)	V	5	1	a		100		100					
1,2-Dichloropropane	V	5	1	CV		5		0	23,000	5,700			

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

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

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

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

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

TABLE 3-2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

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

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

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

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

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

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 MDL RFP	CDH	Method (6)	Statewide Standards (a): Human Health Carcinogens/ Noncarcinogens (2) (8): Water Supply	Statewide Standards (a): Human Health Carcinogens/ Noncarcinogens (2) (8): Water and Fish	Statewide Standards (a): Aquatic Life (8): Acute Value	Statewide Standards (a): Aquatic Life (8): Chronic Value	Statewide Standards (a): Tables I,II,III (1): Aquatic Life: Acute Value (2)	Statewide Standards (a): Tables I,II,III (1): Aquatic Life: Chronic Value (2)	Statewide Standards (a): Tables I,II,III (1): Agricultural Standard (3)	Statewide Standards (a): Tables I,II,III (1): Domestic Water Supply (4)	Basin Standards (b): Organics (7): Aquatic Life	Basin Standards (b): Organics (7): Water Supply
Barium	M	200		CT								1,000		
Beryllium	M	5		CT							100	0.0076		
Cadmium	M	5		CT					TVS	TVS	10	10		
Calcium	M	5,000		CT										
Cesium	M	1,000		NC										
Chromium	M	10		CT										
Chromium III	M	5		SW8467196					TVS	TVS	100	50		
Chromium VI	M	10		E218.5					16	11	100	50		
Cobalt	M	50		CT										
Copper	M	25		CT					TVS	TVS	200	1,000		
Cyanide	M	10		CT					5	5	200	200		
Iron	M	100		CT						1,000		300 (dis)		
Lead	M	5		CT					TVS	TVS	100	50		
Lithium	M	100		NC										
Magnesium	M	5000		CT										
Manganese	M	15		CT						1,000	200	50 (dis)		
Mercury	M	0.2		CT					2.4	0.1		2.0		
Molybdenum	M	200		NC										
Nickel	M	40		CT					TVS	TVS	200			
Potassium	M	5000		CT										
Selenium	M	5		CT					135	17	20	10		
Silver	M	10		CT					TVS	TVS		50		
Sodium	M	5000		CT										
Strontium	M	200		NC										
Thallium	M	10		CT						15		0.012		
Tin	M	200		NC										
Titanium	M	10		E6010										
Tungsten	M	10		E6010										

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
									Aquatic Life					
Parameter	Type (5)	PQL MDL RFP	CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Vanadium	M	50		CT										
Zinc	M	20		CT					TVS	TVS	2,000	5,000		
2,4,5-TP Silvex	P		0.5	d	50									
2,4-D	P		1	d	70									100
Acrolein			10			320	68	21						
Aldicarb	P		10		10									
Aldrin	P	0.05	0.1	CP	0.002 (8)	0.00013	1.5						0.003	
Bromacil	P													
Carbofuran	P			d	36									
Chloranil	P			E619										
Chlordane (Alpha)	P	0.5	1	CP	0.03 (8)		1.2	0.0043						
Chlordane (Gamma)	P	0.5	1	CP	0.03 (8)	0.00058	1.2	0.0043						
Chlorpyrifos	P		0.1				0.083	0.041						
DDT	P	0.1	0.1	CP	0.1	0.00059	0.55	0.001					0.001	
DDT Metabolite (DDD)	P	0.1	0.1	CP		0.0008	0.6						0.001	
DDT Metabolite (DDE)	P	0.1	0.1	CP	0.1	0.00059	1,050						0.001	
Demeton	P		1					0.1					0.1	
Diazinon	P													
Dieldrin	P	0.1	0.1	CP	0.002	0.00014	1.3	0.0019					0.003	
Endosulfan I	P	0.05	0.1	CP		0.93	0.11	0.056					0.003	
Endosulfan II	P	0.1	0.1	CP										
Endosulfan Sulfate	P	0.1	0.1	CP		0.93								
Endrin	P	0.1	0.1	CP	0.2		0.09	0.0023					0.004	
Endrin Aldehyde	P		0.1		0.2	0.2								
Endrin Ketone	P	0.1		CP										
Guthion	P		1.5					0.01					0.01	
Heptachlor	P	0.05	0.05	CP	0.008	0.00021	0.26	0.0038					0.001	0.2

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
									Aquatic Life					
		PQL MDL					Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)		
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish							Aquatic Life	Water Supply
Heptachlor Epoxide	P	0.05	0.05	CP	0.09	0.0001	0.26	0.0038						
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP	0.006		0.0039							
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP		0.014								
Hexachlorocyclohexane, BHC	P	0.05	0.05				100							
Hexachlorocyclohexane, Delta	P	0.05		CP										
Hexachlorocyclohexane, Tech.	P		0.2	f		0.012								
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	0.2	0.019	1.0	0.08					0.01	4.0
Malathion	P		0.2					0.1					0.1	
Methoxychlor	P	0.5	0.5	CP	40			0.03					0.03	100
Mirex	P		0.1					0.001					0.001	
Parathion	P												0.04	
PCBs	P	0.5	1	CP	0.005	0.000044	2.0	0.014					0.001	
Simazine	P			e										
Toxaphene	P	1	5	CP	0.03	0.00073	0.73	0.0002					0.005	5.0
Vaponite 2	P													
Aroclor 1016	PP	0.5		CP										
Aroclor 1221	PP	0.5		CP										
Aroclor 1232	PP	0.5		CP										
Aroclor 1242	PP	0.5		CP										
Aroclor 1248	PP	0.5		CP										
Aroclor 1254	PP	1		CP										
Aroclor 1260	PP	1		CP										
Atrazine	PP			e										
Americium (pCi/l)	R													
Americium 241 (pCi/l)	R	0.01												
Cesium 134 (pCi/l)	R	1			80 (10)									
Cesium 137 (pCi/l)	R	1												

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL							Aquatic Life					
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Gross Alpha (pCi/l)	R	2												
Gross Beta (pCi/l)	R	4												
Plutonium (pCi/l)	R													
Plutonium 238+239+240 (pCi/l)	R	0.01			15 (10)									
Radium 226+228 (pCi/l)	R	0.5/1 (9)			5 (10)									
Strontium 89+90 (pCi/l)	R	1												
Strontium 90 (pCi/l)	R				8 (10)									
Thorium 230+232 (pCi/l)	R				60 (10)									
Tritium (pCi/l)	R				20,000 (10)									
Uranium 233+234 (pCi/l)	R													
Uranium 235 (pCi/l)	R	0.6												
Uranium 238 (pCi/l)	R	0.6												
Uranium (Total) (pCi/l)	R								TVS	TVS				
1,2,4,5-Tetrachlorobenzene	SV		10	b	2 (8)									
1,2,4-Trichlorobenzene	SV	10		CS										
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS	620	620								
1,2-Diphenylhydrazine	SV			b	0.05	0.04	270							
1,3-Dichlorobenzene (Meta)	SV	10	1	CS	620	400								
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75	75								
2,4,5-Trichlorophenol	SV	50		CS										
2,4,6-Trichlorophenol	SV	10	50	CS	2	2		970						
2,4-Dichlorophenol	SV	10	50	CS	21	21	2,020	365						
2,4-Dimethylphenol	SV	10	50	CS			2,120							
2,4-Dinitrophenol	SV	50	50	CS	14	14								
2,4-Dinitrotoluene	SV	10	10	CS		0.11								
2,6-Dinitrotoluene	SV	10	10	CS			330	230						
2-Chloronaphthalene	SV	10		CS										

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

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

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

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
									Aquatic Life					
		PQL MDL					Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish								
Naphthalene	SV	10	10	CS		0.0028	2,300	620						
Nitrobenzene	SV	10	10	CS	3.5	3.5	27,000							
Nitrophenols	SV													
Nitrosamines	SV													
Nitrosodibutylamine	SV		10	b		0.0064								
Nitrosodiethylamine	SV		10	b		0.0008								
Nitrosodimethylamine	SV		10	b		0.00069								
Nitrosopyrrolidine	SV		10	b		0.016								
N-Nitrosodiphenylamine	SV	10	10	CSb		4.9								
N-Nitroso-di-n-dipropylamine	SV	10	10	CSb		0.005								
Pentachlorinated Ethanes	SV			b										
Pentachlorobenzene	SV		10	b	6 (8)									
Pentachlorophenol	SV	50	50	CS	200		9	5.7						
Phenanthrene	SV	10	10	CS		0.0028								
Phenol	SV	10	50	CS		21,000	10,200	2,560					500	1.0
Phthalate Esters	SV			e										
Polynuclear Aromatic Hydrocarbons	SV		10	b		0.0028								
Vinyl Chloride	SV	10	2	CV	2	2								
1,1,1-Trichloroethane	V	5	1	CV	200	200								
1,1,2,2-Tetrachloroethane	V	5	1	CV		0.17		2,400						
1,1,2-Trichloroethane	V	5	1	CV	3	0.6	9,400							
1,1-Dichloroethane	V	5		CV										
1,1-Dichloroethene	V	5	1	CV	7	0.057								
1,2-Dichloroethane	V	5	1	CV	0.4	0.4	118,000	20,000						
1,2-Dichloroethene (cis)	V		1	a	70									
1,2-Dichloroethene (total)	V	5		CV										
1,2-Dichloroethene (trans)	V	5	1	a	100									

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL							Aquatic Life					
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
1,2-Dichloropropane	V	5	1	CV	0.56 (8)	0.56	23,000	5,700						
1,3-Dichloropropene (cis)	V	5	1	CV		10	6,060	244						
1,3-Dichloropropene (trans)	V	5	1	CV		10	6,060	244						
2-Butanone	V	10		CV										
2-Hexanone	V	10		CV										
4-Methyl-2-pentanone	V	10		CV										
Acetone	V	10		CV										
Acrylonitrile	V		5	c		0.58	7,550	2,600						
Benzene	V	5	1	CV	1	1	5,300							
Bromodichloromethane	V	5	1	CV	0.3	0.3								
Bromoform	V	5	1	CV	4	4								
Bromomethane	V	10	1	CV		48								
Carbon Disulfide	V	5		CV										
Carbon Tetrachloride	V	5	1	CV	0.3	0.25	35,200							
Chlorinated Benzenes	V	10		CV/CS										
Chlorobenzene	V	5	1	CV/CVS	100	100								
Chloroethane	V	10		CV										
Chloroform	V	5	1	CV	6	6	28,900	1,240						
Chloromethane	V	10	1	CV		5.7								
Dibromochloromethane	V	5	1	CV	14	6								
Dichloroethenes	V		1											
Ethyl Benzene	V	5	1	CV	680	3,100	32,000							
Ethylene Dibromide	V			d										
Ethylene Oxide	V													
Halomethanes	V				100									
Methylene Chloride	V	5	1	CV		4.7								
Pyrene	V	10	10	CS	.	0.0028								

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)									Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)					Organics (7)	
									Aquatic Life						
		PQL MDL					Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)		Aquatic Life	Water Supply
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish									
Styrene	V	5		CV											
Tetrachloroethanes	V	5	1	CV											
Tetrachloroethene	V	5	1	CV	5	0.8	5,280	840							
Toluene	V	5	1	CV	1,000	1,000	17,500								
Trichloroethanes	V	5	1	CV											
Trichloroethene	V	5	1	CV	5	2.7	45,000	21,900							
Vinyl Acetate	V	10		CV											
Xylenes (Total)	V	5		CV											

EXPLANATION OF TABLE

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

TABLE 3-3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

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

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

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

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

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

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 RFP	CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5): Acute Value	Chronic Value	Table 2 Radionuclides: Woman Creek	Walnut Creek
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							
Nickel	M	40		CT				TVS	TVS		
Potassium	M	5000		CT							
Selenium	M	5		CT				10			
Silver	M	10		CT				TVS	TVS		
Sodium	M	5000		CT							
Strontium	M	200		NC							
Thallium	M	10		CT							
Tin	M	200		NC							
Titanium	M	10		E6010							
Tungsten	M	10		E6010							

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 RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5) Acute Value	Stream Segment Table (5) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek
Vanadium	M	50		CT							
Zinc	M	20		CT				TVS	TVS		
2,4,5-TP Silvex	P		0.5	d	10						
2,4-D	P		1	d	100						
Acrolein	P		10								
Aldicarb	P		10		10						
Aldrin	P	0.05	0.1	CP	0.002 (6)	0.000074			0.000074		
Bromacil	P										
Carbofuran	P			d	36						
Chloranil	P			E619							
Chlordane (Alpha)	P	0.5	1	CP	0.03 (6)	0.00046			0.00046		
Chlordane (Gamma)	P	0.5	1	CP	0.03 (6)	0.00046			0.00046		
Chlorpyrifos	P		0.1								
DDT	P	0.1	0.1	CP	0.1 (6)	0.000024			0.000024		
DDT Metabolite (DDD)	P	0.1	0.1	CP							
DDT Metabolite (DDE)	P	0.1	0.1	CP							
Demeton	P		1								
Diazinon	P										
Dieldrin	P	0.1	0.1	CP	0.002 (6)	0.000071			0.000071		
Endosulfan I	P	0.05	0.1	CP							
Endosulfan II	P	0.1	0.1	CP							
Endosulfan Sulfate	P	0.1	0.1	CP							
Endrin	P	0.1	0.1	CP	0.2						
Endrin Aldehyde	P		0.1								
Endrin Ketone	P	0.1		CP							
Guthion	P		1.5								
Heptachlor	P	0.05	0.05	CP	0.008 (6)	0.00028			0.00028		

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 RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5) Acute Value	Stream Segment Table (5) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek
Heptachlor Epoxide	P	0.05	0.05	CP	0.004 (6)						
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP		0.0092			0.0092		
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP		0.0163			0.0163		
Hexachlorocyclohexane, BHC	P	0.05	0.05								
Hexachlorocyclohexane, Delta	P	0.05		CP							
Hexachlorocyclohexane, Tech.	P		0.2	f		0.0123			0.0123		
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	4	0.0186			0.0186		
Malathion	P		0.2								
Methoxychlor	P	0.5	0.5	CP	100						
Mirex	P		0.1								
Parathion	P										
PCBs	P	0.5	1	CP	0.005 (6)	0.000079			0.000079		
Simazine	P			e		4			4		
Toxaphene	P	1	5	CP	5						
Vaponite 2	P										
Aroclor 1016	PP	0.5		CP							
Aroclor 1221	PP	0.5		CP							
Aroclor 1232	PP	0.5		CP							
Aroclor 1242	PP	0.5		CP							
Aroclor 1248	PP	0.5		CP							
Aroclor 1254	PP	1		CP							
Aroclor 1260	PP	1		CP							
Atrazine	PP			e		3			3		
Americium (pCi/l)	R									0.05	0.05
Americium 241 (pCi/l)	R	0.01					30				
Cesium 134 (pCi/l)	R	1			80		80			80	80
Cesium 137 (pCi/l)	R	1									

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

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

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)						
					Tables 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	Woman Creek	Walnut Creek
2-Chlorophenol	SV	10	50	CS							
2-Methylnaphthalene	SV	10		CS							
2-Methylphenol	SV	10		CS							
2-Nitroaniline	SV	50		CS							
2-Nitrophenol	SV	10		CS							
3,3-Dichlorobenzidine	SV	20	10	CS		0.01			0.01		
3-Nitroaniline	SV	50		CS							
4,6-Dinitro-2-methylphenol	SV	50	50	CS							
4-Bromophenyl Phenylether	SV	10		CS							
4-Chloroaniline	SV	10		CS							
4-Chlorophenyl Phenyl Ether	SV	10		CS							
4-Chloro-3-methylphenol	SV	10	50	CS							
4-Methylphenol	SV	10		CS							
4-Nitroaniline	SV	50		CS							
4-Nitrophenol	SV	50		CS							
Acenaphthene	SV	10	10	CS							
Anthracene	SV	10	1	CS							
Benzidine	SV		10	d	0.0002 (6)	0.00012			0.00012		
Benzoic Acid	SV	50		CS							
Benzo(a)anthracene	SV	10	10	CS							
Benzo(a)pyrene	SV	10	10	CS							
Benzo(b)fluoranthene	SV	10	10	CS							
Benzo(g,h,i)perylene	SV	10	10	CS							
Benzo(k)fluoranthene	SV	10	10	CS							
Benzyl Alcohol	SV	10		CS							
bis(2-Chloroethoxy)methane	SV	10		CS							
bis(2-Chloroethyl)ether	SV	10	10	CS	0.03 (6)	0.0000037			0.0000037		
bis(2-Chloroisopropyl)ether	SV	10	10	CS							

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

TABLE 3-4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Naphthalene	SV	10	10	CS							
Nitrobenzene	SV	10	10	CS	3.5 (6)						
Nitrophenols	SV										
Nitrosamines	SV										
Nitrosodibutylamine	SV		10	b		0.0064			0.0064		
Nitrosodiethylamine	SV		10	b		0.0008			0.0008		
Nitrosodimethylamine	SV		10	b		0.0014			0.0014		
Nitrosopyrrolidine	SV		10	b		0.016			0.016		
N-Nitrosodiphenylamine	SV	10	10	CSb		4.9			4.9		
N-Nitroso-di-n-dipropylamine	SV	10	10	CSb							
Pentachlorinated Ethanes	SV			b							
Pentachlorobenzene	SV		10	b	6 (6)						
Pentachlorophenol	SV	50	50	CS	200						
Phenanthrene	SV	10	10	CS							
Phenol	SV	10	50	CS							
Phthalate Esters	SV			e							
Polynuclear Aromatic Hydrocarbons	SV		10	b		0.0028			0.0028		
Vinyl Chloride	SV	10	2	CV	2						
1,1,1-Trichloroethane	V	5	1	CV	200						
1,1,2,2-Tetrachloroethane	V	5	1	CV		0.17			0.17		
1,1,2-Trichloroethane	V	5	1	CV	28	0.60			0.60		
1,1-Dichloroethane	V	5		CV							
1,1-Dichloroethene	V	5	1	CV	7						
1,2-Dichloroethane	V	5	1	CV	5						
1,2-Dichloroethene (cis)	V		1	a	70						
1,2-Dichloroethene (total)	V	5		CV							
1,2-Dichloroethene (trans)	V	5	1	a	70						

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 RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5) Acute Value	Stream Segment Table (5) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek
1,2-Dichloropropane	V	5	1	CV	0.56 (6)						
1,3-Dichloropropene (cis)	V	5	1	CV							
1,3-Dichloropropene (trans)	V	5	1	CV							
2-Butanone	V	10		CV							
2-Hexanone	V	10		CV							
4-Methyl-2-pentanone	V	10		CV							
Acetone	V	10		CV							
Acrylonitrile	V		5	c		0.058			0.058		
Benzene	V	5	1	CV	5						
Bromodichloromethane	V	5	1	CV							
Bromoform	V	5	1	CV							
Bromomethane	V	10	1	CV							
Carbon Disulfide	V	5		CV							
Carbon Tetrachloride	V	1		CV	5						
Chlorinated Benzenes	V	10		CV/CS							
Chlorobenzene	V	5	1	CV/CVS	300						
Chloroethane	V	10		CV							
Chloroform	V	5	1	CV	Tot THM <100*	0.19			0.19		
Chloromethane	V	10	1	CV							
Dibromochloromethane	V	5	1	CV							
Dichloroethenes	V		1								
Ethyl Benzene	V	5	1	CV	680						
Ethylene Dibromide	V			d							
Ethylene Oxide	V										
Halomethanes	V				100	0.19			0.19		
Methylene Chloride	V	5	1	CV							
Pyrene	V	10	10	CS							

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)	PQL MDL		Method (6)	Tables 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	Woman Creek	Walnut Creek
Styrene	V	5		CV							
Tetrachloroethanes	V	5	1	CV		0.8			0.8		
Tetrachloroethene	V	5	1	CV	10						
Toluene	V	5	1	CV	2,420						
Trichloroethanes	V	5	1	CV							
Trichloroethene	V	5	1	CV	5						
Vinyl Acetate	V	10		CV							
Xylenes (Total)	V	5		CV							

EXPLANATION OF TABLE

* = Total trihalomethanes:chloroform, bromoform, bromodichloromethane, dibromochloromethane

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

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

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. (Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/CWQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990.

4.0 DATA NEEDS AND DATA QUALITY OBJECTIVES

In accordance with the IAG, the RFI/RI for OU10 has been divided into two phases. The objectives of Phase I of the RFI/RI are to characterize the sources/soils and air and determine the risk associated with this contamination at each OU10 IHSS. The objective of Phase II of the RFI/RI is to evaluate the impact of each OU10 IHSS on surface water, sediments, groundwater, air, the environment, and biota. This work plan defines the DQOs, FSP, and BRAP for the Phase I program only.

Data obtained during the Phase I RFI/RI at OU10 will be used to characterize the sources/soils and air contamination, determine the nature and extent of contamination, and support a baseline risk assessment. If required by the results of the risk assessment, these data may also be used to support the development and evaluation of remedial alternatives. Data requirements for this work plan are presented below and derived from guidance documents previously cited.

DQOs are established to ensure that the data collected are sufficient and adequate in quality for their intended uses (EPA 1987). DQOs were established for the OU10 Phase I RFI/RI in accordance with Appendix A of the Rocky Flats Plant Site-Wide Quality Assurance Project Plan (EG&G 1991). The DQO process is divided into three steps: Step 1 identifies decision types, Step 2 identifies data uses and needs, and Step 3 is the design of a data collection program.

4.1 STEP 1—IDENTIFY DECISION TYPES

The major elements of Step 1 include identifying and involving data users, evaluating available data, developing a conceptual model, and specifying objectives and decisions. The following sections address each of these elements.

4.1.1 Identify and Involve Data Users

Data users are divided into three groups: decision makers, program management staff, and technical personnel. The principal decision makers for OU10 are federal officials responsible for RFP operations and the federal and state regulatory officials responsible for environmental protection. These include the DOE Office of Environmental Restoration and Waste Management, DOE Rocky Flats Office, EPA Region VIII, and CDH. The program management staff are the prime EG&G contractor personnel responsible for ER Program activities, which includes the EG&G Rocky Flats Plant Environmental Management Department. Technical personnel include EG&G RFP technical specialists and subcontractors responsible for supervising, coordinating, and performing ER Program activities.

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

4.1.2 Evaluate Available Data

The following three types of data are available to describe conditions at the OU10 IHSSs. Site features and conditions have been investigated using aerial photography and site visits so that current conditions can be incorporated in the conceptual models for each IHSS. Written historical data are available that document spills, overflows, or other types of releases that represent contaminant sources at the IHSSs. Finally, some chemical analytical data are available from previous soil and surface water sampling in this OU.

Section 2.0 describes current conditions and documented histories of the IHSSs. These data are used extensively to identify potential contaminant releases that are evaluated in the conceptual models, plan sampling at locations that are most likely to indicate the presence or absence of contamination, and develop the appropriate analyte list for laboratory analysis of samples.

Chemical analytical waste, soil, and surface water data were collected in 1988 at IHSSs 129, 174, 175, 176, 177, 182, 213, and 214 (Appendix C). These data cannot be considered quantitative because sampling locations are not fully documented and the analytical results cannot be validated. However, the data are discussed in the IHSS descriptions in Section 2.0 of this work plan and are used in developing quantitative DQOs for the Phase I investigation (see Section 4.2.4).

Section 2.0 and Appendix A also present validated groundwater data available for monitoring wells in the vicinity of OU10 IHSSs. The groundwater data are of sufficient quality for eventual use in the Phase II RFI/RI report and baseline risk assessment.

4.1.3 Specify Phase I RFI/RI Objectives

The primary objectives of the Phase I RFI/RI are to characterize the sources/soils and determine the risks associated with the source of contamination at each IHSS. A variety of data quality levels will be included in the investigation to meet these objectives. However, the investigation must be planned to obtain sufficient data at DQO Level IV and V to support a baseline risk assessment. The Phase I data will also be used to identify appropriate remedial responses at each

IHSS that poses an unacceptable risk to human health and the environment. The DQOs established for this investigation will be met by implementation of and adherence to GRRASP protocols for sample analysis and RFP Environmental Management Department Operating Procedures (EMD OPs) for sample collection. Table 4-1 summarizes the specific analytical data quality objectives and types of data needs.

4.2 STEP 2—IDENTIFY DATA USES/NEEDS

The major objectives of Step 2 are the following:

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

The following sections discuss each of these elements.

4.2.1 Identify Data Uses

Data collected by the Phase I RFI/RI will be used to characterize the source/soils, support the BRA and environmental evaluation, and evaluate remedial alternatives. To satisfy the objective of source/soils characterization, data must be collected on the physical characteristics of the soils and the nature and extent of soil or other vadose zone source of contamination. Therefore, chemical analytical data will be collected to identify contaminants and quantify their

Table 4-1 Phase I RFI/RI Analytical Data Quality Objectives

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Determine site-specific transport characteristics of the vadose zone materials	Soil physical parameters	Drill borings and collect samples for moisture content, sieve analysis, determination of porosity, permeameter tests, and analysis of total organic carbon content	I	• Source/Soil Characterization • Baseline Risk Assessment • Evaluation of Remedial Alternatives
Characterize subsurface stratigraphy and depth to groundwater	Geologic description	Drill borings and log subsurface geology	I	• Source/Soil Characterization • Baseline Risk Assessment • Evaluation of Remedial Alternatives
Characterize groundwater flow regime around each Individual Hazardous Substance Site (IHSS)	Water level data	• Obtain quarterly water level measurements form existing monitoring wells and new piezometers around each IHSS	I I	• Source/Soil Characterization • Baseline Risk Assessment • Evaluation of Remedial Alternatives
Characterize movement of water in the vadose zone	Soil moisture levels Matric potential measurements	Install tensiometers or equivalent at selected IHSSs	I	• Source/Soil Characterization • Baseline Risk Assessment • Evaluation of Remedial Alternatives
Characterize tank integrity	Visual inspection and response to pressurization	• Make and record visual observations of interior and exterior • Pressurize tank to detect leaks	I	• Source Characterization

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Table 4-1 Phase I RFI/RI Analytical Data Quality Objectives

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Characterize tank residues	Residue chemical data	Collect liquid or sludge samples for chemical analysis	IV (V for radiological analysis)	• Source Characterization
Characterize presence/absence and nature/extent of contaminant release from underground storage tanks	Test pits and soil sampling	Dig test pits and collect soil samples near valves, pipe joints, and elbows, and where leaks are indicated from tank integrity testing	IV	• Source/Soil Characterization
Characterize source and presence/absence and nature/extent of soil contamination at each IHSS	Soil and source chemical data	• Conduct radiological (HPGe) surveys	II	• Source/Soil Characterization
		• Conduct soil gas surveys at appropriate IHSSs; analyze vapor samples for volatile organic compounds (VOCs)	II	• Baseline Risk Assessment • Environmental Evaluation
		• Collect surficial soil samples; analyze for parameters appropriate for each IHSS	IV (V for radiological analysis)	• Evaluation of Remedial Alternatives
		• Collect soil core samples for depth profiles at soil gas or radiation hot spots or near tanks or other release points; analyze for parameters appropriate for each IHSS	IV (V for radiological analysis)	• Source/Soil Characterization
Characterize presence or absence of surface water contamination	Surface water sample data	Collect surface water samples	IV (V for radiological analysis)	• Surface Water Characaterization • Phase II Planning
Characterize presence or absence of sediment contamination at appropriate IHSSs	Sediment chemical data	Collect sediment samples from drainages downgradient of selected IHSSs	IV (V for radiological analysis)	• Source/Soil Characterization • Phase II Planning
Characterize presence or absence of groundwater contamination	Groundwater grab sample data	Collect grab samples from water table during drilling of soil borings	IV (V for radiological analysis)	• Groundwater Characterization • Phase II Planning

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concentrations. Supplemental chemical and physical data will be required to characterize contaminant migration pathways in support of the risk assessment. These data may include stratigraphy, porosity, total organic carbon content, and permeability of OU10 soils. Other environmental media and contaminant migration pathways, such as those related to air, surface water, and groundwater, are not fully evaluated until Phase II of the RFI/RI.

To meet the objectives of the BRA, specific data need to be obtained to accomplish the four tasks of the assessment (contaminant identification, exposure assessment, toxicity assessment, and risk characterization). The first four steps of the human health risk assessment process will be described in technical memoranda that will be developed as the investigation proceeds and Phase I data are evaluated. These memoranda will describe the processes OU10 followed to identify potentially exposed populations, including assumptions about future land use. Section 8.0 describes this process in further detail. Section 9.0 describes the environmental evaluation portion of the BRA.

Background or control data must also be collected at uncontaminated areas to establish baseline conditions to determine the degree to which contamination may affect receptors. Background data are available for subsurface soil but not for surficial soils that are expected to be the primary focus of the OU10 baseline risk assessment. Planning for data collection to establish background analyte concentrations in RFP surficial soils will be completed separately from this work plan. However, Phase I surficial soil sampling will include data collection outside of IHSS boundaries to evaluate lateral distribution of contaminants in the immediate surroundings.

Data requirements for the evaluation of remedial action alternatives include identification of the nature of contamination at sites of concern and the volumes and areas of contaminated media.

This work plan specifically supports this requirement. Other supporting studies that may be required for alternative selection include treatability studies and geological characterization. Alternatives for soil remediation at OU10 fall into one of four classes: removal and treatment, *in situ* treatment, containment, and no action.

Data collected for the OU10 Phase I RFI/RI will be used in the development of contaminant transport conceptual models, including air dispersion computer models, for the risk assessment. These models will be identified in technical memoranda during Phase I data evaluation. If needed, surface water and groundwater models may also be developed during the OU10 Phase II RFI/RI.

4.2.2 Identify Data Types

Data types will consist of field survey and laboratory analytical results of samples for each RFI/RI objective (Table 4-1). The media that will be sampled during the Phase I RFI/RI include terrestrial and aquatic biota and physical media. The terrestrial media will include vegetation, invertebrates, and vertebrates. Section 9.0 describes the sampling of these media. The physical media include soil, sediment, soil gas, surface water, asphalt/concrete, and groundwater. Radiation surveys will also be performed at selected IHSSs.

Exposure assessment modeling requires additional data types. Data necessary for air dispersion modeling generally includes relative wind direction and frequency, atmospheric stability and wind speeds, ambient concentrations of airborne particulates, soil adsorption coefficients, solubility, particle size, and precipitation. Most of these parameters will be determined from RFP-wide atmospheric studies or from literature values. The OU10 Phase I field program will collect data pertaining to particle size of the surficial soils.

4.2.3 Identify Data Quality Needs

Tables 4-1 and 4-2 list the analytical levels appropriate to intended data uses. The five levels of data quality as presented in EPA's Data Quality Objectives for Remedial Response Activities Development Process (EPA 1987) are as follows:

- Screening (DQO Level I) provides the lowest data quality but the most rapid results, and is used for purposes of site health and safety monitoring, preliminary comparison to ARARs, and initial site characterization to define areas for further study. The data generated provides presence/absence of certain constituents and is generally qualitative rather than quantitative.

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

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

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

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

Data quality for the Phase I RFI/RI will be achieved by adhering to the data collection and

Table 4-2 Appropriate Analytical Levels by Data Use

Analytical Level	Data Use		
	Site Characterization	Risk Assessment	Evaluation of Alternatives
I	X	*	*
II	X	*	*
III	X	X	X
IV	X	X	X
V	X	X	X
Other			

* Physical Data at levels I & II will be used in the exposure assessment.

analysis protocols provided in agency-approved EMD OPs (Volumes I through VI) and the GRASPP. Level I and II data will be generated by the HPGe survey, soil gas survey, and physical testing of soil samples. All laboratory chemical analysis will be performed to meet DQO levels IV or V.

4.2.4 Identify Data Quantity Needs

Data quantity needs are based on an evaluation of available data on OU10 IHSSs and on the data uses outlined in previous sections. This approach is consistent with guidance provided in Data Quality Objectives for Remedial Response Activities (EPA 1987) and Guidance for Data Useability in Risk Assessment (EPA 1990). The presently available field sampling data are insufficient to meet the objectives defined by the IAG because they cannot be validated; therefore, the additional data are needed.

To ensure that a sufficient number of valid data are collected, the FSP (Section 7.0) outlines a four-stage approach to data collection, with an evaluation of data needs following each data collection stage. Therefore, in this work plan, only the Stage 1 data needs will be addressed. As appropriate to each IHSS, Stage 1 data collection may include a radioactivity survey with HPGe detector and sodium iodide scintillation detector, (NaI probe) a soil gas survey, tank inspection and residue sampling, test pits for sampling around underground tanks, vertical soil profiles for analysis of radiation surveys, and surficial soil sampling for nonradiological chemical and physical analysis. The surficial soil analytical data collection program has been designed to allow a determination of variability. The Stage 1 data variability will be used to establish quantitative DQOs for Stage 2 surficial soil sampling for nonradionuclides contamination.

The FSP illustrates the number and location of each sample to be collected during Stage 1 and provides the rationale for the planned sampling. The general approach to determining the number of chemical analytical samples that are needed in this stage is outlined below.

Stage 1 data quantity needs were evaluated both subjectively and statistically. The subjective evaluation of the data quantity needs included a review of site features to ensure that data is collected at each location where contamination is most likely to have been released. This evaluation also resulted in eliminating certain types of samples at IHSSs where the conceptual model showed that such data would not be needed. In addition, a statistical approach was used to estimate the number of surficial soil samples that may be needed to determine nonradiological data variability.

The statistical approach to Stage 1 planning included a classical variability analysis of analyte concentrations using existing nonvalidated data at the four sites for which sufficient data were available (IHSSs 174, 175, 176, and 177). Too few data were available at these sites for geostatistical analysis. The variability analysis resulted in a preliminary estimate that 25 or more systematically located surficial soil samples are needed to begin characterization of each IHSS. This requirement is considered a rough estimate only; it will be reevaluated when larger numbers of validated Stage 1 data are available. The following considerations limit the usefulness of this preliminary estimate:

- Since the Stage 1 radiation survey results will be used to estimate the number of radiological samples required, the estimate will be applied only to those samples analyzed for nonradiological parameters.

- Since the nonvalidated data included very few detections of organic analytes, only the variability of metals concentrations could be used to estimate the number of soil samples needed, although the samples will be analyzed for organic and metallic analytes that may differ in their variability.

- Since classical rather than geostatistical methods were used, the number of samples required is unrelated to the size of the site. When Stage 1 sampling results are evaluated, geostatistical methods may be appropriate for determining whether the data are adequate.

During Stage 1, all of the analyses appropriate to the site history will be conducted on each of the field samples until the variabilities of individual analytes or of analyte groups can be recalculated. The full number of 25 samples is proposed at larger sites. In anticipation that later geostatistical analysis will indicate a need for fewer samples at smaller IHSSs, eight samples are proposed at most smaller IHSSs. The adequacy of these numbers of samples will be evaluated in Technical Memorandum 1, which will propose additional sampling as appropriate.

The calculations of data needs for assessing variability were performed as follows:

The prescribed margin of error and the acceptable error of estimation of the mean were identified. The number of polygons to be sampled to estimate the population mean is a function of (1) the absolute margin of error that can be tolerated and (2) the acceptable confidence limits.

The basic equation for estimating the number of samples according to Gilbert (1987) is the following:

$$n = (t_{1-\alpha/2\,,\,n-1}\ \sigma/d)^2 \qquad (1)$$

where

n	=	number of samples required
n-1	=	degrees of freedom
$\sigma = S$	=	sample standard deviation of the mean estimate

d	=	margin of error
$\alpha/2$	=	one-sided confidence limit
$t_{1-\alpha/2,n-1}$	=	$(1-\alpha/2)$ quantile of the t distribution with n-1 degrees of freedom

Although a reliable value of σ is not available for determining n, an estimate of the relative standard deviation $\eta = \sigma/\mu$ (the coefficient of variation), may be roughly estimated. Because this quantity is usually less variable from one study site to another than the mean (μ), the approach suggested by Gilbert is to specify the relative error (d_r) as $d_r = | x - \mu | / \mu$ such that:

$$\text{Prob}\,[| x - \mu | > d_r \mu] = \alpha$$

Therefore, the equation becomes

$$n = (t_{1-\alpha/2,\,n-1}\, \eta / d_r)^2 \qquad (2)$$

where η must be pre-specified.

For risk assessment, a reasonable bound on the error of estimation is 0.2 of the mean, i.e., the 95 percent confidence interval around the mean is the mean plus or minus 20 percent of the mean. This level of uncertainty is small relative to the uncertainty associated with toxicological parameters used to estimate risk.

The η is first assumed as 0.59, which is common or relatively conservative in most soil sample data analysis. Since $t_{1-\alpha/2,\,n-1}$ depends on n, an iterative procedure should be used. Using this approach, a sample size of 25 polygons is estimated as follows:

$$n = (1.708\ (0.59/0.2))^2$$

$$n = 25$$

where the Student T variate is 1.708, the confidence limit is 0.05 for one-sided, and for 24 degrees of freedom.

Since the number of samples is fully dependent on the estimated value of the coefficient of variation, the sample number 25 can be expected to result in a mean calculation within the 95 percentage confidence limit only for a coefficient of variation less than 0.59. If the actual coefficient of variation is higher than 0.59, the number of samples would have to be increased. The preliminary estimate of 25 samples is also a prudent choice based on the Central Limit Theorem. Many statisticians recommend that this theorem can be safely applied if n is at least 25 or 30. The mean values calculated from subsets of populations of this approximate size tend to be normally distributed, even if the sample populations are non-normal.

Two performance measures that are commonly used to evaluate statistical sampling designs, such as the one presented here, are confidence level (α) and power (β) which are related to sample variability. The confidence level can be used to determine the probability of a false positive or Type I error. The power can be used to determine the probability of a false negative or Type II error. For risk assessment purposes, EPA recommends a minimum confidence of 80 percent (Type I error = 20 percent) and a minimum power of 90 percent (Type II error = 10 percent) (EPA 1990). The confidence level used for this statistical analysis was 95 percent and the power is not considered. However, a 95 percent confidence level provides a reasonable compromise between the probability of Type I and Type II errors.

Once the number of samples is determined, the site is divided into 25 segments of equal size, and one sample is taken systematically within each block. This systematic sampling plan provides more uniform coverage of a site than simple random sampling does.

Variability Analysis

Sampling variability affects the degree of confidence the risk assessor can expect. Large variation of a contaminant in a medium indicates that the number of samples should be increased or that the samples of that medium should be stratified to reduce variability. An estimate of the sampling variability that is a function of the spatial variation in the concentrations of chemicals of potential concern is obtained by calculating the coefficient of variation, η, for each chemical (EPA 1990).

Only data of four sites (IHSSs 174, 175, 176, and 177) are sufficient to perform variability analysis. The results are shown in following tables:

IHSS 174 Variability Analyses for Soil Sampling

Analyte	Coefficient of Variation
Bis(2-ethylhexyl)phthalate	0.721
Aluminum	0.209
Arsenic	0.169
Barium	0.125
Cadmium	0.391
Chromium	0.409
Copper	0.259
Iron	0.202
Lead	0.176
Magnesium	0.105
Manganese	0.140

Nitrate/Nitrite	0.439
Potassium	0.106
Sodium	0.413
Vanadium	2.483
Zinc	0.270

IHSS 175 Variability Analyses for Soil Sampling

Analyte	Coefficient of Variation
Aluminum	0.119
Barium	0.113
Calcium	0.230
Cadmium	0.241
Chromium	0.462
Copper	0.239
Iron	0.152
Lead	0.427
Magnesium	0.061
Manganese	0.218
Mercury	0.836
Nitrate/Nitrite	0.639
Potassium	0.138
Vanadium	0.090
Zinc	0.488

IHSS 176 Variability Analyses for Soil Sampling

Analyte	Coefficient of Variation
Aluminum	0.193
Arsenic	0.855
Barium	0.168
Beryllium	0.070
Calcium	0.749
Cadmium	0.389

Chromium	0.283
Copper	0.211
Iron	0.171
Potassium	0.194
Magnesium	0.177
Manganese	0.248
Sodium	0.366
Nickel	0.367
Lead	0.887
Nitrate/Nitrite	1.119
Vanadium	0.192
Zinc	0.359

IHSS 177 Variability Analyses for Soil Sampling

Analyte	Coefficient of Variation
Aluminum	0.312
Arsenic	0.043
Barium	0.476
Calcium	0.344
Cadmium	1.138
Chromium	0.172
Copper	0.713
Iron	0.281
Potassium	0.534
Magnesium	0.439
Manganese	0.625
Mercury	0.573
Strontium	0.756
Lead	0.254
Nitrate/Nitrite	0.058
Vanadium	0.152
Zinc	0.318

For IHSS 174, the coefficient of variation η of 14 out of 16 analytes is less than 0.59. Only Bis(2-ethylhexyl)phthalate and vanadium have higher coefficients, which are caused by a few extremely large data points that are easily identified as outliers. Therefore, the sample size 25 is a reasonable preliminary estimate for IHSS 174.

For IHSS 175, the coefficient of variation η of thirteen out of fifteen analytes is less than 0.59. Only mercury with 0.836 and nitrate/nitrite with 0.639 would require more than 25 samples. The distribution of these data does not obviously indicate that they are caused by outliers or errors. To honor the highest calculated variability of $\eta = 0.836$, at least 48 samples should be collected. However, the coefficient of variation was calculated from only four data points in this case, so that the number of required samples is not certain. Furthermore, the site is very small; therefore, only eight samples are recommended in Step 1.

For IHSS 176, the coefficients of variation η of fourteen out of eighteen analytes less than 0.59. Arsenic, calcium, lead, and nitrate/nitrite have higher values with no obvious evidence that they are caused by outliers or errors. If the highest variability, $\eta = 1.119$, is honored, the number of samples should be at least 86 according to Equation (2).

For IHSS 177, the coefficients of variation η of thirteen out of seventeen analytes are less than 0.59. Cadmium, copper, manganese, and strontium have higher values with no obvious evidence that they are caused by outliers or errors. If the highest variability, $\eta = 1.138$, is honored, 88 samples should be collected. However, this analysis was based on only four data points, and has a high degree of uncertainty. Therefore, eight samples are recommended for this relatively small site.

This analysis is the basis for the number of samples to be collected at each IHSS during Stage 1. At the completion of Stage 1, validated data will be used to review the nonradiological surficial soil data variability to support recommendations on further sampling. This further evaluation may include consideration of the variability in data for specific analytes, the costs and time requirements of sampling and analysis, and the confidence level that is acceptable for use in the risk assessment.

4.2.5 Evaluate Sampling/Analysis Options

The Phase I RFI/RI for OU10 will consist of a staged approach in which the results of field screening and soil sample collection and analysis are evaluated and used in planning successive stages. This approach will be used to ensure that sample locations and depths result in a representative set of data to characterize the site. The reevaluation of the data at each stage will also allow quantitative DQOs to be reviewed and planned for during the investigation to ensure that the data are statistically adequate for the intended uses.

This approach maximizes collection of useful data because surficial soil sampling and field screening techniques are used to properly locate and minimize borehole drilling. Additionally, this approach minimizes the volume of generated hazardous waste material that requires special management, and the potential exposure of field personnel to hazardous waste material. Technical memoranda are planned at each stage to report results and present recommendations for any further sampling.

The actual sampling that is performed at each IHSS during the four Phase I stages will be as appropriate to the history and features of each site. However, these stages may include the following types of sampling:

- Stage 1—HPGe and NaI probe radioactivity surveys, vertical soil profiles for analysis of radiation surveys, soil gas survey, surficial soil sampling (for nonradiological analysis), sampling and inspection of tanks and ancillary equipment, and test pit/soil sampling around tanks

- Stage 2—Surficial soil sampling for radiological analysis and as needed to evaluate soil gas hot spots and augment Stage 1 nonradiological surficial soil data, surficial soil sampling at paved areas, asphalt/concrete sampling, and soil borings

- Stage 3—Soil borings to determine the presence or absence of vadose zone contamination

- Stage 4—Soil borings to delineate the extent of vadose zone contamination, tensiometer nests and leachability tests to evaluate contaminant migration through the vadose zone, and surface water and sediment sampling, limited piezometer installation and groundwater level measurement, and groundwater grab sampling (using the BAT® or equivalent) to support Phase II planning at the conclusion of Phase I.

Section 7.5 of this work plan discusses the analytical program requirements for OU10. Appendix B of the QAPjP (EG&G 1991) provides a listing of the CLP analytes and detection/quantification limits for Target Compound List (TCL) volatile and semivolatile organics, Target Analyte List (TAL) metals and cyanide, radionuclides, pesticides/PCBs, inorganic parameters, and other surficial soil sampling parameters. These analytical methods are appropriate for meeting the data quality requirements for analytical Levels I through V during the Phase I RFI/RI.

4.2.6 Review of PARCC Parameter Information

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

Precision measures the reproducibility or degree of agreement among replicate measurements under a given set of conditions. The closer the numerical values of the measurements are to each other, the more precise the measurements. During the OU10 Phase I RFI/RI, collection of data using field instrumentation such as water level meters, pH meters, and conductivity meters will be checked by reporting at least three measurements taken at one location and comparing the results. Field analysis instruments such as a field gas chromatograph (GC) will be checked by the analysis of replicate samples. Sample collection precision will be measured in the laboratory with analysis of field replicates and laboratory duplicates.

Accuracy measures the bias in a measurement system. Sources of error include the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and sample analysis techniques. Sampling accuracy of the OU10 Phase I RFI/RI will be assessed by evaluating the results of field rinse and trip blanks. The accuracy of the laboratory analysis will be determined from the results of matrix spike recovery.

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. Given the lack of previous usable data from the OU10 IHSSs, designing a representative sampling program is difficult in Phase I. However, representativeness can be assured for the OU10 Phase I RFI/RI by the use of proper sampling techniques.

Section 7.7 describes the sampling rationale and techniques. Representativeness will also be assessed by the collection and analysis of field duplicate samples.

Completeness is defined as the percentage of measurements made that are judged to be valid. The target completeness objective for the OU10 field and analytical data is 100 percent; 90 percent will be the minimum acceptable level. To ensure that a sufficient amount of valid data are generated, the FSP was designed to include a rationale for all field activities and a phased approach using screening level techniques to identify and locate critical sampling sites. Section 7.0 further discusses these components of the FSP.

Comparability is a qualitative measure defined by the confidence with which one data set can be compared to another. Differences in field and laboratory procedures greatly affect comparability. To optimize comparability, all OU10 Phase I RFI/RI sampling techniques and analytical methods will be in accordance with approved EMD OPS.

4.3 STEP 3—DESIGN DATA COLLECTION PROGRAM

The intent of Step 3 is to compile the information and DQOs developed for specific tasks in Step 2 into a comprehensive data collection program. The data collection program has been prepared for the OU10 Phase I RFI/RI and is presented in the FSP (Section 7.0). The FSP includes a detailed list of all samples to be collected including media, sample type, and number of samples. The FSP also includes sample location maps for each IHSS and lists of the number and type of QC samples to be collected.

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

Project Manager — 12/8/93 Date

Approved By: [signature] for W.S. Busby 8-Dec-93
Manager, Remediation Project — Date

5.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION TASKS

5.1 TASK 1 - PROJECT PLANNING

The project planning task involves all efforts required to initiate the Phase I RFI/RI of OU10 Other Outside Closures. Activities conducted for this project have included review of topographic maps and historical aerial photographs, a site visit, evaluation of existing data, development of conceptual models, and development and preparation of a work plan. Results of these activities are presented in Section 2.0. Preliminary identification of ARARs and TBCs are presented in Section 3.0. Identification of data requirements and DQOs are presented in Section 4.0.

Several project planning documents were prepared which pertain to this Phase I RFI/RI as required by IAG (1991). The FSP identifies sampling locations and frequencies for each of OU10 Other Outside Closure sites and is included as Section 7.0 of the work plan. Other documents required by the IAG (1991) are a Sampling and Analysis Plan (SAP) and a Health and Safety Plan (HSP). Included in the SAP are an EMD OPS for all field activities. The QAPjP and EMD OPS exist as separate stand-alone documents. A QAA has been prepared describing quality assurance/quality control (QA/QC) requirements specific to the OU10 investigation. The QAA is included as Section 10.0 of this work plan. The HSP is a separate stand-alone document.

The objective of the QAPjP is to identify the QA requirements and specific measures for implementing these requirements during investigations and remediation activities at RFP. The

QAA supplements the QAPjP and provides additional QA information specific to the OU10 Phase I RFI/RI.

5.2 TASK 2 - COMMUNITY RELATIONS

In accordance with the IAG, the RFP Communications Department is developing a sitewide community relations plan (CRP) to develop an interactive relationship with the public relating to environmental restoration activities. A draft CRP was issued for public comments in January 1991 and was revised to reflect public comment. Following EPA and CDH approval, a final CRP was released in December 1991. Accordingly, a site-specific CRP is not required for OU10. The ER Program community relations activities include participation by RFP representatives in informational workshops, Rocky Flats Environmental Monitoring Council meetings, public briefings on proposed remedial action plans, and public meetings held to solicit comment on various ER Program plans and actions.

The RFP Communications Department is continuing other public information efforts to keep the public informed of environmental restoration activities and other issues related to RFP operations. A Speakers Bureau Program sends speakers to civic groups and educational organizations, while a public tour program allows the public to visit RFP. In addition, an Outreach Program sends RFP officials to visit elected officials, the news media, and business and civic organizations to further discuss any issues related to RFP and environmental restoration activities. The RFP Communications Department responds to numerous public inquiries by telephone or by sending written informational materials to the requestor.

5.3 TASK 3 - FIELD INVESTIGATION

A field investigation will be conducted to characterize sources, and delineate the vertical and horizontal extent of soil contamination associated with OU10 IHSSs, to provide data for BRA which is Task 6, and analysis of remedial alternatives which is Task 7. The field investigations program is designed to collect data to meet the DQOs for the Phase I RFI/RI described in Section 4.0. As this is a Phase I program, data collection will be primarily restricted to source, soil (surficial and vadose zone), and asphalt/concrete sampling. However, field screening techniques such as soil gas sampling, radioactivity surveys, and groundwater grab sampling may be proposed in some cases. Surface water, sediment, and groundwater sampling may also be proposed in later stages of the investigation in support of Phase II planning. A limited number of piezometers may be installed to determine groundwater flow directions to aid in planning Phase II groundwater monitoring well locations. A detailed description of the field investigation program is presented in Section 7.0.

5.4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

All analytical procedures will be in accordance with the ER Program QAPjP (EG&G 1991a). Also provided in the QAPjP are the analytical detection limits, sample container and volume requirements, preservation requirements, and sample holding times. Sample analysis will be conducted under a separate work order contract.

All data, including analytical data will be reviewed and validated by the ER Program staff or a designated contractor. Results of data review and validation activities will be documented in data validation reports. EPA data validation functional guidelines will be used for validating organic and inorganic (metals) data (EPA 1988a). Validation methods for radiochemistry and major ions data have not been published by the EPA; however, data and documentation requirements have been developed by the ER Program QA staff. Data validation methods for these data are derived from these requirements. Details of the data validation process are described in the QAPjP (EG&G 1991a) and the Data Validation Guidelines (EG&G 1990).

When the guidelines for validating radiochemistry analytical data are published, it should be noted that the validation criteria contained in the guidelines (both EPA CLP and EG&G documents) will not strictly parallel EPA CLP or EG&G scopes of work in all cases. These documents were created as guidelines rather than SOPs to allow data reviewers to exercise appropriate discretion and professional judgment in evaluating data.

5.5 TASK 5 - DATA EVALUATION

Data collected during Phase I will be incorporated with existing data describing contamination at OU10 IHSSs. The objectives of the data evaluation effort include analysis of actual and potential magnitude of releases from sources, horizontal and vertical spread of contamination in soil, and mobility and persistence of contaminants. Analysis of the data will focus on the refinement of the conceptual models described in Section 2.2. The RFI/RI results will be used in delineating the requirements for the Phase II RFI/RI work plans.

5.5.1 Site Characterization

The physical data collected during the Phase I RFI/RI will be used, along with previously collected site and historical information, to define the surface and subsurface characteristics of each IHSS. Geologic maps and cross sections will be prepared from the boring logs to identify the characteristics of the vadose zone. This information, along with geotechnical data from the physical soil samples, will be used to revise and quantify the conceptual models developed in this work plan. This information will be used in the baseline risk assessment.

5.5.2 Source and Soil Characterization

Standard graphical and, where appropriate, statistical analysis methods will be employed to: (1) characterize the presence/absence of contaminants in sources and soils; (2) characterize the extent of contaminants in soils; and (3) quantify volume of source material. Numerous types of work products, such as soil and sediment chemical tables, soil concentration isopleth maps, soil concentration versus depth profiles, and overlays of soil concentrations and IHSS boundary maps will be used in the characterization of the nature and extent of soil contamination.

5.6 TASK 6 - BASELINE RISK ASSESSMENT

A baseline risk assessment will be prepared for OU10 as part of the Phase I RFI/RI to evaluate the potential threat to human health and the environment from contaminated soil in the absence of remedial action. The baseline risk assessment will provide input for determining whether or not remedial action is necessary in the area and provide justification for performing remedial action (EPA 1988b). EPA's interim final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual and Volume II: Environmental Evaluation Manual (EPA 1989) provide detailed guidance on evaluating potential human health impacts as part of this baseline risk assessment. The development of a baseline risk assessment is shown in Figure 5.6-1 and discussed fully in Section 8.0.

Several objectives will be accomplished under the baseline risk assessment task, including identification and characterization of the following (EPA 1988b):

- Toxicity and levels of hazardous and radioactive contaminants present in soils
- Environmental fate and transport mechanisms within soils and cross-media fate and transport where appropriate
- Potential human and environmental receptors

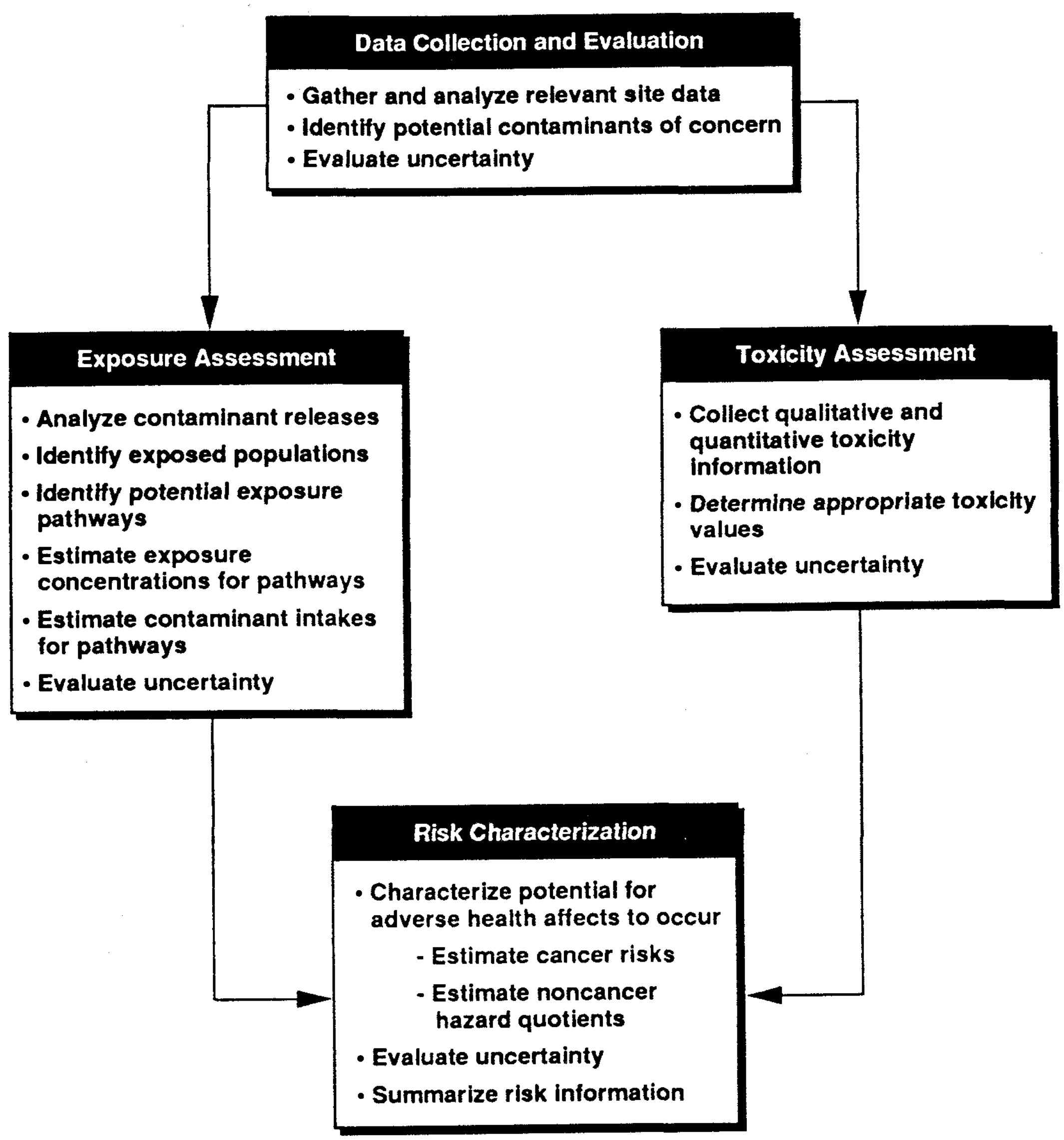

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Figure 5.6-1

Baseline Risk Assessment Development Process

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- Potential exposure routes and extent of actual or expected exposure
- Extent of expected impact or threat and the likelihood of such an impact or threat occurring (i.e., risk characterization)
- Level(s) of uncertainty associated with any of the above

The baseline risk assessment will address the potential human health and ecological risks associated with the site under the no-action alternative (no remedial action taken). This assessment will aid in the selection of site remedies based on the contaminants of concern and the environmental media associated with potential risks to human health.

The risk assessment process is divided into the following tasks:

- Contaminant identification
- Exposure assessment
- Toxicity assessment
- Risk characterization

The objectives and description of work for the human health risk assessment are described in detail in Section 8.0. The environmental evaluation work plan is presented in Section 9.0.

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

5.7.1 Remedial Alternatives Development and Screening

This section identifies potential technologies applicable to remediation of contaminated soils, wastes, surface water, sediments, and groundwater at OU10. The identified technologies are based on the preliminary site characterization developed in Section 2.0. Identification and screening of technologies, assembling an initial screening of alternatives, and identification of interim response actions will be conducted while the Phase I RFI/RI is being conducted. However, investigation of OU10 is in an early stage in which the presence or absence of contamination will be determined. Therefore, remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives for OU10 will be performed as more data are collected and as IHSSs are identified that may require corrective action.

The process employed to develop and evaluate alternatives for OU10 will follow guidelines provided in the NCP. Although RCRA regulations will direct the RFI/RI at OU10 as stipulated in the IAG, CERCLA guidance will also be followed because it specifies in greater detail the steps that should be followed for selection of remedial alternatives.

The steps to be followed to develop remedial alternatives for the OU10 IHSSs are as follows:

1. Develop remedial action objectives specifying exposure pathways and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed for sources and soils on the basis of ARARs and site-specific risk-related factors. These goals will be developed as site characterization data and information from the BRA become available.

2. Develop a list of general types of actions appropriate for the IHSS areas constituting OU10 (such as containment, treatment, and/or removal). These general types or classes of actions are generally referred to as "general response actions" in EPA guidance.

3. Identify and screen technology groups for each general response action. Screening will eliminate groups that are not technically feasible at the site.

4. 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 to represent a technology group for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group.

5. Assemble the selected representative technologies into site closure and corrective action alternatives for the IHSS areas of OU10 that represent a range of treatment and containment combinations, as appropriate.

6. Screen the assembled alternatives in terms of the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the purpose of the screening evaluation is to reduce the number of alternatives that will undergo thorough and extensive analysis, alternatives will be evaluated in less detail than subsequent evaluations.

7. Develop preliminary risk-based remedial action goals for affected media. Preliminary remedial action goals will be applied as performance objectives for evaluating the effectiveness of specific technology processes identified as candidate components of viable remedial action alternatives. Consistent with the NCP, preliminary remediation goals will be established at a 1×10^{-6} excess cancer risk point of departure and at other intervals within the 1×10^{-4} to 1×10^{-6} decision range. As the CMS/FS evolves, preliminary remediation goals may be revised to a different risk level on the basis on consideration of appropriate factors that include, but are not limited to, exposure, uncertainty, and technical issues.

For the Phase I RFI/RI work plan, the appropriate level of alternatives analysis is the listing of general response actions most applicable to the type of site under investigation. General response actions are defined as those broad classes of actions that may satisfy the objectives for remediation defined for OU10. Table 5-1 provides a list, which is not all-inclusive, and description of general response actions and typical technologies associated with remediating soils, wastes, groundwater, sediments, asphalt/concrete, and surface water. Table 5-1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways.

Table 5-1 General Response Actions, Typical Associated Remedial Technologies, and Evaluation

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
No Action	No remedial action taken at site.	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control on-site contact.
Access and use restrictions	Permanent prevention of entry into a contaminated area of site. Control of land use.	Site security; fencing; deed use restrictions; warning signs.	Could control on-site exposure and reduce potential for off-site exposure. 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; 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; 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, and tanks and pipelines.	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.
Treatment	Application of technology to change the physical or chemical characteristics of the contaminated material. Applied to material that has been removed.	Solidification: biological, chemical, and physical treatment.	Applied to removed source material; could be used to control all pathways. Applied to removed transport media, could control air, surface water, groundwater, and sediment pathways.

Table 5-1 General Response Actions, Typical Associated Remedial 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; 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 landfill; 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.

Table 5-1 does not list all possible actions nor may all of the alternative response actions and typical technologies listed be appropriate for the IHSS areas of OU10. Some will be discarded during the screening of alternatives.

The response actions outlined in Table 5-1 must be applied to the potential exposure pathways that will be identified for OU10. The response actions must be capable of providing control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that provide control over all pathways.

In general terms, potential human exposure can be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source; (2) in the transport medium; and (3) at the exposure point where the contact could occur with the released contaminant.

The existing data do not adequately characterize the source, release mechanisms, and migration pathways for contamination at OU10. Therefore, the existing data are not sufficient for implementing the screening of alternatives. Phase I will generate data (Table 5-2) necessary to characterize the sources and soils. Phase II of the RFI/RI will evaluate the impact of OU10 on surface water, groundwater, air, sediments, and biota in addition to characterizing potential contaminant migration pathways. Data obtained from these investigations will:

- Characterize the nature, rate and extent of contamination
- Define pathways and methods of migration
- Identify areas threatened by releases from the facility
- Determine short and long-term threats to human health and the environment

Table 5-2 Response Actions, Remedial Technologies, and Data Requirements

General Response Actions	Associated Remedial Technologies	Data Purpose	Data Need
Complete or Partial Removal and Treatment of Contaminated Soils	Disposal (off-site)	Evaluate RCRA Land Bank and Radioactivity Restrictions	- 40 CFR 268 Table CCWE and Appendix III Analyses - Full Suite of Radionuclide Analyses
		Cost Analysis	- Vertical and Horizontal Extent of Contamination
In Situ Contaminated Soils Treatment	Immobilization	Determine Viscosity of Grout Material	- Soil Grain Size Distribution (sieve analysis)
		Effectiveness	- Full Suite of Organic and Inorganic Analyses
	Soil Flushing	Effectiveness	- Full Suite of Organic and Inorganic Analyses - Soil Organic Matter Content - Soil Classification - Soil Permeability - Treatability Study
	Vapor Extraction	Effectiveness	- Full Suite or Organic and Inorganic Analyses - Subsurface Geological Characteristics - Depth to Groundwater - Soil Permeability - Treatability
	Vitrification	Cost Effectiveness	- Full Suite of Organic and Inorganic Analyses - Treatability Study
Groundwater Collection	Well Array/Subsurface Drains	Storativity (transient flow)	- Aquifer Tests

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Table 5-2 Response Actions, Remedial Technologies, and Data Requirements

General Response Actions	Associated Remedial Technologies	Data Purpose	Data Need
Infiltration and Groundwater Containment Controls	Capping/Subsurface Barriers	Suitability of Off-Site Soil for Use	- Gradation (Sieve Analysis) - Atterberg Limits (Plasticity Tests) - Percent Moisture - Compaction (Proctor) - Permeability (Triaxial Permeability) - Strength (Triaxial or Direct Shear)
		Effectiveness	- Location of Subcroping Sandstones - Hydraulic Conductivity of Bedrock Materials
		Construction Feasibility	- Grade - Depth to Bedrock
In Situ Groundwater Treatment/Immobilization	Immobilization	Determine Viscosity of Grout Material	- Soil Grain Size Distribution (sieve analysis)
		Effectiveness	- Full Suite of Organic and Inorganic Analyses
	Aeration	Effectiveness	- Full Suite of Organic and Inorganic Analyses - Subsurface Geological Characteristics - Depth the Groundwater - Soil Permeability - Treatability Study
Groundwater/Surface Water Treatment	UV/Peroxide or UV/Ozone	Process Control	- Iron and Manganese
		Effectiveness	- Full Suite of Organic and Inorganic Analyses - Treatability Study

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Table 5-2 Response Actions, Remedial Technologies, and Data Requirements

General Response Actions	Associated Remedial Technologies	Data Purpose	Data Need
Groundwater/Surface Water Treatment (cont)	Air Stripping	Process Control	- Hardness
		Effectiveness	- Full Suite of Organic and Inorganic Analyses - Treatability Study
	Other Water Treatment Technologies (carbon adsorption, ion exchange, electrodialysis, and reverse osmosis)	Process Control	
		Effectiveness	

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 FSP (Section 7.0) describes the methodology that will be followed to obtain the required information for the Phase I RFI/RI characterization.

5.7.2 Detailed Analysis of Remedial Alternatives

Sufficient data may not be generated during the Phase I RFI/RI to allow for a detailed analysis of alternatives; however, this is not a requirement of the Phase I RFI/RI. The detailed analysis of each alternative will be performed when sufficient data are generated during Phase II. The detailed analysis and selection of alternatives is not a 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 in terms of nine evaluation criteria is necessary for the CMS/FS and the subsequent Corrective Action Decision (CAD)/Record of Decision (ROD). The nine specific evaluation criteria are as follows:

- Overall protection of human health and the environment
- ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability

- Cost
- State acceptance
- Community acceptance

These criteria are described in recently revised guidelines provided in the NCP. The first two criteria are considered threshold criteria because they must be evaluated before further consideration of the remaining criteria. The next five criteria are considered the balancing criteria on which the analysis is based. The final two criteria are addressed during the final decision-making process after completion of the CMS/FS.

5.8 TASK 8 - TREATABILITY STUDIES/PILOT TESTING

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

The need for treatability studies is usually not identified until after the remedial alternatives have been developed and additional data needs are identified for the detailed analysis of alternatives process. The detailed analysis of remedial alternatives will not occur until sufficient data are generated in Phase II. Therefore, if treatability studies are deemed necessary, they will not be conducted until Phase II. Treatability tests may be used to evaluate specific technologies to support the remedy-selection process. If a treatability test is required, it will include the following steps:

- Preparation of a work plan for the bench or pilot studies
- Performance of field sampling, and/or bench testing, and/or pilot testing
- Evaluation of data from field studies, and/or bench testing, and/or pilot testing
- Preparation of a brief report documenting the results of the testing

Bench tests may be used to determine if the "chemistry" of the process works and are normally performed in a laboratory using small volumes of the waste. Pilot studies use a larger volume of waste and larger treatment unit size to simulate the physical as well as chemical parameters of a full-scale treatment process. The decision as to whether to perform bench or pilot studies will be determined during the scoping of the treatability study.

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

The treatability work plan will discuss the following:

- The scale of the treatability study
- Key parameters to be varied and evaluated and criteria to be used to evaluate the tests
- Specifications for test samples and the means for obtaining these samples
- Test equipment and materials and procedures to be used in the treatability test
- Identification of where and by whom the tests and any analytical services will be conducted, as well as any special procedures and permits required to transport samples and residues and conduct the test

- Methods required for residue management and disposal

- Any special QA/QC needed for the tests

5.9 TASK 9 - PHASE I RFI/RI REPORT

5.9.1 Report Content

The Phase I RFI/RI report will summarize the findings of the Phase I soil contamination RFI/RI program for OU10 Other Outside Closures IHSSs. The report will be organized into sections that provide an overview of the RI program, describe the physical features of the site and individual IHSSs, and present the results of the Phase I RFI/RI. The report will also include sections describing soil, surface water, sediment, groundwater, and asphalt/concrete contamination related to activities of the IHSSs and the baseline risk assessment.

5.9.2 Report Reviews

The Phase I RFI/RI report will be issued as a draft final report that will undergo formal review by EPA and CDH. The final report will incorporate agency comments from EPA and CDH.

Project Manager 12/8/93 Date

Approved By:
Manager, Remediation Project for W.S. Busby 8 Dec 93 Date

6.0 SCHEDULE

Figure 6.0-1 summarizes the schedule for conducting the Phase I RFI/RI. Dates from the IAG were used where appropriate. The OU10 Phase I RFI/RI project began in January 1990 with the commencement of project planning and will continue until May 1995 when the treatability studes are completed.

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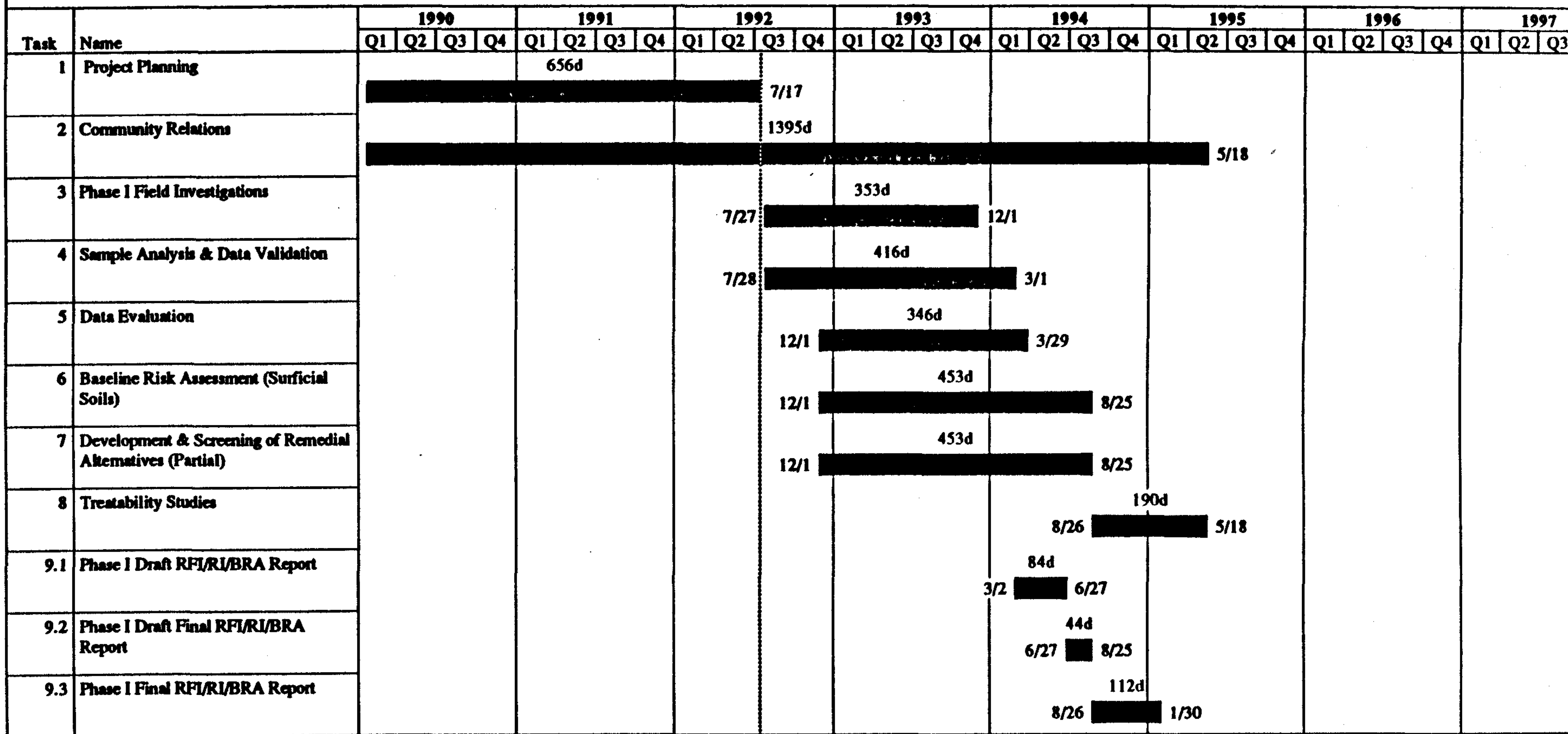


Figure 6.0-1 OU10 Phase I RFI/RI Schedule

7.0 FIELD SAMPLING PLAN

The purpose of this section of the work plan is to provide a field sampling program that will generate sufficient data to satisfy the Phase I RFI/RI objectives for investigating sources/soils and their associated risks (Section 4.0). Section 7.1 describes how the investigation will be divided into stages and what types of sampling will be considered at each stage. Section 7.2 summarizes site background information and the rationale for the sampling and analysis and other data collection activities needed to obtain necessary data to meet the Phase I RFI/RI objectives. Section 7.3 discusses the field data collection locations and frequencies for each site. Section 7.4 describes field sampling procedures and equipment. Section 7.5 describes the general analytical program including sample designation, analytical requirements, sample containers and preservation, and sample handling and documentation. Descriptions of data management procedures (Section 7.6) and QA/QC procedures (Section 7.7) complete the FSP for OU10.

7.1 OU10 PHASE I RFI/RI OBJECTIVES

The specific objectives of the Phase I RFI/RI field investigation for OU10 are as follows:

- Completely characterize contaminant sources and soils
- Support a BRA
- Support selection of remedial action alternatives

Source/soil characterization requires the determination of the type and concentration of sources of contamination at each IHSS. Soils characterization requires the determination of the nature and extent of soils contamination at and surrounding each IHSS as well the determination of physical characteristics that are necessary for risk assessment and evaluation of any required remedial alternatives.

This FSP was developed to characterize contamination that may have resulted from historical spills at OU10 IHSSs. Some of these IHSSs will continue to be used after the investigation according to the terms of their RCRA operating or interim status permits.

7.2 BACKGROUND AND FSP RATIONALE

The design of an FSP for sources/soils characterization requires an understanding of both the physical characteristics of the IHSS and the nature of potential sources of contamination. OU10 consists of 15 IHSSs that can be categorized as follows:

- Four large surface storage areas greater than 100,000 ft^2 in area
- Four drum storage areas less than 5,000 ft^2 in area
- Three former locations of aboveground tanks
- Two former locations of cargo containers containing drums
- One former location of a combined drum surface storage and cargo container area
- One underground storage tank

Of the surface storage sites and surface tanks, six are located over uncovered soils and the rest are located on asphalt or cement, although two of these were formerly uncovered soils. These categories of sites are addressed in the FSP according to the conceptual models (Section 2.2) and data needs and uses (Section 4.0).

The OU10 field sampling program will be conducted in four stages (Table 7-1). This generalized program will be adapted to address the specific data needs for each IHSS, according to the site conceptual model (Section 2.2) and the results of each previous investigative stage. However, the IHSS-specific sampling program will be developed according to the following general rationale.

Stage 1

Historical information and previous sampling data indicate that the possible contaminants at the IHSSs include all or some combination of radionuclides, VOCs, SVOCs, and inorganic contaminants, including metals and anions. The radionuclides and VOCs can be detected and hot spots mapped in the field using real-time screening methods. These screening methods can be used to direct soil sampling programs and reduce the total number of samples needed to characterize the nature and extent of contamination at the IHSSs. Because SVOCs and inorganic compounds are not as easily detected, soil sampling is the only practical method for determining the nature and extent of these contaminants.

Stage 1 sampling will include collection of radionuclide and VOC screening-level data and an initial number of surficial soil samples for nonradionuclide analysis as appropriate to the types of suspected contaminants and exposure pathways at each IHSS. Radionuclide screening level data will include field measurements of gamma activity using an HPGe detector at all suspected radionuclide sites. At smaller sites, gamma activity measurements will be collected using a sodium iodide scintillation detector (NaI probe) (Section 7.4.2) in conjunction with the HPGe. VOCs screening-level data collection will be by an active soil gas survey technique. Soil gas samples will be extracted and analyzed in the field where releases of VOCs are suspected from

Table 7-1 Phase I Investigation Stages for OU10

Activity	Purpose	Location	Sample Number
Stage 1			
HPGe Radiation Survey	Identify areas of anomalous gamma ray radiation readings.	Entire IHSS area.	IHSS dependent.
Soil Gas Survey	Locate VOC anomolies.	Entire IHSS area grid spacing IHSS dependent.	IHSS dependent.
Sodium Iodide Probe Radiation Survey	Identify areas of anomalous radiation readings.	Small IHSSs.	IHSS dependent.
Vertical Soil Profiles	Aid interpretation of HPGe survey.	Locations selected after HPGe survey completed.	Minimum of one per IHSS where HPGe survey conducted.
Surficial Soil Samples (Non-Radiological at Unpaved Sites)	Assess non-radiological analytical data variability and begin characterization of surface contamination.	On grid throughout IHSS.	IHSS dependent.
Inspect and test Tanks and Ancillary Equipment (pipelines, valves, and fittings)	Establish tank and ancillary equipment integrity.	IHSS dependent.	None.
Sample Tank Residue	Determine what remains in tanks.	IHSS dependent. If tank is empty, a wipe sample will be taken at the bottom.	Minimum of 1 per tank at each IHSS.
Test Pits and Associated Soil Sampling	Determine presence/absence of contamination originating from leaks in tanks and associated piping.	IHSS 129.	Dependent on tank integrity testing results.
TECHNICAL MEMORANDUM 1			

Table 7-1 Phase I Investigation Stages for OU10

Activity	Purpose	Location	Sample Number
<u>Stage 2</u>			
Surficial Soil Samples (Radiological and Non-Radiological at Paved and Unpaved Sites)	Determine the presence/absence and nature/extent of contaminants. Further characterize contamination found in Stage 1.	IHSS dependent (defined in technical memorandum).	To be determined by statistical analysis.
Soil Borings	a. Characterize subsurface vadose zone conditions and contamination.	At soil gas survey hot spots and in areas of stained soil or stressed vegetation.	To be determined.
	b. Transect and sample anomolies identified by soil gas.		
Asphalt/Concrete Samples	Determine the presence or absence of PCBs and radionuclides contaminants.	Paved IHSSs.	To be determined.
TECHNICAL MEMORANDUM 2			
<u>Stage 3</u>			
Soil Borings	Continue assessment of the presence/absence and nature/extent of contaminants.	Based on Stage 2 soil borings and surficial soil samples.	To be determined.
TECHNICAL MEMORANDUM 3			
<u>Stage 4</u>			
Soil Borings	Complete assessment of contaminants in the subsurface.	Where contamination is indicated based on Stage 3 soil borings.	To be determined.
Sediment and Surface Water Samples	Preliminary collection of information for Phase II planning.	Drainage areas and depressions with water accumulation. (Soil borings in depressions and sediment samples in defined drainages.)	To be determined.
Tensiometer Nests or Equivalent and Leachability Tests	Determine transport characteristics and provide information for Phase II.	To be determined.	To be determined.
Piezometers, BAT® Samples or equivalent.	Preliminary collection of information for Phase II planning.	To be determined.	To be determined.

underground sources or on unpaved surface storage sites where spillage and leakage might have occurred (Section 7.4.3).

After the completion of the HPGe and NaI surveys, the resultant data will be examined and discussed with CDH and EPA and the location of vertical profile samples will be determined. The vertical profile samples will be used to determine whether the radionuclides detected by the HPGe are only in the surface soils or if they are deeper.

Surficial soil samples for analysis of nonradioactive contaminants will be collected in Stage 1 only from unpaved IHSSs. The purpose of the Stage 1 surficial soil sampling is to collect enough data to determine contaminant variability in order to design a statistically-based sampling program for Stage 2. Surficial soil samples from paved IHSSs will not be collected until Stage 2 to avoid the mobilization of a drill rig in Stage 1.

Stage 1 will also include inspection of tanks and ancillary equipment to assess tank integrity and identify potential release locations. Any residues in the tanks will be sampled. Test pits will be excavated for underground inspection of tanks and pipelines, and grab samples will be collected from the pits in areas of possible contaminant release (Section 7.4.4.1).

Technical Memorandum 1 will be prepared at the completion of Stage 1 sampling. This memorandum will present the results of the HPGe, sodium iodide scintillation detector, and soil gas surveys; vertical profile soil sampling results; nonradiological surficial soil sampling analytical results; and the tank inspection/sampling program results. Technical Memorandum 1 will also include proposed sampling locations to verify radionuclide and VOC hot spots and a statistical surficial soil sampling program for nonradionuclides.

Stage 2

Stage 2 will include collection of surficial soil samples at paved sites and additional surficial soil samples as required by the Stage 1 radiation survey and the reevaluation of quantitative DQOs for radioactive and nonradioactive analytes. This stage will also include collection of asphalt/concrete samples and drilling soil borings at VOC hot spots to begin the characterization of the nature and extent of the contamination in the vadose zone.

Soil borings will be drilled to the water table or 6 ft into bedrock (whichever is shallower). Soil samples will be collected from these borings to investigate the presence or absence of vadose zone contamination that may be suggested by the Stage 1 soil gas survey or surficial soil sampling results. Subsurface soil samples will also be required to investigate the vertical profile of any HPGe radioactivity anomalies. The results of Stage 2 will be presented in Technical Memorandum 2, which will outline the FSP for Stage 3.

Stage 3

Stage 3 sampling may include collection of additional surficial soil samples and will include soil borings to continue assessment of the vertical and horizontal extent of contamination. The results of Stage 3 will be presented in Technical Memorandum 3, which will assess the adequacy of the data and include the FSP for Stage 4.

Stage 4

Stage 4 sampling may include additional soil borings to complete the assessment of the extent of vadose zone contamination. In addition, some sampling may be conducted in the final stage of Phase I to support Phase II planning. The Stage 4 samples may include sediment, surface water, and groundwater grab samples (BAT® samples) or equivalent. To assess the potential of leaching of vadose zone contaminants to the water table, tensiometer nests (or equivalent) may be installed and monitored at certain IHSSs and samples may be collected for leachability testing. Piezometers may be installed to provide groundwater level data for use in assessing groundwater flow directions before planning Phase II groundwater monitoring well locations.

Section 7.3 presents the planned Stage 1 sampling at each IHSS. The procedures that will be used in each type of sampling at any investigative stage are listed in Table 7-2 and discussed in Section 7.4.

7.3 SAMPLING LOCATION AND FREQUENCY

Stage 1 sampling locations and frequency at each IHSS have been determined through review of the conceptual models for each category of site (Section 2.2) and both subjective and statistical evaluation of data needs (Section 4.0).

The HPGe radioactivity survey at the larger IHSS (170, 176, 213, and 214) will be conducted on a grid spacing of 150 ft which will provide 100 percent coverage of each IHSS. Only one survey point may be needed for full coverage of smaller IHSSs. Collimaters will be used at these smaller IHSSs to focus the results on the area of interest. A collimater is a device for confining the elements of a beam within an assigned solid angle. After the initial HPGe survey is complete, DOE will approach EPA and CDH to determine anomalies that require additional investigation. These radioactivity anomalies, with a 150-ft spacing, will be investigated at a 75-ft spacing and confirmed with surficial soil samples in Stage 2.

At smaller IHSSs (174, 175, 177, 181, 182, and 207), a sodium iodide (NaI) scintillation probe will be used to survey for gamma emitting radionuclides in addition to the HPGe to provide

Table 7-2 Summary of Sampling Procedures Used in the OU10 Stage I RFI/RI Field Investigation Program

IHSS	Sample Type	Applicable Guidance Procedures
129	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
	Tank residue	To be developed
	Tank/pipeline inspection	To be developed
	Test pits sampling	EMD OP GT.8
	Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
170	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
	Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
174	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
	Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
175	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
	Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
176	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
	Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
177	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
	Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
181	Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
182	Soil gas survey	EMD OPs GT.09 and applicable EMD OPs referenced in Section 4.2
	Soil boring	EMD OPs GT.10, GT.02, GT.04, GT.03, GT.08, GT.01, GT.05, GT.17, FO.15, FO.06, FO.03, FO.04, FP.13, FO.07
	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed

Table 7-2 Summary of Sampling Procedures Used in the OU10 Stage I RFI/RI Field Investigation Program

IHSS	Sample Type	Applicable Guidance Procedures
205	Tank inspection Tank residue	To be developed To be developed
206	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
207	Radiation survey	EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
208	Surficial soil (exposed, for nonradiological)	As in OU1 Technical Memorandum 5 (SOPs to be developed)
210	Soil gas survey Surficial soil (exposed, for nonradiological) Soil gas survey	EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2 As in OU1 Technical Memorandum 5 (SOPs to be developed) EMD OP GT.09 and applicable EMD OPs referenced in Section 4.2
213	Surficial soil (exposed, for nonradiological) Radiation survey	As in OU1 Technical Memorandum 5 (SOPs to be developed) EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed
214	Surficial soil (exposed, for nonradiological) Radiation survey	As in OU1 Technical Memorandum 5 (SOPs to be developed) EMD OP FO.16 and applicable EMD OPs referenced in Section 4.2; HPGe and NaI OPs to be developed

added sensitivity in coverage of small areas. The NaI scintillation probe survey will be conducted on a grid spacing of 25 ft, consistent with the FIDLER grid spacing presented in Table 5 of the IAG.

Soil gas sample spacing was selected by professional judgment to provide complete coverage of sites and a variable amount of resolution of contaminant concentrations, depending upon site size and features. Soil gas samples will be spaced 40 ft apart at larger IHSSs (170 and 176) 20 ft apart at smaller IHSSs (174, 175, 177, 181, 182, and 210) and 10 ft apart at IHSS 129. At the 20- and 40-ft spacings, adjacent soil gas contaminant concentrations are expected to be similar to one another except near local hot spots because of the relatively coarse-grained, permeable soil that is characteristic of RFP. The soil gas screening technique that will be used is an active real-time method that allows the mapping of VOC anomalies as the investigators collect and analyze the vapor samples. In order to fully map any anomalies detected, additional samples may be collected between proposed grid locations. If the soil gas anomalies continue beyond the present IHSS boundaries, additional soil gas samples will be collected and analyzed outside the IHSS boundaries until the anomalies are completely mapped or the boundary of a neighboring IHSS is encountered.

During Stage 1, composite surficial soil samples for IHSS-specific nonradioactive parameters will be collected at evenly spaced locations on a triangular grid or where field personnel observe visual evidence of contamination. The composite surficial soil samples will be collected at random locations according to preliminary estimates of the numbers of samples that may be needed to achieve the quantitative DQOs for the BRA data. The Stage 1 surficial soil data will be evaluated in Technical Memorandum 1 and augmented by additional data if necessary.

As described in detail in Section 4.0, the surficial soil data quantity needs have been evaluated using assumptions about data variability at some IHSSs and calculations of data variability at others for which available data were adequate (IHSSs 174, 175, 176, and 177). The data variability assumptions and actual calculations resulted in a recommendation for 25 or more surficial soil samples at each IHSS, regardless of its size. In anticipation that later geostatistical analysis will indicate a need for fewer samples at smaller IHSSs, Stage 1 surficial soil sampling will include 25 samples at certain larger IHSSs and 8 samples at most smaller IHSSs.

The locations of the 25 samples at IHSSs 170, 176, 213, and 214 were selected by partitioning the IHSS into 50- by 100-ft cells, and sample locations were distributed systematically across these cells using a triangular grid spacing. The cell dimensions were chosen as the approximate average lot size that could be expected in a residential development future use scenario. All of the other IHSSs were too small to be partitioned into 25 cells of these dimensions, and the sampling locations were therefore evenly spaced to offer complete coverage of the potential sources areas.

In order to evaluate the horizontal extent of OU10-related surficial soil contamination, one to two surficial soil samples are proposed outside of the boundaries of several IHSSs. The locations of these samples have been selected subjectively and may or may not be affected by OU10 contaminant releases. The need for additional sampling to characterize the extent of OU10 surficial soil contamination and background levels of metals and radionuclides will be evaluated carefully at the end of Stage 1.

Additional samples will be collected at two surface soil sample locations at each IHSS for analysis of physical parameters. These samples will be tested to determine moisture content, grain size distribution, bulk density, specific density, porosity, and saturated hydraulic conductivity. A minimum of four samples will also be collected for the determination of TOC content and soil pH. The locations of these samples will be determined in the field by the sampling team so that all soil types encountered on site can be sampled.

All materials will be removed from surface storage IHSSs before sampling begins. No other difficulties are expected in reaching any sampling locations with the simple equipment that will be required for Stage 1 data collection. Technical memoranda will discuss the solutions to sampling difficulties that may arise at sites with overhead piping or other obstructions.

Table 7-3 summarizes the sampling proposed only for Stage 1. Tables 7-4 and 7-5 contain the specific analyte lists for the samples collected throughout Phase I. As discussed in Section 7.2, a series of technical memoranda will present the rationale, locations, and numbers of samples to be collected in later stages of the Phase I sources/soils investigation. These technical memoranda will contain tables similar to Table 7-3 and the FSPs for successive stages.

7.3.1 Oil Leak (IHSS 129)

Previous sampling at IHSS 129 indicated the presence of solvents, fuels/oils, and metals. This sampling data has not been validated. This site has overhead pipelines, guy wires, abovegrade tanks and belowgrade pipelines, limiting access for drilling borings.

Tanks and pipelines will be inspected and tested to determine the horizontal extent of potential VOC contamination from the leaking tanks or ancillary equipment. Trenches will be excavated

IHSS	Type of Contamination: Acids	Solvents	Fuels/ Oils	Anions	Metals	Radionuclides	HPGe and Vertical Profile Samples[1]	NaI Probe Survey	Soil Gas Analyses[2]	Surface Soil Analyses: TCL BNAs	TCL PCBs[3]	TAL Metals	CN	Tritium	pH[4]	Physical Parameters	Tank Liquid and Residue Analyses: VOC	TCL BNAs	TAL Metals	pH	Tank Test Pits and Samples: VOC	TCL BNAs	TAL Metals
129		H, S	H, R, S		S				•	•		•				•	•	•	•		•	•	•
170	H, R	H, R	H, R	H	H	H, R	• 35		•	•	•	•	•		•	•							
174		H, S	H, R, S	S	H, R, S	S	• 2	• 24	•	•	•	•	•			•							
175		H, S	H	S	H, S	S	• 1	• 7	•	•	•	•				•							
176		H, S	H, S	S	H, S	S	• 22		•	•	•	•				•							
177		H, S	H, S	S	H, S	H, S	• 2	• 18	•	•	•	•				•							
181		H	H		H	H	• 1	• 7	•														
182		H, S	H, R, S		H, R, S	H, S	• 1	• 9	•														
205	H	H	H		H												•	•	•	•			
206				H	H	H, R, S[5]						•		•		•							
207	H			H	H	H, R, S	• 1	• 5															
208	H			H	H							•	•		•	•							
210		H	H		H				•	•	•	•				•							
213				H, R		H, R, S	• 24			•		•				•							
214				H, R		H, R, S	• 13			•		•				•							

Table 7-3 • Phase I, Stage 1, Analytical Program

Key

- BNAs - Base/neutral and acid extractable organics
- CN - Cyanide
- H - Historical storage information
- HPGe - Radiation field screening using high-purity germanium detector
- NaI - Radiation field screening using sodium iodide scintillation detector
- PCBs - Polychlorinated biphenyls
- R - Documented release information
- S - Sample analysis information
- VO - Volatile organics
- ■ - Paved site - surface soil below pavement will be sampled in Stage 2

Notes

1 If HPGe and/or NaI surveys do not detect activity, vertical profile samples will not be collected.

2 All soil gas samples will be analyzed in the field for the constituents listed in Table 7-5.

3 Oil contamination assessment will include analysis for PCBs.

4 Acid contamination assessment will include analysis for metals and pH.

5 Tritium is the only radionuclide at this IHSS.

Refer to Tables 7-4 and 7-5 for the specific analyte lists.

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Analyte List	Water (µg/l)	Soil/Sediment (mg/kg)
Metals and Cyanide		
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	2.0
Calcium	5,000	2,000
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Magnesium	5,000	2,000
Manganese	15	3.0
Mercury	0.2	0.2
Nickel	40	8.0
Potassium	5,000	2,000
Selenium	5	1.0
Silver	10	2.0
Sodium	5,000	2,000
Thallium	10	2.0
Vanadium	50	10.0
Zinc	20	4.0

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Compound List	Water (µg/l)	Soil/Sediment (mg/kg)
Other Metals		
Lithium	100	20
Molybdenum	200	40
Tin	200	40
Target Compound List		
Voltatile Organics		
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10II	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	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,2-Dichloropropane	5	5

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Compound List	Water (µg/l)	Soil/Sediment (mg/kg)
cis-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
trans-1,3-Dichloropropene	5	5
Bromoform	5	5
4-Methyl-2-pentanone	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
Total Xylenes	5	5
BNAs		
Phenol	10**	330
bis(2-Chloroethyl)ether	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

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Compound List	**Water (μg/l)**	**Soil/Sediment (mg/kg)**
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitroso-di-n-propylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10**	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic acid	50	1,600
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 (para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1,600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1,600
Dimethylphthalate	10	330
Acenaphthylene	10	330

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Compound List	Water (µg/l)	Soil/Sediment (mg/kg)
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1,600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1,600
4-Nitrophenol	50	1,600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl-phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1,600
4,6-Dinitro-2-methylphenol	50	1,600
N-nitrosodiphenylamine	10	330
4,-Bromophenyl-phenylether	10	330
Hexachlorobenzene	10**	330
Pentachlorophenol	50	1,600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butylbenzylphthalate	10	330
3,3'-Dichlorobenzidine	20**	660
Benzo(a)anthracene	10	330
Chrysene	10	330

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Compound List	Water (µg/l)	Soil/Sediment (mg/kg)
bis(2-Ethylhexyl)phthalate	10	330
Di-n-octylphthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	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
Pesticides		
alpha-BCH	0.05	8.0
beta-BCH	0.05	8.0
delta-BCH	0.05	8.0
gamma-BCH(Lindane)	0.05	8.0
Heptachlor	0.05**	8.0
Aldrin	0.05**	8.0
Heptachlor epoxide	0.05**	8.0
Endosulfan I	0.05	8.0
Dieldrin	0.10	16.0
4,4'-DDE	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
Endosulfan sulfate	0.10	16.0
4,4'-DDD	0.10	16.0
4,4'-DDT	0.10	16.0

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Compound List	Water (µg/l)	Soil/Sediment (mg/kg)
Methoxychlor	0.5	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.5**	80.0
gamma-Chlordane	0.5**	80.0
Toxaphene	1.0	160.0
PCBs		
Aroclor-1016	0.5**	80.0
Aroclor-1221	0.5**	80.0
Aroclor-1232	0.5**	80.0
Aroclor-1242	0.5**	80.0
Aroclor-1248	0.5**	80.0
Aroclor-1254	1.0**	160.0
Aroclor-1260	1.0**	160.0
Anions		
Carbonate	10,000	NA
Bicarbonate	10,000	NA
Chloride	5,000	NA
Sulfate	5,000	NA
Nitrate as N	1,000	NA
Fluoride	5,000	NA

Table 7-4 Phase I Source, Soil, Sediment, Water, and Asphalt/Concrete[1] Sampling Parameters and Detection/Quantitation Limits

	DETECTION LIMITS*	
Target Compound List	Water (μg/l)	Soil/Sediment (mg/kg)
Special Surficial Soil Sampling Parameters		
Total Organic Carbon	—	1
pH	—	0.1 pH unit
Specific Conductance	—	2.5 μmHos/cm
Radionuclides		
Gross Alpha	2	4 dry
Gross Beta	4	10 dry
Uranium 233+234, 235, and 238 (each species)	0.6	0.3 dry
Americium 241	0.01	0.02 dry
Plutonium 239+240	0.01	0.03 dry
Tritium	400	400 (pCi/ml)
Cesium 137	1	0.1 dry
Strontium 89+90	1	1 dry

*Detection and quantitation limits are highly matrix dependent. The limits here are the minimum achievable under ideal conditions. Actual limits may be higher.

**The laboratory Practical Quantification Limits (PQLs) for these analytes exceed ARARs.

NA - Not Applicable
[1] - Radionuclides and PCBs only

Table 7-5 Phase I Investigation Soil Gas Parameters and Proposed Detection Limits

Sample Type	Detection Limit (µg/l)
Acetone	1
Benzene	1
Carbon tetrachloride	1
Ethylbenzene	1
Hydrogen sulfide	1
Methylene chloride	1
Methane	1
PCE	1
TCE	1
Toluene	1
Xylenes (total)	1
1,1,1-TCA	1
1,2-DCE	1
2-Butanone	1

Note: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary. Target detection limits will be at or below the listed values.

and soil samples collected to verify the results of the tank testing. These soils samples will be analyzed for VOCs, BNAs, and metals. One residue sample from the tank will be analyzed for VOCs, BNAs, and metals. Soil gas data collection points located above the subsurface piping and the tank (Figure 7.3-1) will be sampled on a 10-ft grid. Soil gas samples will be analyzed for fuel and solvent constituents listed in Table 7-5. Surficial soil samples will be collected from below the gravel cover because of a history of surface spills at this IHSS. The surficial soil samples will be analyzed for BNAs and metals.

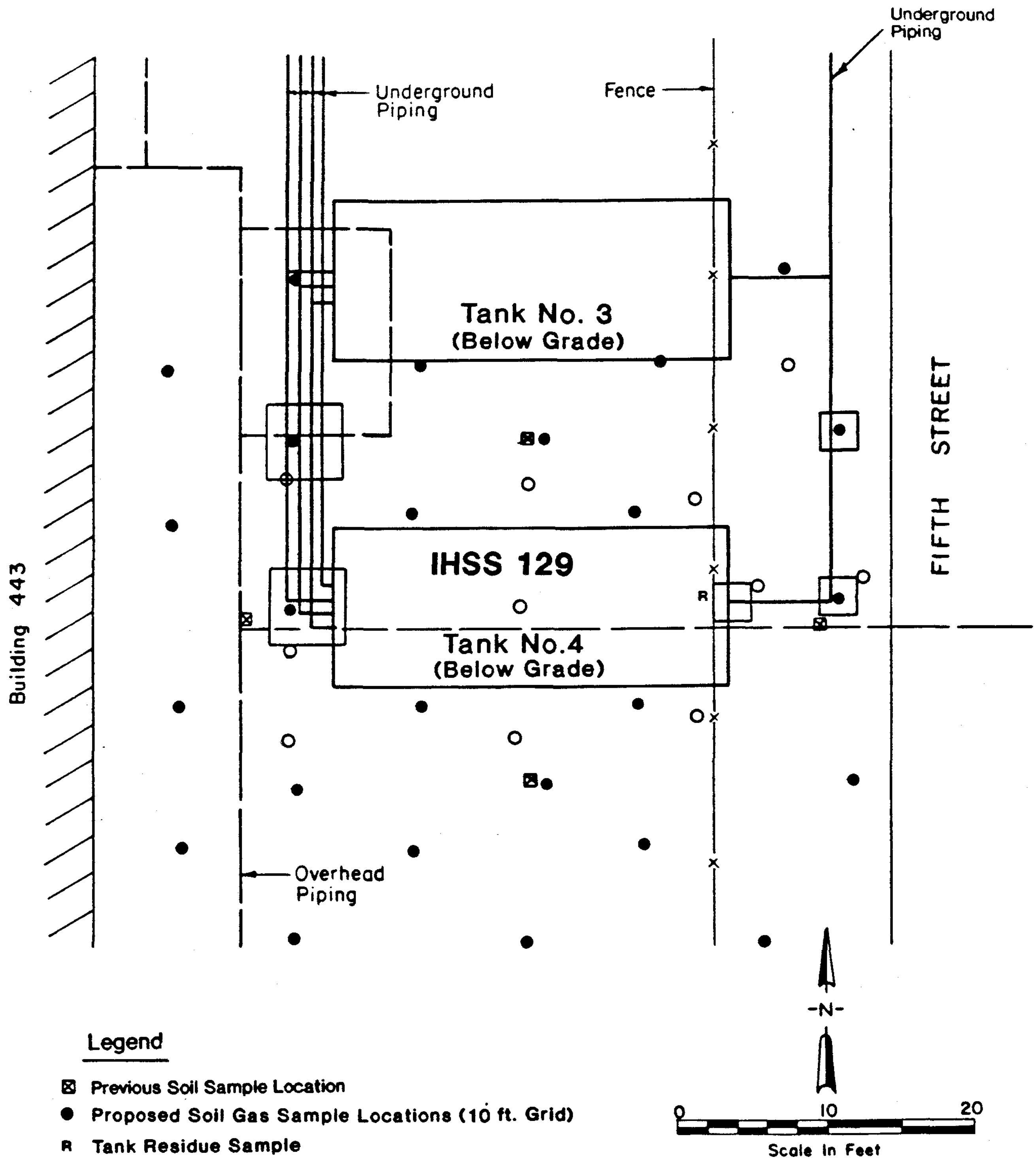
7.3.2 P.U.&D. Storage Yard - Waste Spills (IHSS 170)

IHSS 170 has historical information indicating the potential presence of acids, solvents, fuels/oils, anions, metals and radionuclides. This site has no known restrictions limiting sampling. HPGe and soil gas surveys will be used to locate areas of potential contamination. The soil gas survey will be initially conducted on a 40-ft grid and the HPGe will be initially conducted at 150-ft spacings (Figures 7.3-2 and 7.3-3). The soil gas survey will be used to locate possible occurrences of solvent spills. The sampling locations will be adjusted to define anomalous hot spots if necessary.

A total of 25 surficial soil samples will be collected on a triangular grid. Eight additional surficial soil samples will be collected in an area of staining, and two samples will be located outside the IHSS boundary (Figure 7.3-2). Surficial soil samples will be analyzed for BNAs, PCBs, metals and cyanide.

7.3.3 P.U.&D. Container Storage Facilities (IHSS 174)

IHSS 174 has sample analysis verifying the presence of solvents, fuels/oils, anions, metals, and radionuclides. This sampling data has not been validated. This site has no known restrictions



Legend

- ⊠ Previous Soil Sample Location
- ● Proposed Soil Gas Sample Locations (10 ft. Grid)
- R Tank Residue Sample
- ☐ Inspection Pit Location
- ○ Proposed Surficial Soil Sample Location (Nonradiological)

Note: Tank locations are from the closure report, and have not been verified by facility drawings.

Excavations for inspection will occur at pipe elbows, fittings and valves.

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

FIGURE 7.3- 1
Proposed Sampling Locations for Oil Leak (IHSS 129)

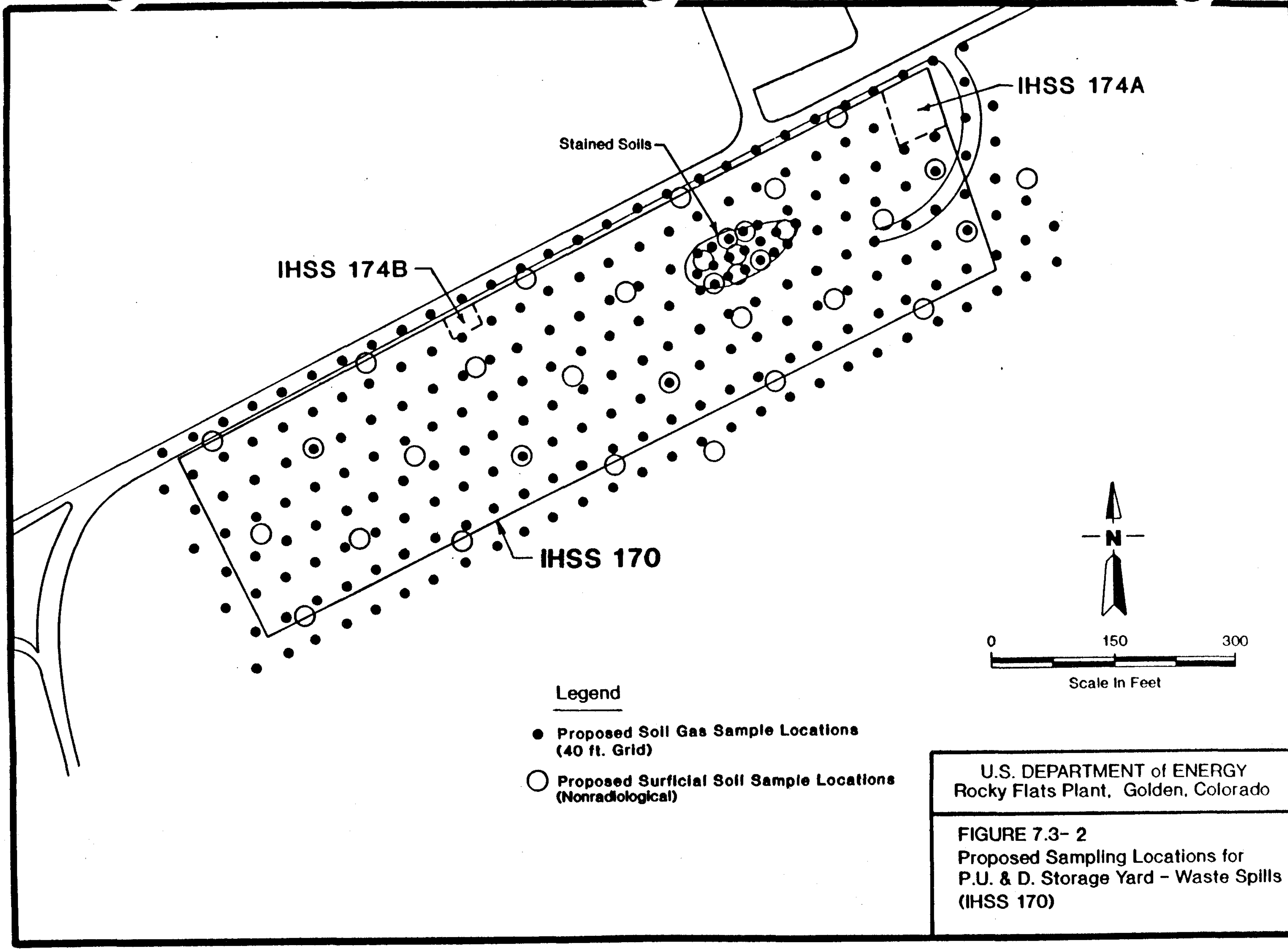


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FIGURE 7.3- 2
Proposed Sampling Locations for
P.U. & D. Storage Yard – Waste Spills
(IHSS 170)

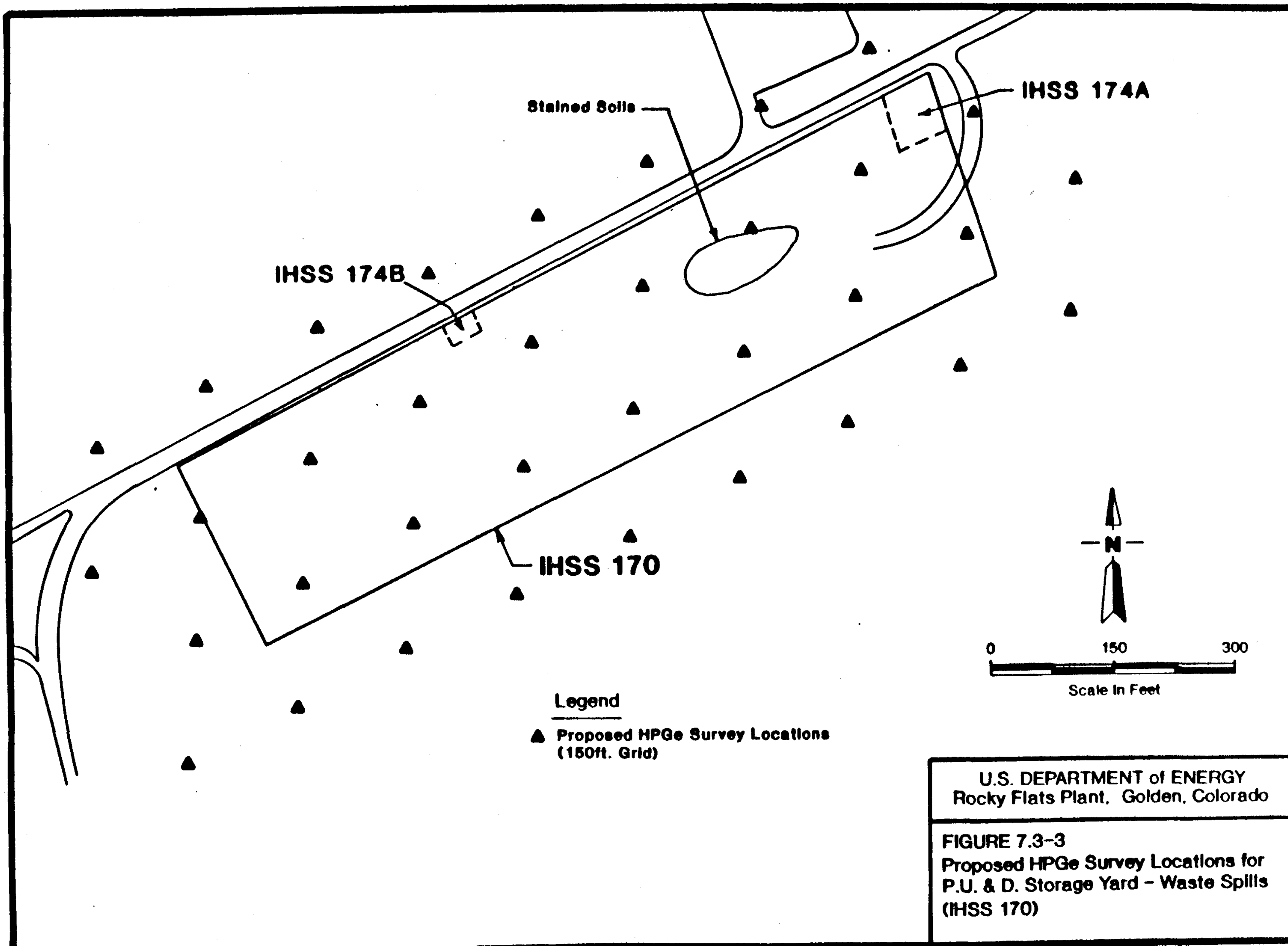

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FIGURE 7.3-3
Proposed HPGe Survey Locations for P.U. & D. Storage Yard - Waste Spills (IHSS 170)

to limit sampling. The soil gas survey will be conducted on a 20-ft grid and surficial soil samples will be collected at some of these locations to verify contamination (Figure 7.3-4). The soil gas samples will be analyzed for the constituents listed in Table 7-5. An HPGe survey will be conducted at a 150-ft spacing at IHSS 170 (Figure 7.3-5). A NaI probe survey will also be conducted at a 25-ft spacing. The results of these surveys will be used to determine radionuclide contamination at IHSS 174. Twenty-five surficial soil samples are proposed for the drum storage area of IHSS 174 and are located based on a triangular grid (Figure 7.3-4). Eight samples are proposed in the reported dumpster storage area. Surficial soil samples will be analyzed for BNAs, PCBs, metals and cyanide.

7.3.4 <u>S&W Building 980 Container Storage Facility (IHSS 175)</u>

IHSS 175 has historical and sample analysis information indicating the potential presence of solvents, fuels/oils, anions, metals, and radionuclides. The sample data has not been validated. This IHSS has an overhead power line located near the site and an embankment to the south, but the line should not pose a restriction to sampling. Soil gas techniques will be used to determine the horizontal extent of potential contamination that may have leaked or spilled from drums or containers stored in IHSS 175. If the potentially spilled waste included solvents or other VOCs in vadose zone soil, soil gas techniques can quickly locate these constituents. Soil gas samples will be collected on a 20-ft grid (Figure 7.3-6). HPGe and NaI probe surveys will be conducted at this IHSS. The HPGe survey will include the use a collimater to reduce the field of view, and the NaI probe survey will be conducted on a 25 ft grid (Figures 7.3-6 and 7.3-7).

Ten surficial soil samples, four around the perimeter, four within the site, and two outside the IHSS boundary will be collected (Figure 7.3-6). Surficial soil samples will be analyzed for BNAs, PCBs and metals.

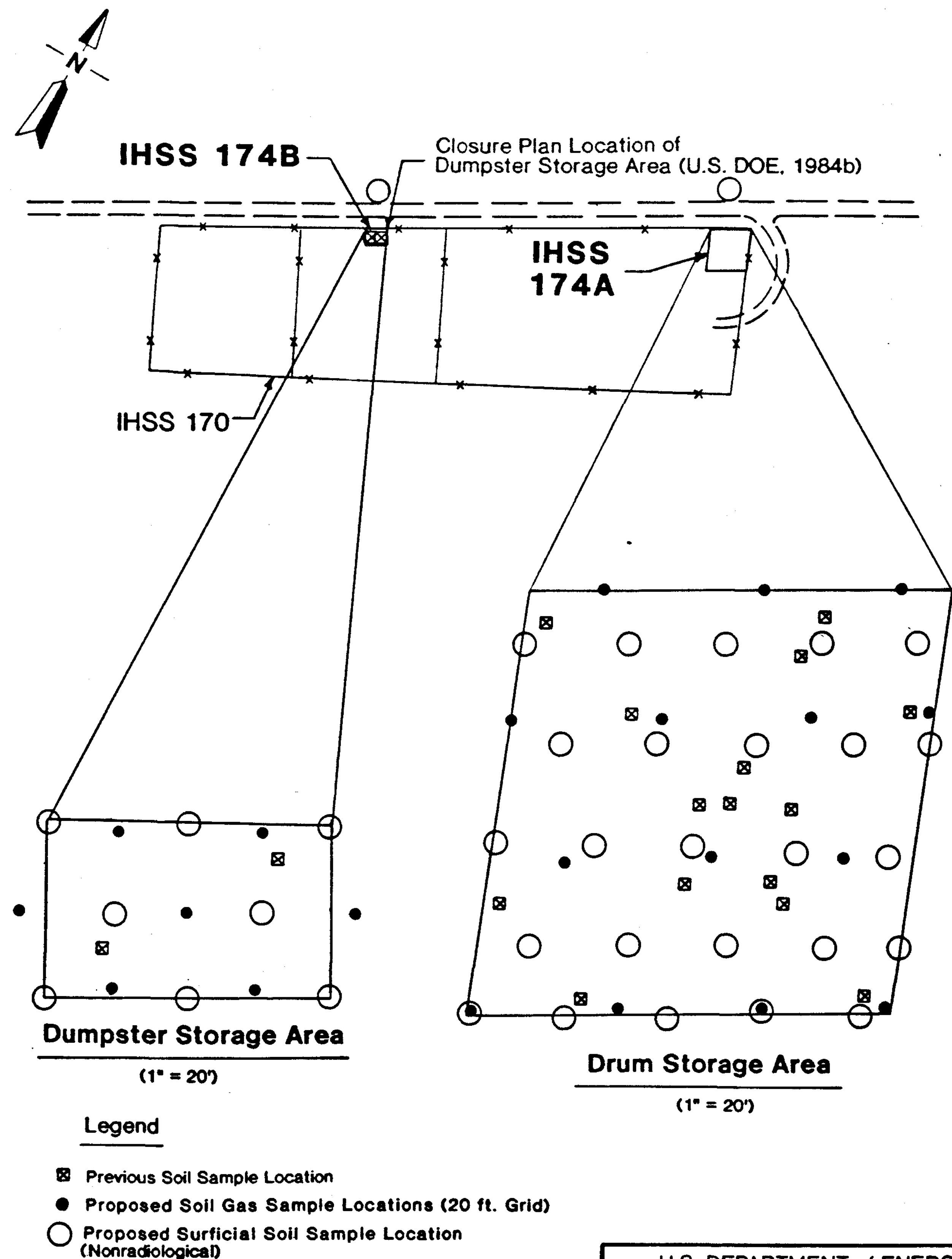

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FIGURE 7.3-4
Proposed Sampling Locations for
P.U.&D. Container Storage Facilities
(IHSS 174)

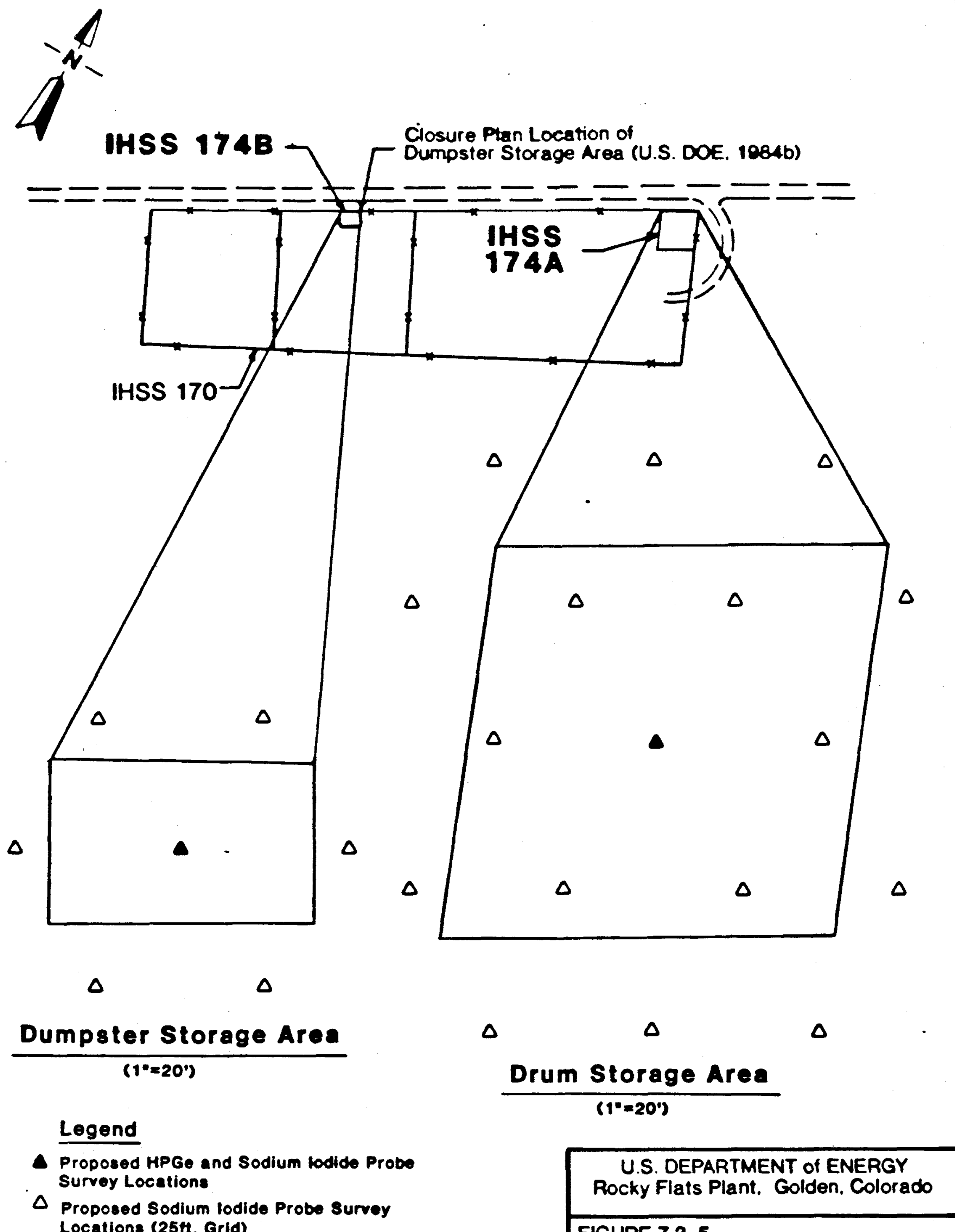

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FIGURE 7.3-5
Proposed HPGe and Sodium Iodide Probe Survey Locations - P.U. & D. Container Storage Facilities (IHSS 174)

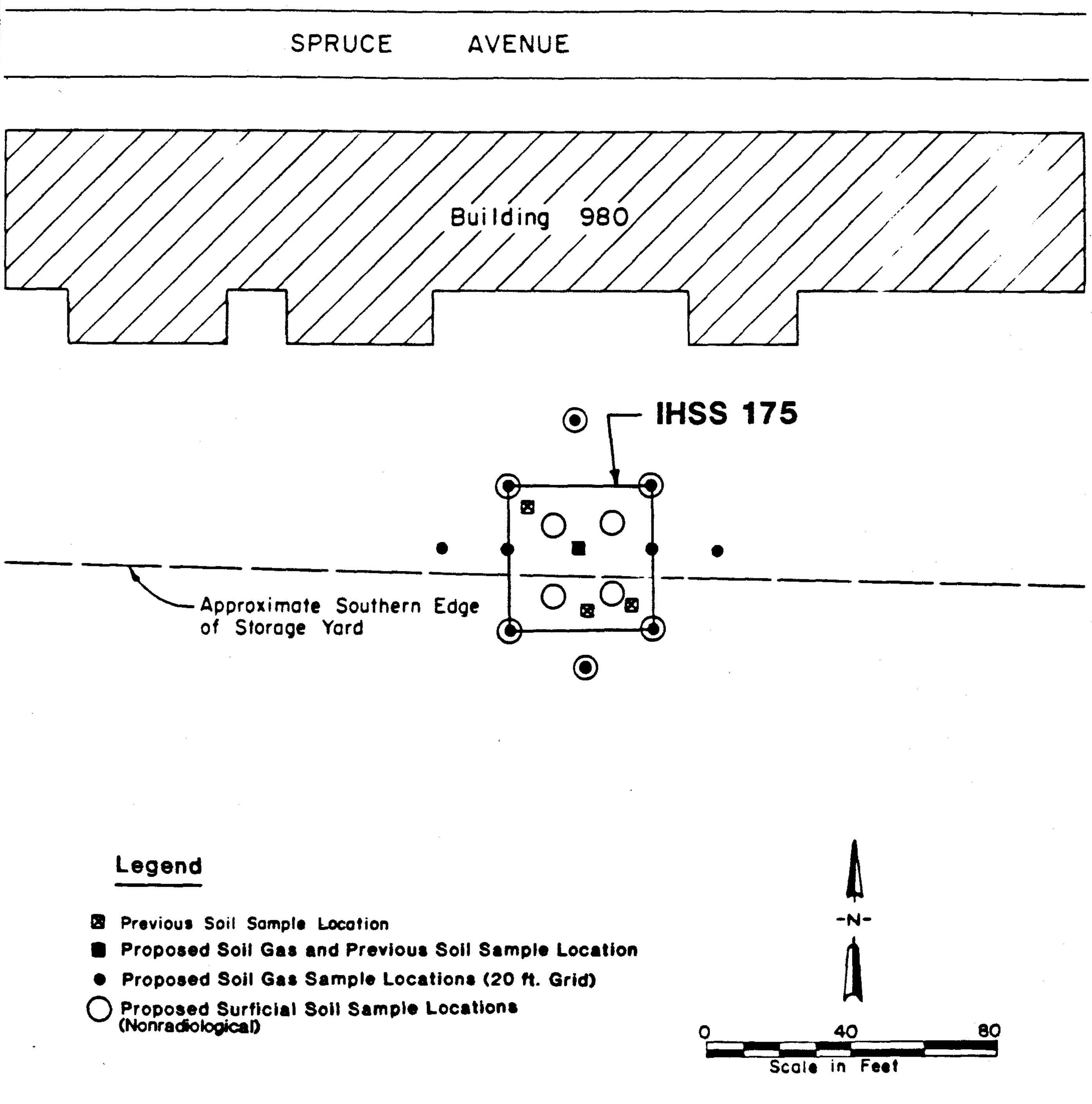

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FIGURE 7.3- 6
Proposed Sampling Locations for S & W Building 980 Container Storage Facility (IHSS 175)

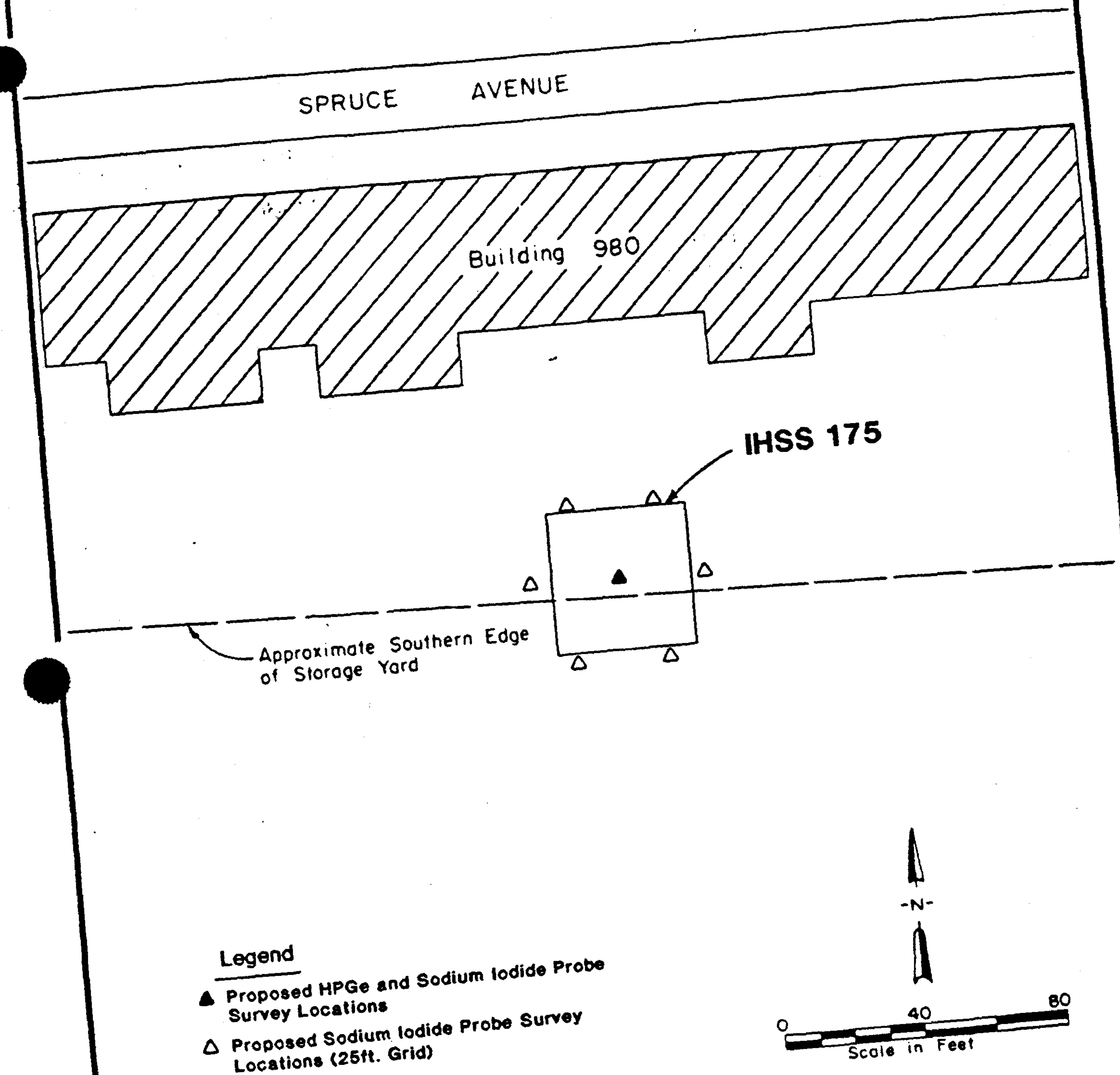

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FIGURE 7.3-7
Proposed HPGe and Sodium Iodide Probe Survey Locations - S & W Building 980 Container Storage Facility (IHSS 175)

7.3.5 S&W Contractor Storage Yard (IHSS 176)

Aerial photographs taken between 1980 and 1985 indicate that surface storage at this site extended to the north and east of the boundaries defined in the IAG. The sampling program has been extended to include these areas.

IHSS 176 has historical and sample analysis information indicating the potential presence of solvents, fuels/oils, anions, metals, and radionuclides. The sample data has not been validated. This IHSS has an overhead power line located near the site, but the line poses no real restriction to soil boring sampling. Soil gas and HPGe surveys will be conducted to determine the horizontal extent of potential contamination that may have leaked or spilled from drums or containers stored in IHSS 176. Sampling points for the soil gas survey will be located on a 40-ft triangular grid and the HPGe survey will be conducted on a 150-ft spacing (Figures 7.3-8 and 7.3-9).

Twenty-seven surficial soil samples are proposed inside the IHSS, and two samples will be located outside the IHSS boundary (Figure 7.3-8). The location of the surficial soils samples may be changed to sample areas of visually stained soil. Surficial soil samples will be analyzed for BNAs, PCBs, and metals.

7.3.6 Building 885 Drum Storage Area (IHSS 177)

IHSS 177 has historical and sample analysis information indicating the potential presence of solvents, fuels/oils, anions, metals, and radionuclides. The sample data has not been validated. This IHSS is covered with concrete and the perimeter is asphalt. Drilling may be hindered by the narrow pathway that runs between the building and fence on the south side and by an overhead power line that runs to the east. Soil gas techniques will be used to determine the

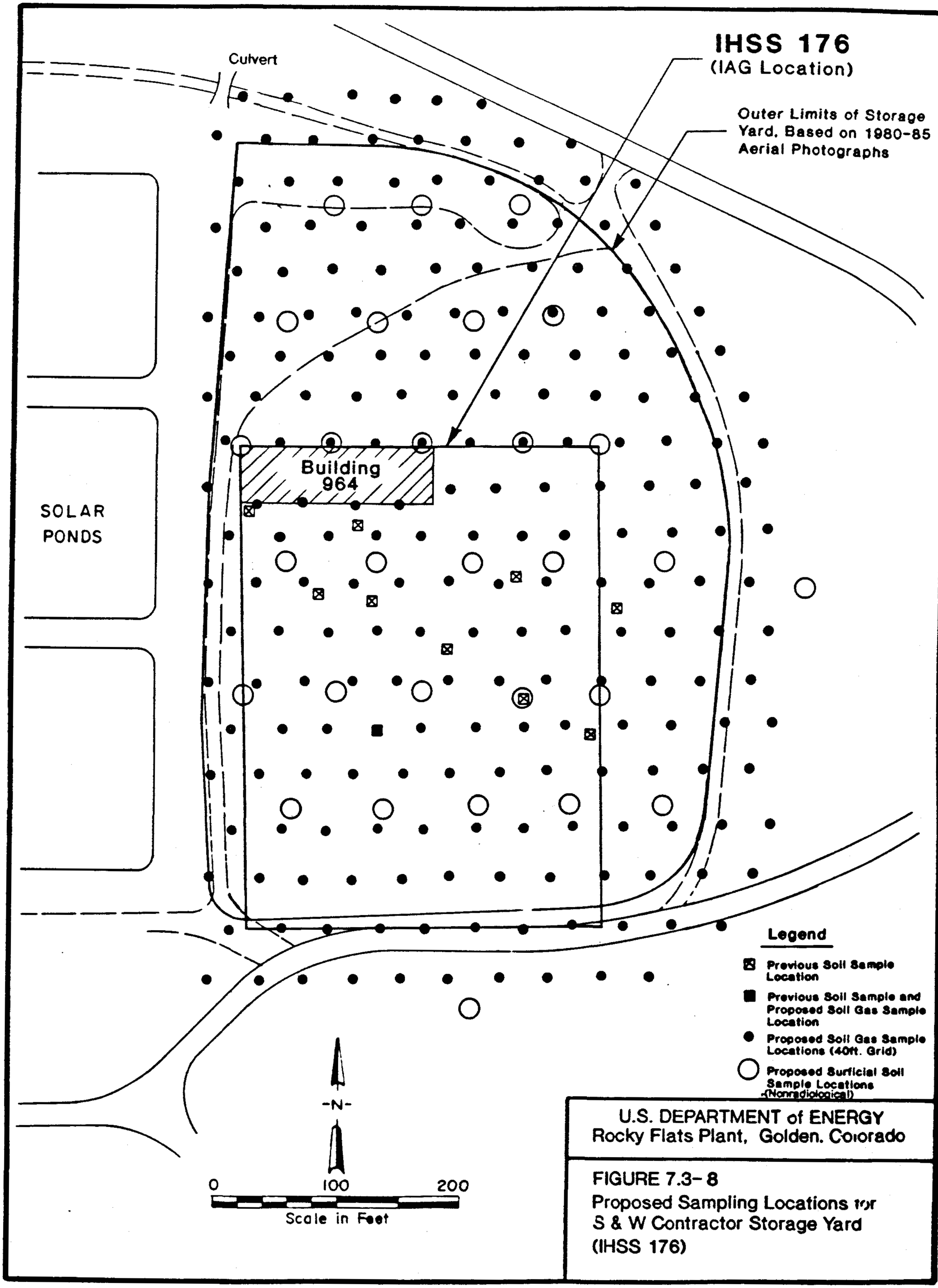

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FIGURE 7.3-8
Proposed Sampling Locations for S & W Contractor Storage Yard (IHSS 176)

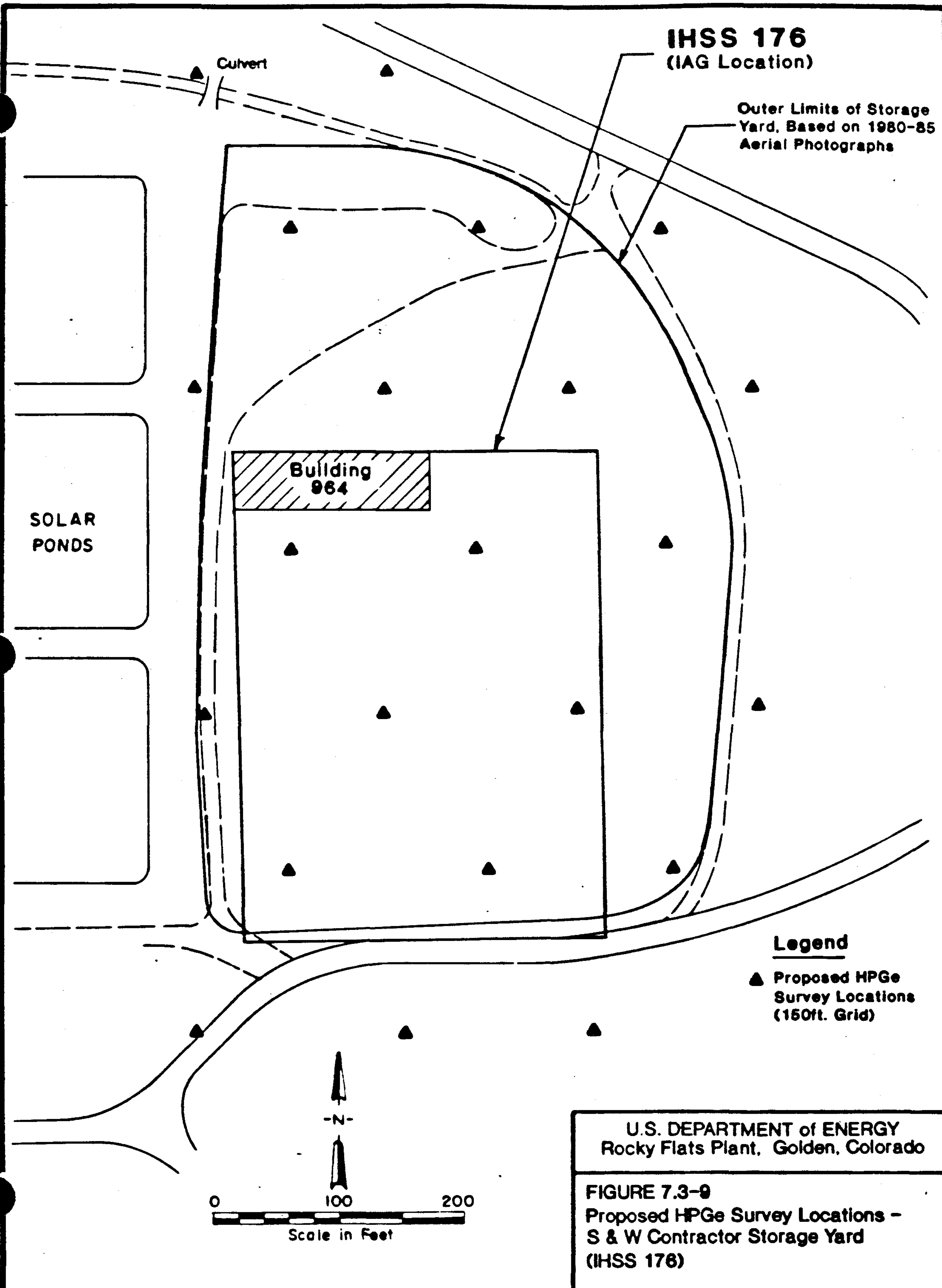

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FIGURE 7.3-9
Proposed HPGe Survey Locations – S & W Contractor Storage Yard (IHSS 176)

horizontal extent of potential contamination that may have leaked or spilled from drums or containers stored at IHSS 177. The soil gas survey will be performed to the south, east, and west of Building 885 on a 20-ft grid (Figure 7.3-10). There is no asphalt in these areas and dispersal of contaminants by surface runoff is likely. Building 885 was placed on top of asphalt, so a soil gas survey to the north and beneath the building will not be necessary as contamination would not reach the vadose zone in this area.

An HPGe survey will be conducted to screen areas for possible radioactive contamination (Figure 7.3-11). In addition, a survey with a NaI probe will be conducted on a 25-ft grid. Ten surficial soil samples are proposed for the IHSS 177 investigation (Figure 7.3-10). Eight samples are located along the perimeter of Building 885 and surface water ponding areas to the south and southwest of Building 885. Two samples are located outside of the fence south of Building 885. Surficial soil samples will be analyzed for BNAs, PCBs, and metals.

7.3.7 <u>Building 334 Cargo Container Area (IHSS 181)</u>

IHSS 181 has historical information indicating the potential presence of solvents, fuels/oils, metals, and radionuclides. This site is covered with asphalt under and to the north of the former cargo container location, and a drainage ditch is located to the south. There are no known restrictions limiting sampling. A soil gas survey will be performed at three sites located south of the IHSS at a 20-ft spacing (Figure 7.3-12). Samples will be analyzed for the constituents listed in Table 7-5. An HPGe survey will be performed at a single point to screen for possible radioactive contamination. In addition, a survey with a NaI probe will be performed on a 25-ft grid.

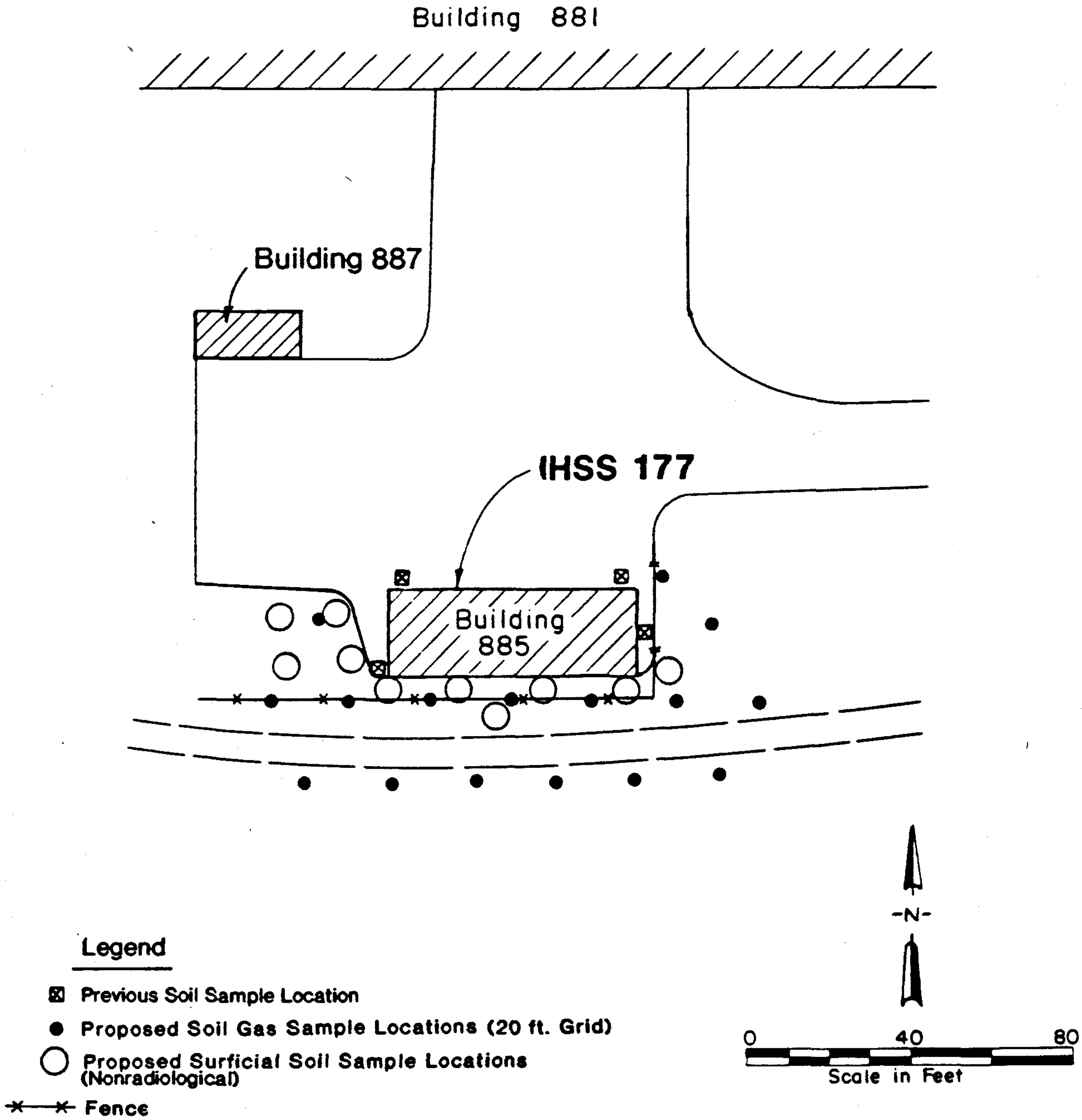

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FIGURE 7.3-10
Proposed Sampling Locations for Building 885 Drum Storage Area (IHSS 177)

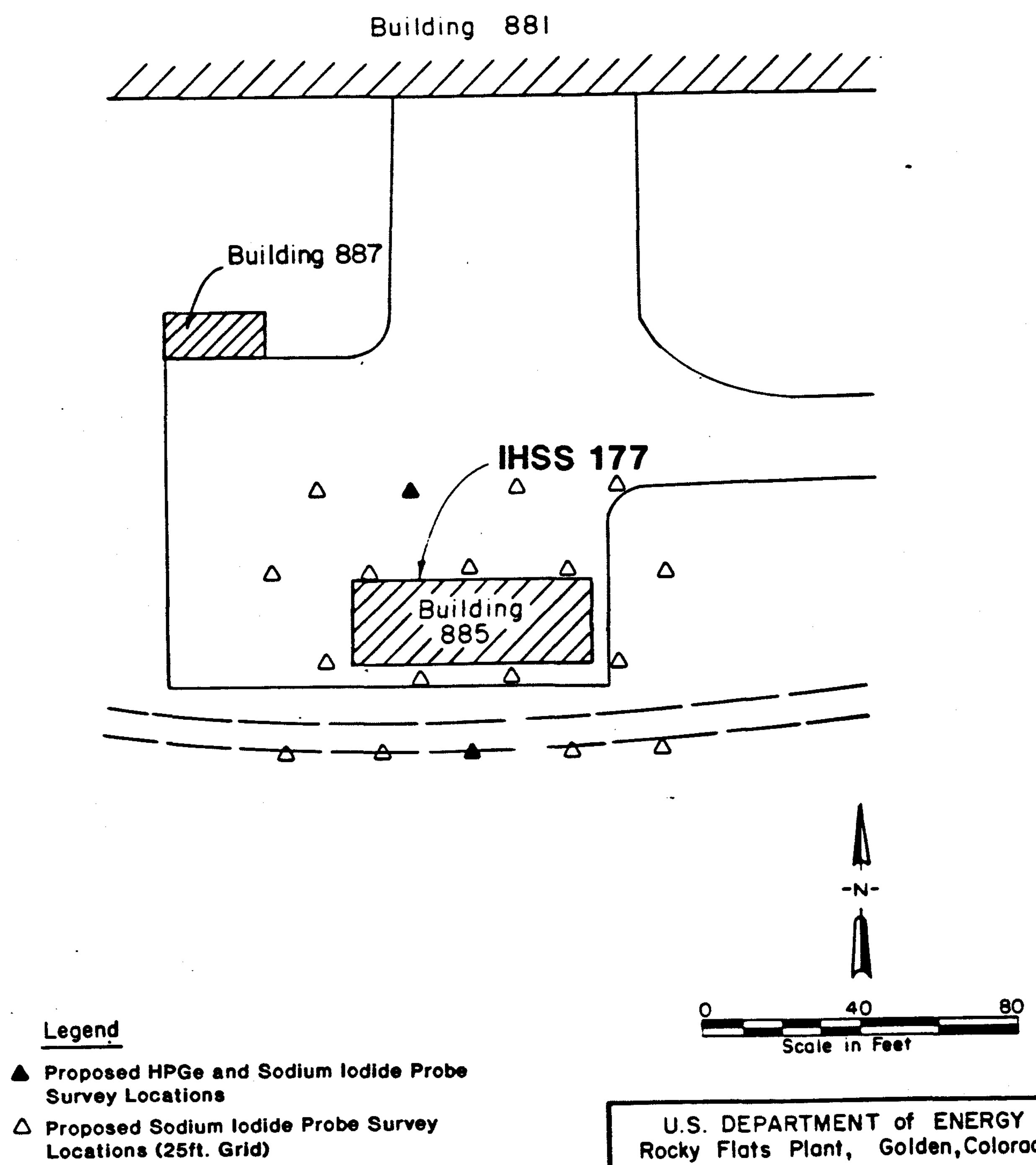

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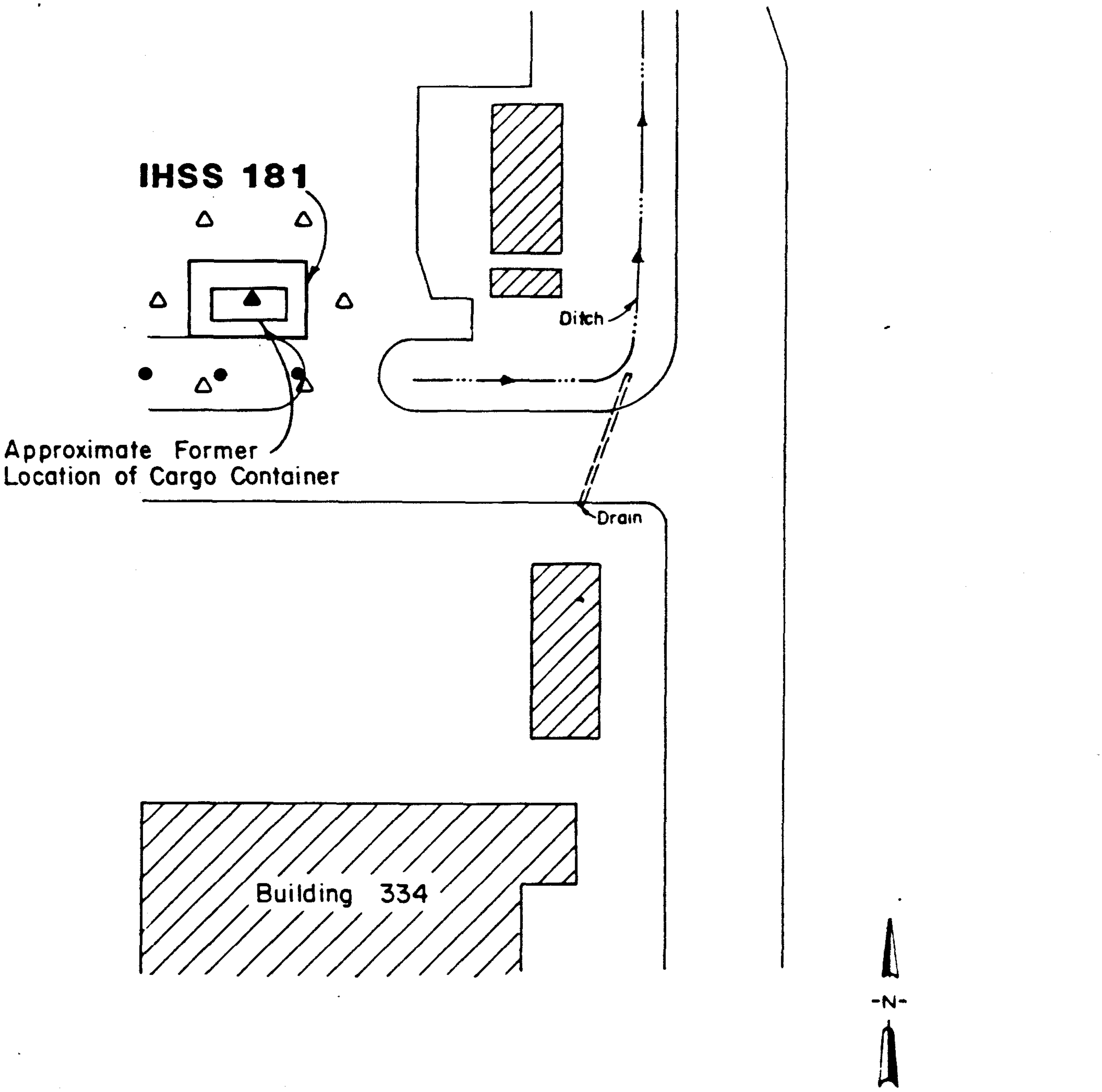
FIGURE 7.3-11
Proposed HPGe and Sodium Iodide Probe Survey Locations - Building 885 Drum Storage Area (IHSS 177)



Legend

- Surface Drainage, Indicating Direction of Flow
- ● Proposed Soil Gas Sample Locations (20 ft. Grid)
- ▲ Proposed HPGe and Sodium Iodide Probe Survey Locations
- △ Proposed Sodium Iodide Probe Survey Locations (25ft. Grid)

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FIGURE 7.3- 12
Proposed Sampling Locations for Building 334 Cargo Container Area (IHSS 181)

No surficial soil samples will be taken because this site has always been paved and contamination would already have been removed by surface runoff.

7.3.8 Building 444/453 Drum Storage Area (IHSS 182)

IHSS 182 may be contaminated by solvents, fuels/oils, metals, and radionuclides. This site is covered with asphalt that was placed after releases may have occurred. A narrow pathway between Buildings 453 and 444 may restrict access for soil boring sampling. A soil gas survey will be conducted on a 20-ft grid and samples will be analyzed for the constituents listed in Table 7-5 (Figure 7.3-13). An HPGe survey will be performed at a single point to evaluate possible radioactive contamination. Because Building 453 may shield the HPGe detector from radioactivity to the north and east, a NaI probe will also be used to measure radioactivity on a 25 ft grid (Figure 7.3-14).

In Stage 2, when drilling equipment is available, surficial soil samples will be collected from beneath the pavement that was installed after contaminant releases may already have occurred.

7.3.9 Building 460 Sump #3 Acid Side (IHSS 205)

IHSS 205 has historical information indicating the potential presence of acids. This site is covered by concrete and the presence of tanks limits access to sampling the concrete pad. No soil gas or surficial soil sampling is planned for IHSS 205 during the Phase I RFI/RI. If visual inspection indicates tank leakage, such as deteriorated or stained concrete in the vicinity of the tank, then one soil sample will be collected from the stained location and analyzed for pH, volatiles, BNAs and metals. Two residue samples will be collected and analyzed for pH, volatiles, BNAs, and metals (Figure 7.3-15).

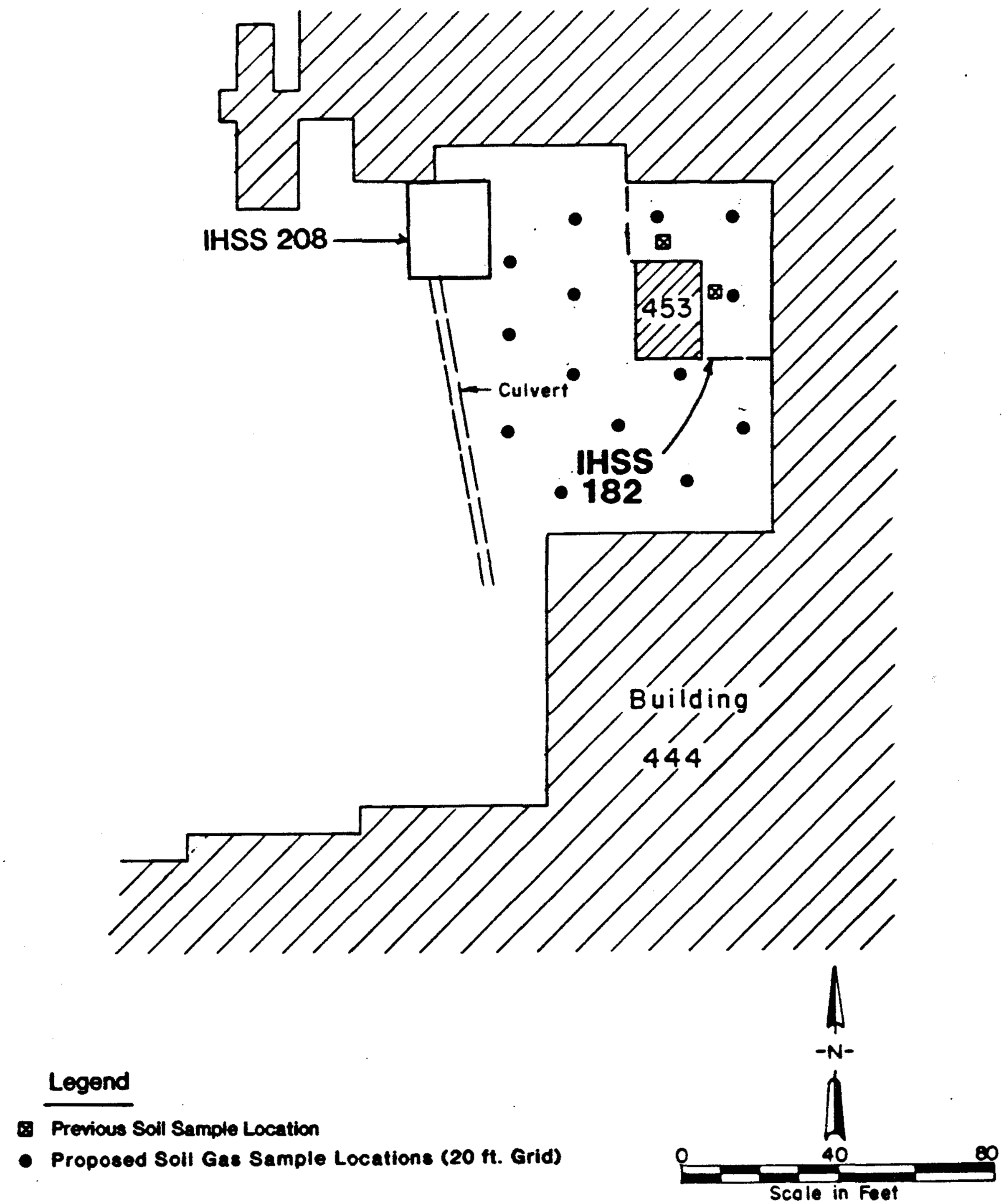

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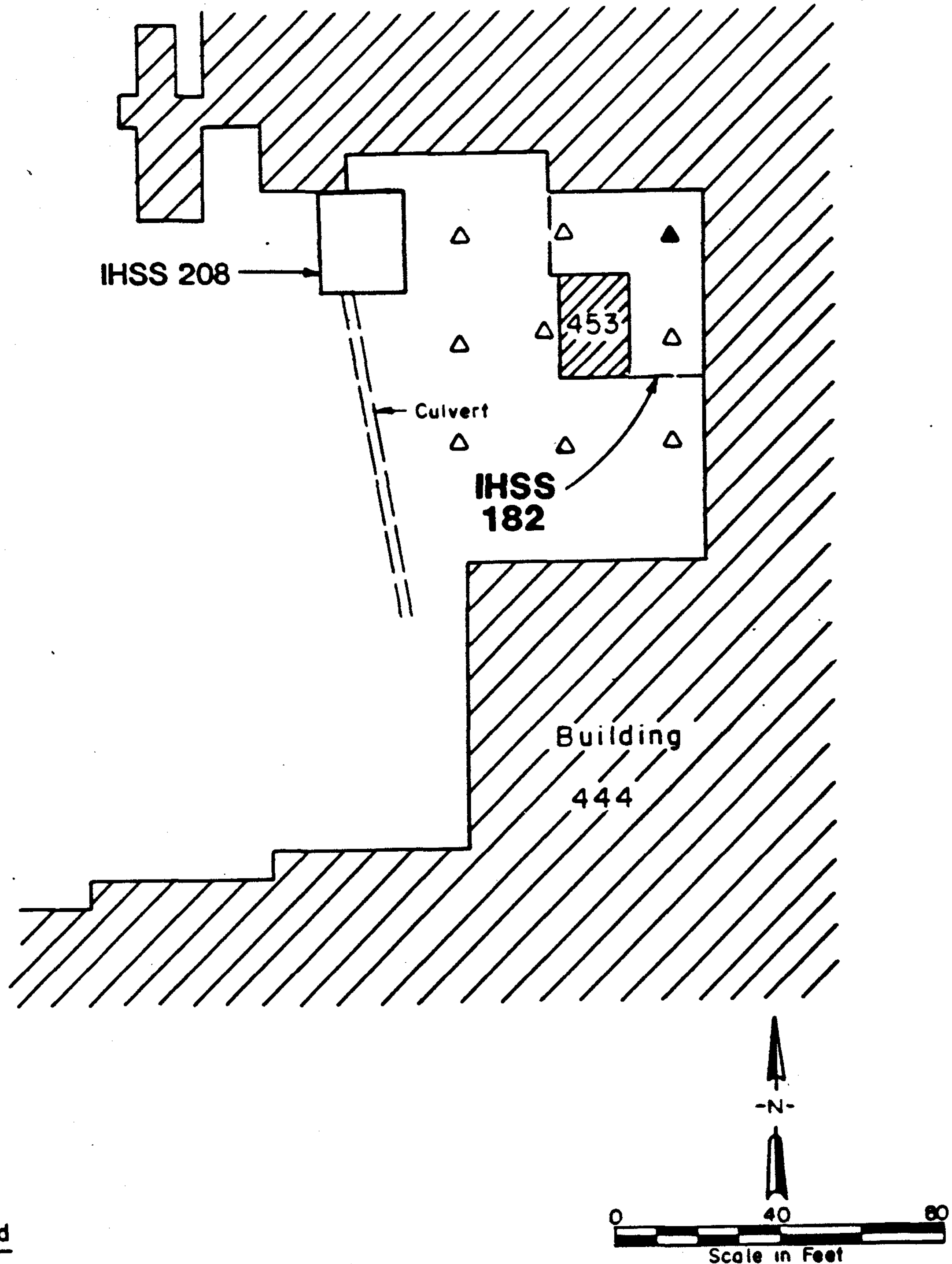
FIGURE 7.3-13
Proposed Sampling Locations for Building 444/453 Drum Storage Area (IHSS 182)



Legend

▲ Proposed HPGe and Sodium Iodide Probe Survey Locations

△ Proposed Sodium Iodide Probe Survey Locations (25ft. Grid)

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FIGURE 7.3-14
Proposed HPGe and Sodium Iodide Probe Survey Locations – Building 444/453 Drum Storage Area (IHSS 182)

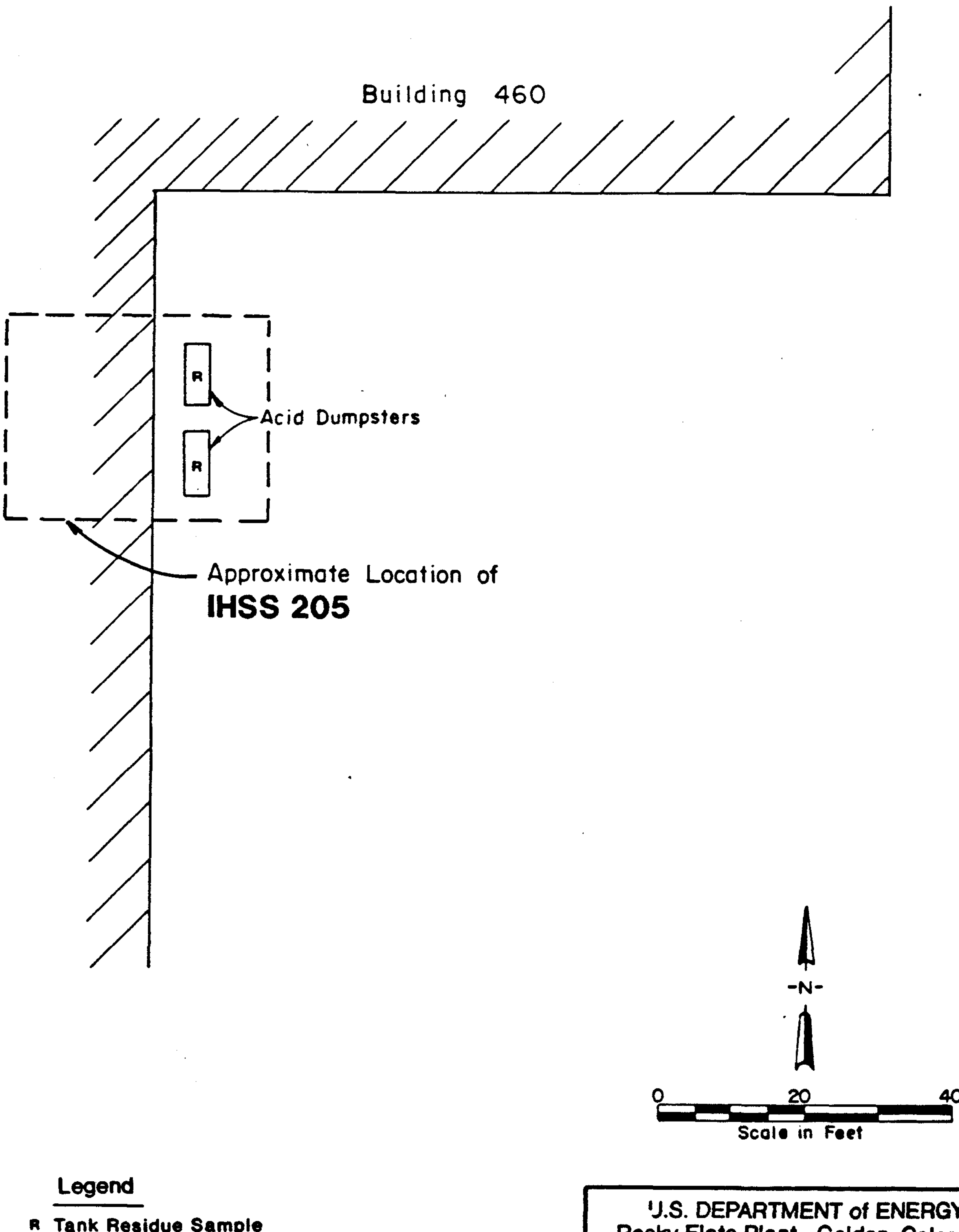

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FIGURE 7.3-15
Proposed Sampling Locations for Building 460 Sump #3 Acid Side (IHSS 205)

7.3.10 Inactive D-836 Hazardous Waste Tank (IHSS 206)

IHSS 206 has historical information indicating the potential presence of metals and radionuclides. However, the radioactive contaminant was tritium in condensate that could be expected to have evaporated or migrated to the water table. For this reason and as tritium is not a gamma emitter, no HPGe survey is proposed. This site has guy wires and overhead structures restricting access for soil boring sampling. No soil gas sampling will be conducted at IHSS 206 during Stage 1 RFI/RI. Ten surficial soil samples are proposed at this location for Stage 1 (Figure 7.3-16). Eight samples will be located where the tank was formerly located, one sample will be located where the piping exited the building, and one sample will be located on the north side of the former location of the tank. The soil samples will be analyzed for metals and tritium. Surficial soil analytical results will be evaluated in Technical Memorandum 1.

7.3.11 Inactive Building 444 Acid Dumpsters (IHSS 207)

IHSS 207 has historical information indicating the potential presence of acids, anions, metals, and radionuclides. This site is covered by concrete and has no known restrictions limiting sampling. No soil gas or surficial soil sampling is planned for IHSS 207. If visual inspection reveals indication of leakage, such as deteriorated or stained concrete, a surficial soil sample will be collected if exposed soil is present. The HPGe survey will be conducted at one location in the center of the IHSS (Figure 7.3-17). A survey with a NaI probe will also be conducted on a 25 ft grid to supplement the HPGe survey.

7.3.12 Inactive 444/447 Hazardous Waste Storage Area (IHSS 208)

IHSS 208 has historical information indicating the potential presence of acids, anions, and metals. This IHSS, except for a narrow strip in its center, is covered by asphalt and has no known restrictions limiting sampling. Three surficial samples are proposed for IHSS 208 during Stage 1

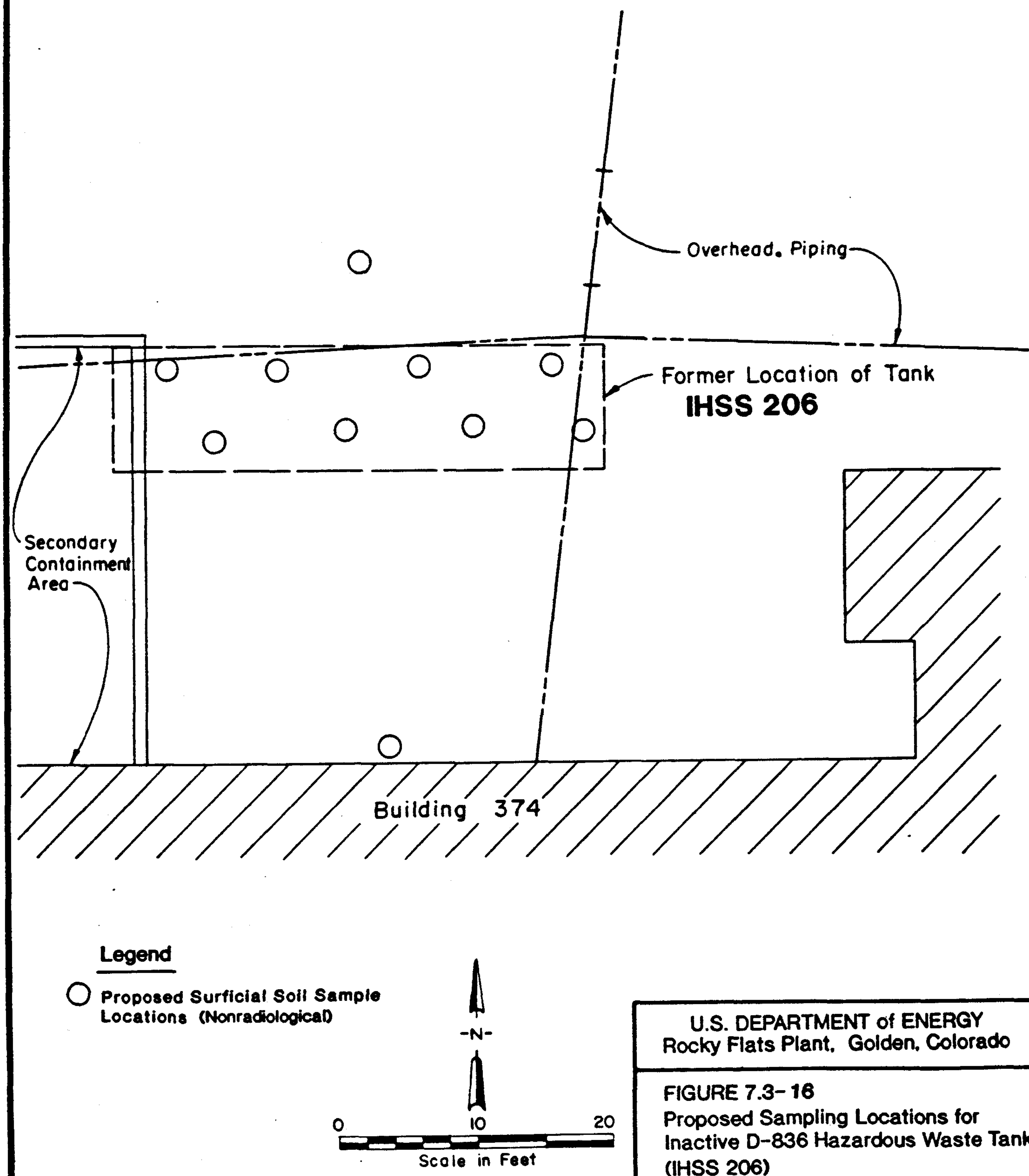

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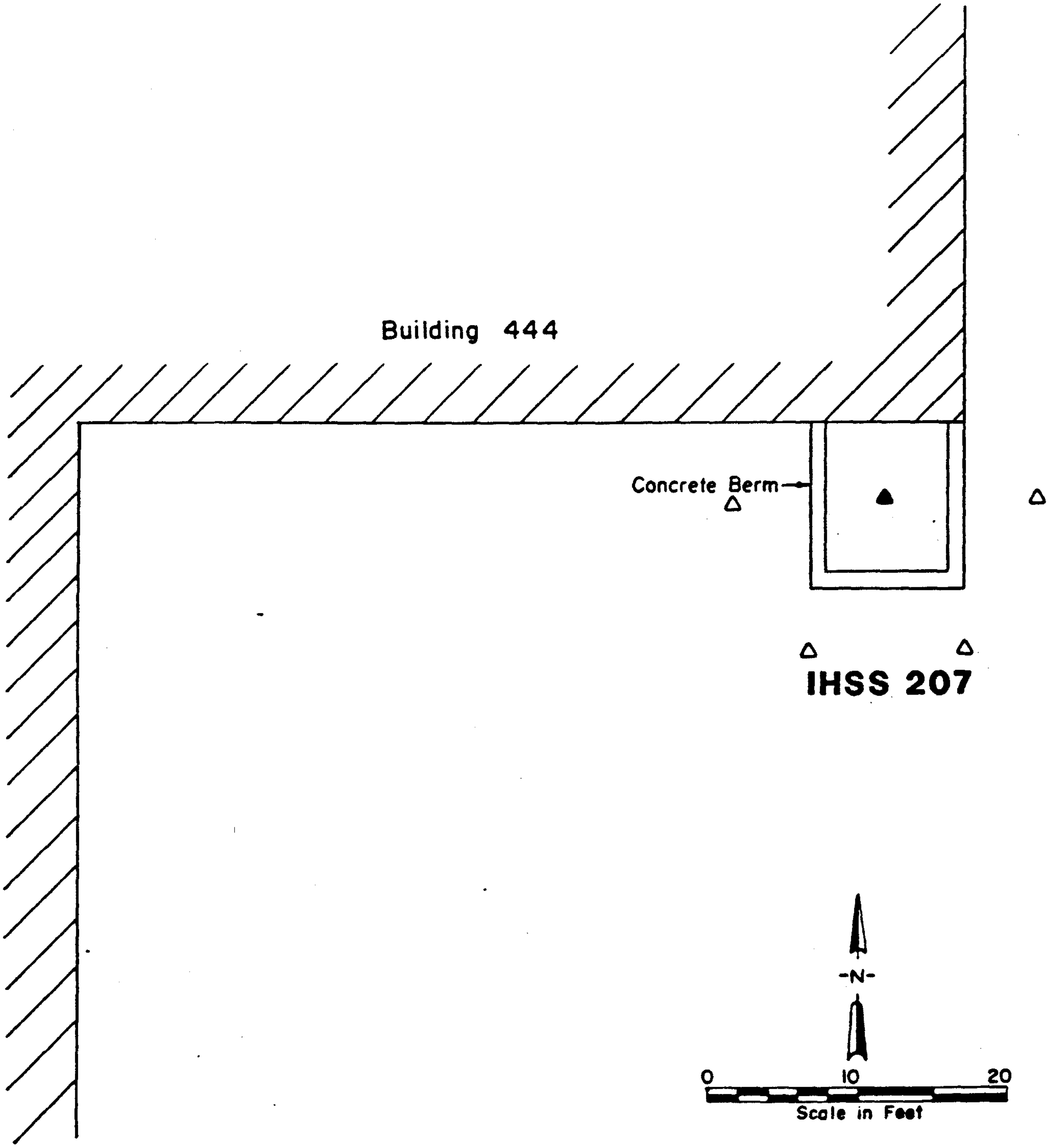
FIGURE 7.3-16
Proposed Sampling Locations for Inactive D-836 Hazardous Waste Tank (IHSS 206)



Legend

▲ Proposed HPGe and Sodium Iodide Probe Survey Locations

△ Proposed Sodium Iodide Probe Survey Locations (10ft. Grid)

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FIGURE 7.3-17
Proposed HPGe and Sodium Iodide Probe Survey Locations - Inactive Building 444 Acid Dumpsters (IHSS 207)

(Figure 7.3-18). The three samples are located in the center of the IHSS on the soil area. Surficial soil samples will be analyzed for pH, metals, and cyanide.

7.3.13 Unit 16 Building 980 Cargo Container (IHSS 210)

IHSS 210 has historical information indicating the potential presence of solvents, fuels/oils, and metals. There is an embankment to the south, but it should not pose a restriction to sampling. A soil gas survey will be used to determine the horizontal extent of potential contamination from spills or leaks from drums or containers stored at IHSS 210. The soil gas sampling survey will be conducted on an approximate 20-ft grid.

Six surficial soil samples are proposed along the perimeter of the maximum areal extent of the container area, two samples will be placed in the center of the IHSS, one on the north of the site, and one south of the site (Figure 7.3-19). Surficial soil samples will be analyzed for BNAs, PCBs, and metals.

7.3.14 Unit 15, 904 Pad Pondcrete Storage (IHSS 213)

IHSS 213 has historical information indicating the potential presence of anions and radionuclides on and below the pad and to the west of the pad where contaminated soil was previously buried. This site was previously uncovered but is currently paved with asphalt. There are overhead power lines at this IHSS that can be avoided during sampling. Spills involving poorly solidified pondcrete may involve VOCs and SVOCs. However, due to the small volume of liquid in these wastes, and the prompt cleanup by RFP employees, it is not expected that VOCs will be present in soils surrounding the pad. Therefore, a soil gas survey is not proposed for IHSS 213. Metals will most likely be concentrated within the ditches adjacent to the site. An HPGe survey will be conducted on a 150-ft spacing to define areas of potential radionuclide contamination.

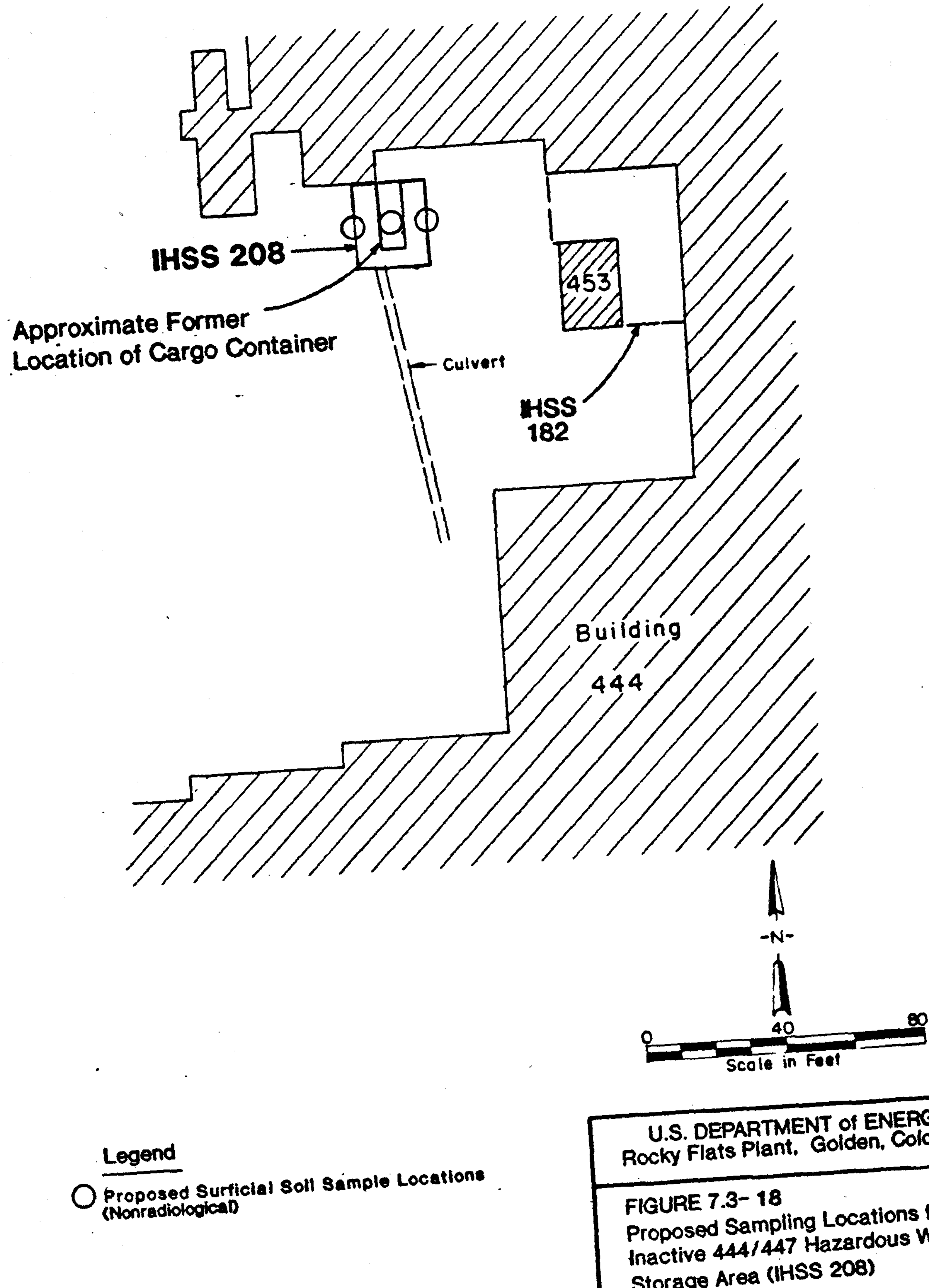

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FIGURE 7.3-18
Proposed Sampling Locations for Inactive 444/447 Hazardous Waste Storage Area (IHSS 208)

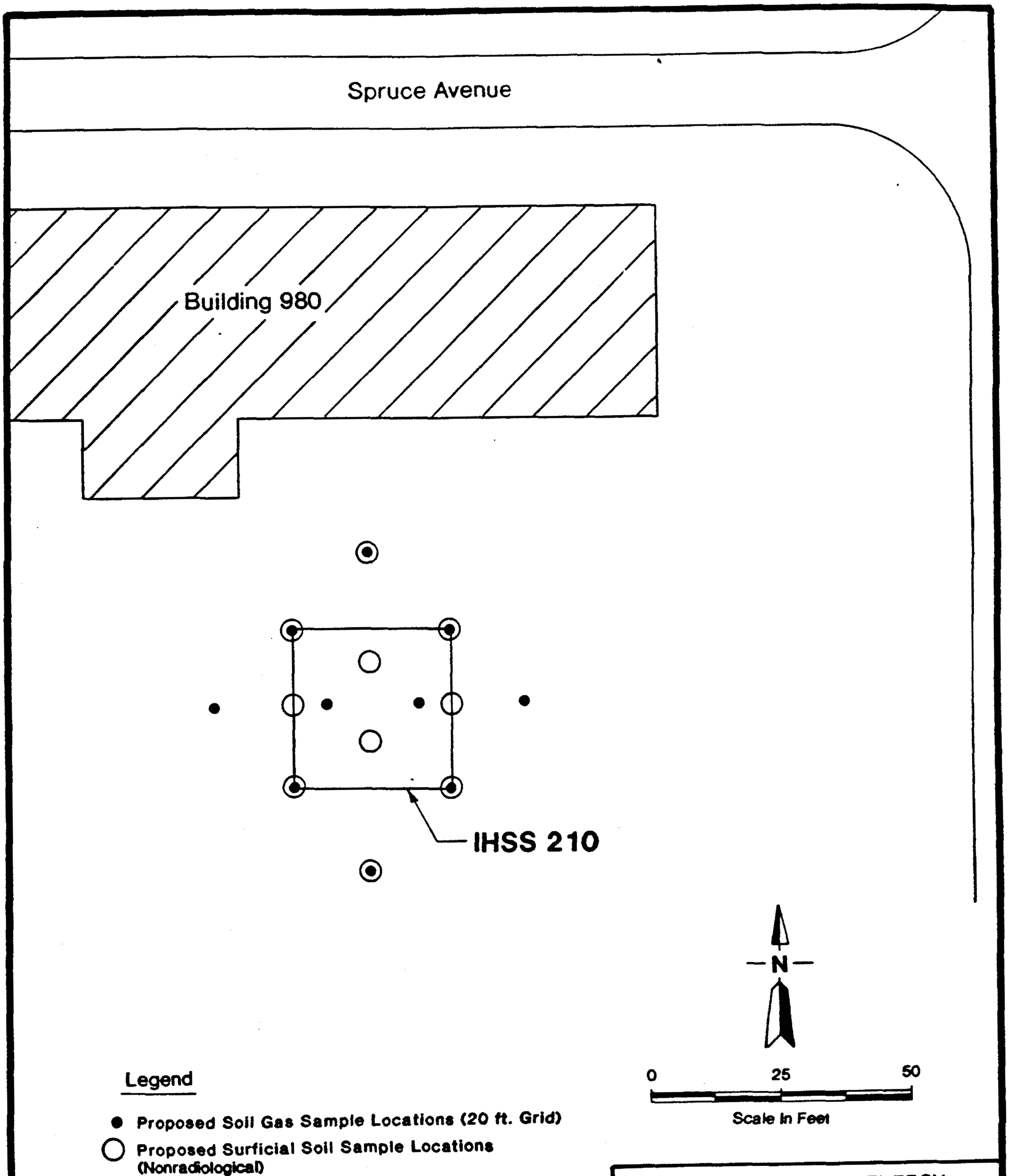

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FIGURE 7.3-19
Proposed Sampling Locations for Unit 16, Building 980 Cargo Container (IHSS 210)

Twenty-five surficial soil samples are proposed around the outside of the IHSS boundary (Figure 7.3-20). It is likely that contaminants washed off the pad will migrate to the drainage ditches. These samples will document potential dispersion of contaminants along the length of the ditch. Surficial soil samples will be analyzed for BNAs and metals. Borings will be drilled in Stage 2 to characterize and delineate contaminated soil that was removed and buried on the west side of the pad.

7.3.15 Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214)

IHSS 214 has historical information indicating the potential presence of anions and radionuclides. This site is covered by asphalt and there are overhead pipelines and power lines. The pipelines and power lines can be avoided during sampling. This site also has concrete drains associated with it. Because IHSS 214 is similar to IHSS 213, the sampling approach for IHSS 214 will generally follow that planned for IHSS 213 (Section 7.3.14). An HPGe survey will be conducted on a 150-ft grid prior to sampling. A soil gas survey will not be conducted because there is no historical evidence of storage of volatile substances.

As IHSS 214 has always been paved, 25 surficial soil samples are proposed outside of IHSS 214 (Figure 7.3-21). Surficial soil samples will be analyzed for BNAs and metals.

7.4 SAMPLING EQUIPMENT AND PROCEDURES

All field sampling and decontamination procedures will be in accordance with the most recent versions of the RFP EMD OPs (EG&G 1991a). (See Table 7-2 for procedures that will be used for each IHSS during Phase I.) The version used to prepare this plan is dated February 1991. Sections of the EMD OPs are referenced where appropriate in the following sections. The EMD

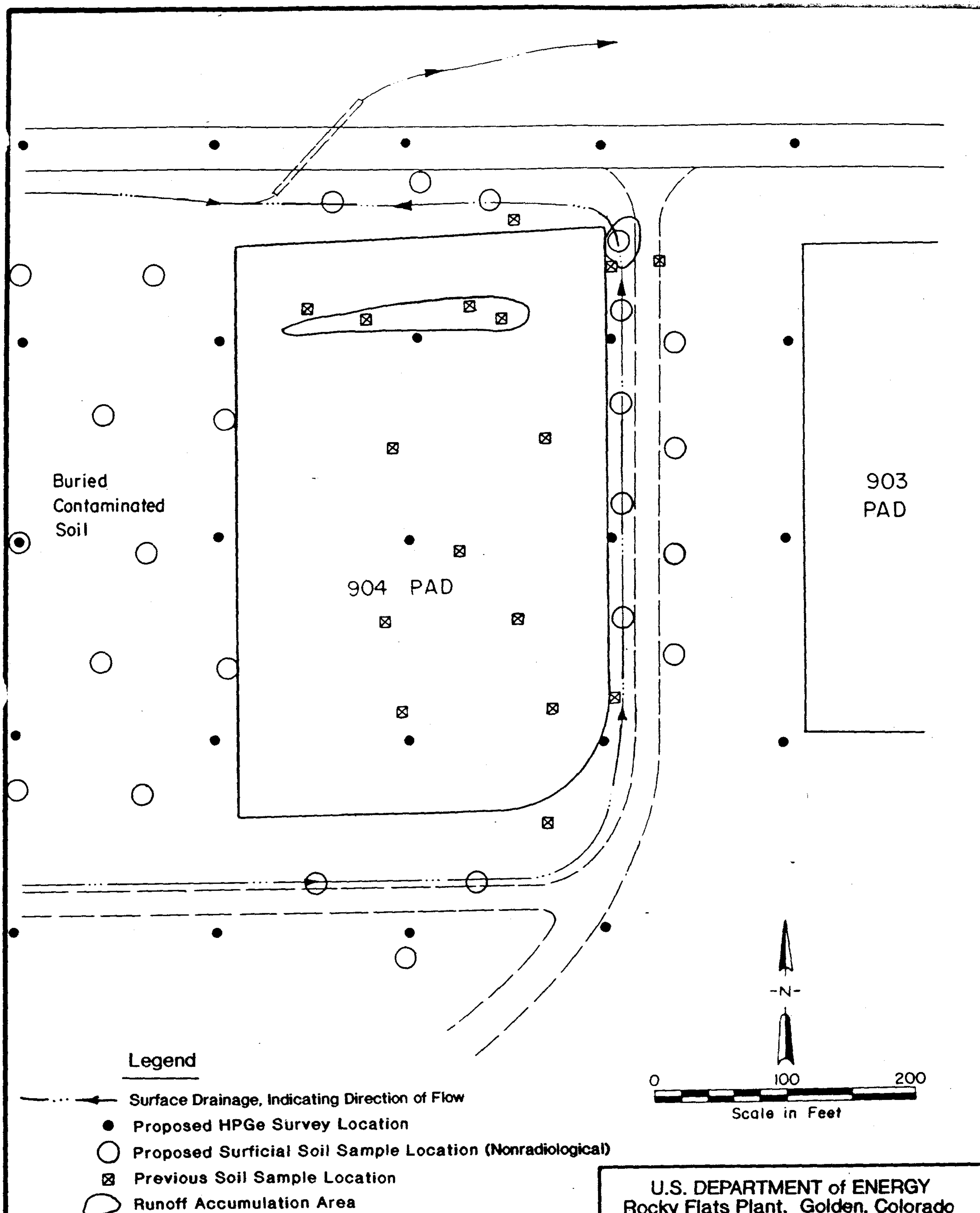

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FIGURE 7.3-20
Proposed Sampling Locations for
Unit 15, 904 Pad Pondcrete Storage
(IHSS 213)

OPs are supplemented by EPA procedures (EPA 1987) and American Society of Testing Materials (ASTM) standards (ASTM 1991).

7.4.1 Surficial Soil Sampling Procedure

Surficial soil samples will be collected during Phase I from exposed sites and from beneath asphalt or concrete and fill material. These samples will be collected for both radionuclide and nonradionuclide analysis. Given these conditions, separate surficial soil sampling procedures are required for: radionuclide composite sampling at exposed sites; nonradionuclide composite sampling at exposed sites; and radionuclide/nonradionuclide grab sampling from covered sites.

Surficial soil sampling at exposed sites for radiological analysis will be conducted in accordance with EMD OPs GT.8 using the CDH method. A sample to be analyzed for radionuclides will be collected using a CDH sampler.

Surficial soil sampling at exposed sites for nonradionuclides will follow procedures outlined in OU1 Technical Memorandum 5. An EMD OPs will be prepared for surficial sampling at exposed sites for both radionuclides and nonradionuclides prior to any OU10 Phase I field work.

At sites where pavement was placed after the area had been used for storage, a surficial soil grab sample will be taken for radionuclide and nonradionuclide analysis. The procedures for nonradiological surficial soil sampling below pavement will require a modification of EMD OPs GT.8 for nonradionculide surface soil sampling and procedures will also be developed for radiological sampling below pavement.

7.4.2 Radiation Survey Procedure

The radiation survey will be conducted using an HPGe gamma ray detector developed for high resolution spectroscopy. The HPGe has a broad energy range; exhibits high-resolution, excellent gain stability, moderate area averaging; and has the ability to identify and quantify all gamma ray emitting radionuclides. The EMD OP for the HPGe is presently under development and will be available prior to any OU10 Phase I field work. Other equipment requirements are listed in Section 5.2 of EMD OP FO.16.

Radiation surveys will be performed at many of the OU10 IHSSs (Section 7.3). At larger IHSSs, the radiation readings will be taken on a 150-ft grid to provide 100 percent coverage. A 75-ft grid or a single point will be surveyed at smaller IHSSs. Data will be collected according to the procedure described in EMD OP FO.16 and the applicable EMD OPs cross-referenced in Section 4.2 of this EMD OPs. Using the HPGe, the 150-ft spacing will provide full coverage of the site. At smaller IHSSs, only a single HPGe survey point may be required. Collimaters will be used to focus the readings on the smaller IHSSs. A collimator is a device for confining the elements of a beam within an assigned solid angle.

Where buildings or other obstructions create shadow zones and at all smaller IHSSs, a NaI probe will be used to supplement the HPGe data. The NaI scintillation detector is one of the best scintillators for detecting gamma photons. The detector consists of a single crystal of sodium iodide to which has been added a small amount of thallium. The advantages of sodium iodide detectors are: it is dense, therefore, the probability of interaction per centimeter is higher; it has a high light yield from deposited energy; and it has a high atomic number. The gamma interactions are more likely to result in photon absorption rather than photon scattering (Shapiro

1981). The EMD OP for the NaI scintillation detector is presently under development and will be available prior to any OU10 Phase I field work.

Surficial samples and depth profile samples will be collected at a subset of the HPGe survey locations, not necessarily at the grid nodes, to determine the vertical extent of radionuclide contamination. These samples will be collected at HPGe/NaI "hot spots" and in areas where radionuclides were not detected. This information is required in soil or gravel covered sites only to determine the vertical distribution of gamma emitting radionuclides contributing to the HPGe survey readings. Comparison of HPGe survey readings with surficial soil and depth profile samples will allow correlation of these remote and direct measurements. At selected soil covered survey points, surficial soil samples will be collected using the RFP method presently outlined in EMD OP GT.08. Subsurface soil samples will also be collected from selected locations at 0- to 2-, 2- to 4-, and 4- to 6-inch vertical depths to provide profile information and allow correlation of radionuclide depth distributions with HPGe measurements. These surficial and subsurface samples will be measured onsite for radionuclide concentration using a laboratory HPGe. The availability of a laboratory HPGe for OU10 field samples is currently uncertain. In the event a laboratory HPGe is not available by the time OU10 field work commences, samples will be sent to a radiochemistry laboratory for analysis.

All HPGe and NaI readings will be plotted and contoured on maps of the IHSSs. DOE will present the results of the surveys to EPA and CDH to determine where additional readings on a finer grid spacing are needed. If readings warrant additional measurements, a grid spacing of 75 ft will be used to further define the area of radioactive contamination. If readings above background are detected near the existing boundary of OU10 IHSSs, the grid will be expanded past the existing boundary. Both the initial HPGe survey and additional measurements on the finer grid and beyond IHSS boundaries will be completed in Stage 1. The Stage 1 HPGe results will be used to plan Stage 2 sampling of asphalt/concrete and soil for radionuclide analyses.

7.4.3 Soil Gas Sampling Procedure

Soil gas sampling will be conducted in accordance with EMD OP GT.09. All soil gas locations will be cleared for underground utilities prior to sample collection. Soil gas samples will be collected from 5 ft below the ground surface. If soil gas samples are to be collected beneath asphalt or concrete, an electrical rotary hammer will be used to reach the soil surface. Other related EMD OPs can be referenced in EMD OP GT.09, Section 4.2; and equipment requirements are listed in Section 5.3.1.1.

The soil gas samples will be analyzed using a portable gas chromatograph (GC). The GC will be calibrated prior to inital use in accordance with EMD OP GT.09A using standards prepared for the analytes listed in Table 7-5.

7.4.4 Pipeline Investigation

Pipeline investigation is part of the field operation referred to as "tank and ancillary equipment inspection" in Section 7.3. The sampling design and locations for pipeline investigation are discussed below. Pipeline inspection and sampling will be conducted using a three-stage approach. This section details activities to be conducted during each of the three stages of the pipeline investigations.

Tentative Stage 1 pipeline test pit locations will be at pipeline endpoints and known structural features. Information derived from additional data compilation activities, field observations, surface radiation surveys, and analytical results from previous investigation will dictate the specific sampling intervals required. The decision process for identification of sampling locations is discussed below.

7.4.4.1 Stage 1 Investigation

As discussed in Section 7.2, the investigation is designed to locate areas of contamination in OU10 vadose zone soils, based on conceptual model release scenarios (Section 2.2) and to provide an assessment of the nature of contamination at these locations. Pipelines will be investigated by excavating a series of test pits. These test pits will provide the following:

- Confirmation of pipeline location and configuration
- Visual inspection of pipeline integrity
- Samples of surface soils
- Samples of pipeline trench backfill
- Samples of native soils beneath the pipeline trench
- Samples of any residue in pipelines

The Stage 1 pipeline investigation will be conducted in accordance with all applicable EMD OPs. Activities will be governed by EMD OPs as follows:

- Any prework radiation survey of test pit locations will be conducted according to EMD OP FO.16
- Prior to excavation, test pit locations will be cleared according to EMD OP GT.10
- Surface soil samples will be collected according to the appropriate EMD OPs listed in Table 7-2
- Test pits will be excavated and sampled according to EMD OP GT.7
- Water encountered in test pits will be sampled in accordance with EMD OP SW.3

- Field parameters will be measured on test pit water samples in accordance with EMD OP SW.2

- Residue sampling in pipelines will be performed according to the EMD OPs revision presented in Section 11.0 of the Final Phase I RFI/RI Work Plan for Operable Unit 9

- Wastes generated during the excavation of test pits and pipeline opening and sampling will be handled in accordance with EMD OP FO.8

- Test pit locations will be surveyed to achieve final location and elevation accuracies of ±0.1 ft per EMD OP GT.17

Location of Test Pits

As discussed in the pipeline release conceptual model (Section 2.2), pipeline releases are most likely to occur at structural features in the pipeline. Structural features will be identified as primary test pit locations. Examples of structural features include the following:

- Valves, cleanouts, manholes, and other pipeline openings
- Elbows, tees, and reducers
- Pipe/tank connections
- Transitions in pipeline materials

As described in Section 7.3, test pit construction will be performed at documented fittings, elbows, and valves. However, certain conditions may exist which mandate closer test pit spacing. Test pit spacing will be reduced under the following conditions:

- Poor pipeline integrity is observed in a test pit

- Poor pipeline integrity is observed in pipeline video inspection (see discussion below under Pipeline Video Inspection)

- Pipeline pressure testing results indicate pipeline leakage (see discussion below under Pipeline Pressure Testing)

The rationale for the reduction in test pit spacing is to double the sampling density in areas of uncertain conditions. This will increase the probability of identifying areas of contamination along the pipelines.

Surface Soil Sampling

A surface soil sample will be collected from each test pit location prior to excavation of the test pit. The sample location will be as close as possible to the center of the area to be excavated. Surface soil samples for radionuclide analysis will be collected in accordance with the grab sample method described in OP GT.8 using the CDH method, and GT.17. For nonradiological analysis, surficial soil will be collected from a 6-inch square area sampled to a depth of 6 inches (i.e., a sample of dimensions 6 by 6 by 6 inches) according to the method outlined in OU1 Technical Memorandum 5. Overlying pavement or other surface cover will be removed if necessary. This will provide sufficient sample volume to perform the analyses specified in Section 7.5. The SOPs for this type of surficial soil sampling will be approved by EPA and CDH before implementation.

Test Pit Excavation Procedures

Test pits will be excavated in accordance with the applicable provisions of EMD OP GT.7. Test pit excavation will commence after collection of a surface soil sample at the test pit location, and after removal of any pavement or other surface cover as necessary. Pipelines must be exposed in their *in situ* condition so that unbiased assessment of pipeline integrity can be made. Test pit construction will, therefore, be performed in a manner that does not damage the *in situ* conditions of the pipelines. Mechanized digging equipment (e.g., backhoes) will be used to remove only the bulk of material covering the pipeline. Periodic manual probing may be necessary to measure the depth of the remaining cover. Once a depth of cover less than 1 ft remains, test pit excavation will be completed with shovels. Information gathered to complete excavation permitting procedures, described in EMD OP GT.10, will help in planning the excavation by identifying potential interferences (e.g., nearby underground utilities).

Test Pit Logging and Sampling

Test pit logging and sampling will be conducted in accordance with EMD OP GT.7, Logging and Sampling of Test Pits and Trenches. At each test pit, the condition of the exposed pipe material will be described and documented. Evidence of pipeline degradation (e.g., excessive corrosion, holes, cracks) will be described in detail. The pipeline and test pit will be photographed and sketched in accordance with EMD OP GT.7. The location and invert elevation of the pipe will be surveyed. Soil exposed in the excavations will be described for visible contamination, extent of trench backfill, and the type of backfill material.

Discrete soil samples will be collected at each of the following locations:

- In trench backfill directly beneath the pipeline
- In native soil directly below trench

After collection of soil samples, one sample of pipeline residue will be collected at every test pit where feasible to characterize wastes. In instances where no residue is present, one wipe sample may be taken on the interior surface of pipeline components if radioactive contamination is suspected. Wipe samples will be collected and tested according to EMD OP FO.16. This will provide a qualitative measure of radionuclide contamination. In addition, inside surface radiological dose rate measurements will be obtained by inserting a low-energy gamma probe radiation detector into the pipeline. These measurements will be useful in verifying process piping historical data and allow for future disposal criteria. Valves, cleanouts, and other pipeline openings will be the preferred locations for collection of residue samples. Where other access is unavailable, the pipe will either be cut open or dismantled at test pit exposure. Pipe sections which are dismantled will be reassembled, if possible. Pipe sections that are cut or that cannot be reassembled will be grouted closed with a plug of nonshrinking cement.

If groundwater is encountered in a test pit, a groundwater grab sample will be collected in accordance with EMD OP SW.3 and submitted for analysis. As discussed in Section 7.5, field parameters will be measured on the groundwater sample. No attempt will be made to open pipelines and collect residue samples. The trench backfill directly below the pipeline will be sampled if possible, but the native soil directly beneath the trench will not be sampled. The depth at which groundwater is encountered will be recorded.

Pipeline Location and Tracing

In general, it is expected that pipeline structural features will allow pipeline alignments to be traced sufficiently to locate test pits along the alignment. Where structural features are absent or widely spaced, however, pipeline location devices may be utilized to trace the pipelines. The method used will depend upon the pipe construction material. Conductive pipes can be readily located by attaching a transmitter to the outer surface of the pipe. This produces a signal along the buried pipeline that can be traced by a detector at the surface. For nonconductive pipes, a flexible steel tape or similar conductive material must be inserted into an opening in the pipe and fed down the pipeline to carry the signal. Alternatively, a transmitting sound can be inserted and moved down the pipeline with push rods or a steel tape. Pipeline video inspection (see discussion below) can also be utilized to trace pipeline alignments by providing azimuth and range data. Ground-penetrating radar (GPR) may provide another method of tracing pipelines, although its efficacy may be limited by the clayey, cobble-rich soil of the site and by congestion of pipelines and utility lines at many locations.

Pipeline location and tracing methods will be field-tested if it appears that pipeline tracing will be necessary to the Stage 1 pipeline investigation. Specific procedures for performing pipeline location and tracing will be provided by the contractor(s) selected to provide the service. These procedures will be modified as necessary to support the objectives of the OU10 RFI/RI and conform with project-specific health and safety or environmental protection requirements.

Pipeline Pressure Testing

In order to more fully evaluate the current status of the pipeline system, pressure testing will be performed where possible on pipeline segments between available access points (test pits, valves, etc.). Pressure testing will not be performed where potential access points are below the water table.

Pipeline pressure testing may aid in detecting release locations in unexcavated portions of pipelines, and in confirming the integrity of pipelines that appear sound in test pits. Where successfully performed, the testing will provide an additional measure of assurance that sections of pipeline which are not visually inspected have been evaluated. Pressure testing results together with historical data may provide sufficient justification to remove a particular pipeline section from further investigation and, more importantly, from having to be addressed by a final remedial action for OU10.

It should be noted that contamination may exist at locations where pipeline leaks were excavated and repaired. Contamination may also exist at locations where a replacement pipeline was installed in the same alignment where an older, leaking pipeline was removed. Pipelines that currently test "tight" may have ben repaired, or may be a replacement line for an older pipeline which leaked. Historical data may help identify locations of pipeline repair and replacement. However, it is expected that maintenance and construction records for the pipelines will be incomplete.

Techniques using tracer gas (typically helium) or sensors to detect air motion around leaks can be employed during pressure testing to identify specific leak locations along pipelines.

Pipeline Video Inspection

Video inspection of pipeline interior may be beneficial in evaluating the integrity of the pipeline and in tracing pipeline alignments. In particular, video inspection may aid in evaluating leaks detected through pipeline pressure testing, and aid in evaluating pipelines that are not conducive to pressure testing (e.g., vitrified clay pipelines). Video inspection can be performed on pipelines as small as 3 inches in diameter.

The potential applicability and benefits of pipeline video inspection depend upon the same factors that are identified above for pipeline pressure testing. Pipeline video inspection may be field-tested in order to evaluate its feasibility and potential benefits to the Stage 1 pipeline investigation. As with pipeline pressure testing, specific procedures for conducting video inspections will be provided by the contractor(s) selected to provide the service. These procedures will be modified as necessary to support the objectives of the OU10 RFI/RI and conform with project-specific health and safety or environmental protection requirements.

7.4.4.2 Stage 2 Investigation

As discussed in Section 7.3, the Stage 2 pipeline investigation will target contaminated sites identified during the Stage 1 investigation. The Stage 2 investigation is designed to provide a reasonable preliminary assessment of the extent of vadose zone soils contamination along pipeline alignments. The initial spread of contamination from pipeline releases is expected to be preferentially aligned along the pipeline. It is also expected that contaminant movement into native soils surrounding the pipeline trench will occur primarily from the bottom of the trench. Therefore, Stage 2 soil borings will be drilled along the pipeline alignments and will sample both trench fill material and native soil underlying the trench. The spacing of borings along the alignment is meant to help differentiate aerially restricted, lower-volume releases from potentially more significant higher-volume releases. The following discussion outlines the methods and procedures which will be employed during Stage 2.

Test pits (and borings for removed pipeline) identified as contaminated by Stage 1 analytical results will be sampled by soil borings drilled in a nominal pattern around the test pits as described in Technical Memorandum 1. When a contaminated test pit is detected, additional soil borings will be drilled along the alignment in both directions from the contaminated pit. Where drilling rig access is restricted, the borings will be drilled as closely as possible to this nominal pattern. It may be possible in such instances to drill the borings with a hand auger, depending upon the depth required. Similarly, obstructions along the pipeline alignment (e.g., a building or security fence) may require modification of the nominal spacing.

Surface soil samples will be collected using the grab method described in EMD OP GT.8, Surface Soil Sampling. Each surface soil sample will consist of a 6-inch-square area sampled to a depth of 6 inches. Soil borings will be drilled and sampled in accordance with EMD OP

GT.2 using the continuous core auger method. A 3-inch inside diameter sample barrel will be used to collect 2-ft-long soil samples from the borings. A sample volume of 2,250 cubic centimeters (approximately 140 cubic inches) will be required to perform the analyses specified in Section 7.5.

Recent water level monitoring data, combined with information from alluvial isopach maps, will be used to predict depths to the water table and to bedrock at the various sampling locations. If the depth between the trench bottom and the water table or bedrock is less than 5 ft, the mid-depth soil sample will be omitted.

The Stage 2 pipeline investigation will be conducted in accordance with all applicable EMD OPs. Activities will be governed by OPs as follows:

- Prework radiation surveys of soil boring locations will be conducted according to EMD OP FO.16.
- Prior to drilling, soil boring locations will be cleared according to EMD OP GT.10
- Soil borings will be drilled and sampled by continuous core auger methods according to EMD OP GT.2
- Soil boring samples will be logged according to EMD OP GT.1
- Cuttings and fluid generated during drilling will be handled in accordance with EMD OP FO.8
- Soil borings will be plugged and abandoned per EMD OP GT.5
- Soil boring locations will be surveyed to achieve final location and elevation accuracies of ±0.1 ft per EMD OP GT.17

7.4.4.3 Stage 3 Investigation

The Stage 3 pipeline investigation may identify areas that warrant further characterization of vadose zone soils contamination. In particular, Stage 3 may indicate areas where contamination affects a significant length of pipeline alignment, suggesting a relatively large release from the pipeline. Following the completion of the Stage 3 pipeline investigation, the results of Stage 1 will be summarized in a technical memorandum, and the need for additional investigation will be resolved on a site-by-site basis for each contaminated area. Where additional investigation is determined to be appropriate, a Stage 3 pipeline investigation will be performed.

The Stage 3 investigation will utilize additional soil borings drilled along the pipeline alignment as necessary to fully determine the extent of contamination in vadose zone soils along the alignment, and in native soil adjacent to the alignment to evaluate any spread of contamination laterally from the pipeline trench into vadose zone soils.

Proposed Stage 3 boring locations will be documented through Technical Memorandum 2 which will be approved prior to implementation.

The Stage 3 pipeline investigation is designed to fully assess the lateral and vertical extent of contamination in vadose zone soils affected by pipeline releases. It is reasonable to expect that Stage 3 will be implemented in stages in order to meet this objective, with borings located increasingly distant from the contaminant source until the lateral extent of vadose zone soils contamination is delineated. The extent of contamination will be determined through comparison of analytical results to background values provided in the Final Background Geochemical Characterization Report (EG&G 1991b) or to the most current background data available at the time the FSP is implemented, and to potential ARARs.

7.4.5 Tank Investigation

The sampling design and locations for the tank investigation are discussed below. This section details the activities to be conducted during the Stage 1 and Stage 2 tank investigations.

Tank locations targeted for investigation under the OU10 Phase I RFI/RI are identified in Figure 7.3-1, and 7.3-15. Only tank locations identified in the Closure Plan are included. The decision process used to identify tank investigation activities and sampling locations is discussed below.

7.4.5.1 Stage 1 Investigation

As discussed in Section 7.2, the Stage 1 tank investigation is designed to locate areas of contamination in OU10 vadose zone soils, based on conceptual model release scenarios (Section 2.2) and to provide an assessment of the nature of contamination at these locations. The following discussion outlines the methods and procedures that will be employed in the Stage 1 tank investigation.

The Stage 1 tank investigation will consist of visual inspections, pressure testing, and residue sampling.

Tanks that are part of active waste management units will not be investigated. Residue samples will not be collected from tanks that have been cleaned and painted since being removed from service.

Stage 1 tank investigation activities will be conducted in accordance with all applicable EMD OPs. Activities will be governed by the EMD OPs as follows:

- Tank residue sampling will be performed according to the EMD OP revision presented in Section 11.0 of the Final Phase I RFI/RI Work Plan for Operable Unit 9
- Prework radiation survey of soil boring locations will be conducted according to EMD OP FO.16
- Prior to drilling, soil boring locations will be cleared according to EMD OP GT.10
- Surficial soil samples for radionuclide analysis will be collected according to the EMD OPs listed in Table 7-2
- Soil borings will be drilled and sampled by continuous core auger methods according to EMD OP GT.2
- Soil boring locations will be surveyed to achieve final location and elevation accuracies of ±0.1 ft per EMD OP GT.17

Tank Inspections

Tanks will be inspected to visually assess tank integrity. Both the interior and exterior of above-grade and on-grade tanks will be inspected. Detailed tank inspection work instructions and a form to document the inspection will be developed by the contractor that implements the OU10 Phase I RFI/RI. Observations of poor tank integrity (e.g., excessive corrosion, holes, and cracks, and visual indication of contamination) will be documented and used to focus subsequent soil sampling efforts. Where possible, tank inspection will be conducted remotely to mitigate the need for entry into confined spaces. Access permits may be required to inspect some tank locations. Tank inspection will include pressurization, where possible, to verify visual observations.

Residue Sampling

One residue sample will be collected from each tank that has not been cleaned since removal from process waste service to help characterize wastes. In instances where no residue is present, one wipe sample will be taken on the interior surfaces of the tank (preferably at the base of the tank or near pipeline connections). Wipe samples will be collected and tested according to EMD OP FO.16. This will provide a qualitative measure of radionuclide contamination. Where possible, residue or wipe samples will be collected remotely, to mitigate the need for entry into confines spaces. In addition, inside surface radiological dose rate measurements will be obtained by inserting a low-energy gamma probe radiation detector into the tank. These measurements will be useful in verifying tank historical data and allow for future disposal criteria.

7.4.5.2 Stage 2 Investigation

Soil Boring Locations

Soil borings will be drilled and sampled during the Stage 2 tank investigation to identify areas of contamination immediately adjacent to the tank location. As discussed in the conceptual model release scenario (Section 2.2), contamination is most likely to exist at the following locations around tanks:

- Beneath or near external connections and openings
- Near joints or corners around underground tanks
- Beneath the base of the tank

Areas beneath or near external connections and openings, and near joints or corners around underground tanks, will be targeted as primary soil boring locations. "Hot spots" identified through the surface radiation or soil gas surveys will also be targeted as primarily test pit locations. Soil borings will not be drilled for tanks inside or beneath production buildings that are not accessible from outside the building, as this would disrupt building operations.

Because tank locations vary widely in size and configuration, a nominal pattern for soil borings is not appropriate. As a general rule, it is proposed that one soil boring be drilled on each accessible side of the tank location. If field observations suggest that more or fewer soil borings are needed to adequately characterize the soils immediately surrounding a tank location (i.e., for very large or very small tank locations), proposed soil boring locations for the particular site will be documented in technical memoranda and approved prior to implementation. In all cases, soil borings will be drilled as close as possible to the tank structure.

Sampling of Soil Borings

Nominal soil boring sampling locations for the Stage 2 tank investigation will be addressed in Technical Memorandum 1. One discrete soil sample will be collected at each of the following locations:

- Ground surface (prior to drilling)
- One to 3 ft below the base of below-grade tanks unless base of tank is in bedrock; for above-grade or on-grade tanks, mid-depth between the ground surface and the water table or alluvium/bedrock interface, whichever is encountered first
- Directly above the water table or bedrock/alluvium interface, whichever is encountered first

Regardless of whether the water table is encountered during drilling, a soil sample will be collected if possible from the interval 1 to 3 ft below the base of underground tanks. If the base of the tank extends into bedrock, however, a sample will be collected from the alluvium/bedrock interface and drilling will discontinue.

Surface soil samples will be collected using the grab method described in EMD OP GT.08. Each surface soil sample will consist of a 6-inch-square area sampled to a depth of 6 inches. Soil borings will be drilled and sampled in accordance with EMD OP GT.02 using the continuous core auger method. A 3-inch inside diameter sample barrel will be used to collect 2-ft-long soil samples from the borings. A sample volume of 2,250 cubic centimeters (approximately 140 cubic inches) will be required to perform the analyses specified in Section 7.5.

Recent water level monitoring data, combined with information from alluvial isopach maps, will be used to predict depths to the water table and to bedrock at the various tank locations. If the depth between the ground surface and the water table or bedrock is less than 5 ft at above-grade or on-grade tank locations, the mid-depth soil sample will be omitted.

7.4.5.3 Stage 3 Investigation

The Stage 3 tank investigation is designed to determine the horizontal and vertical extent of contamination in vadose zone soils surrounding tank locations identified as contaminated during the Stage 2 tank investigation. These tank locations will be further investigated by drilling and sampling additional soil borings.

As with Stage 2 soil boring locations, the unique configuration of each tank location makes it impractical to establish a nominal sampling pattern for Stage 3 activities. As such, Stage 3 soil boring locations and subsurface sampling frequency will be developed on a case-by-case basis. The proposed Stage 3 investigation for each tank location will be documented in Technical Memorandum 2 which will be approved prior to implementation.

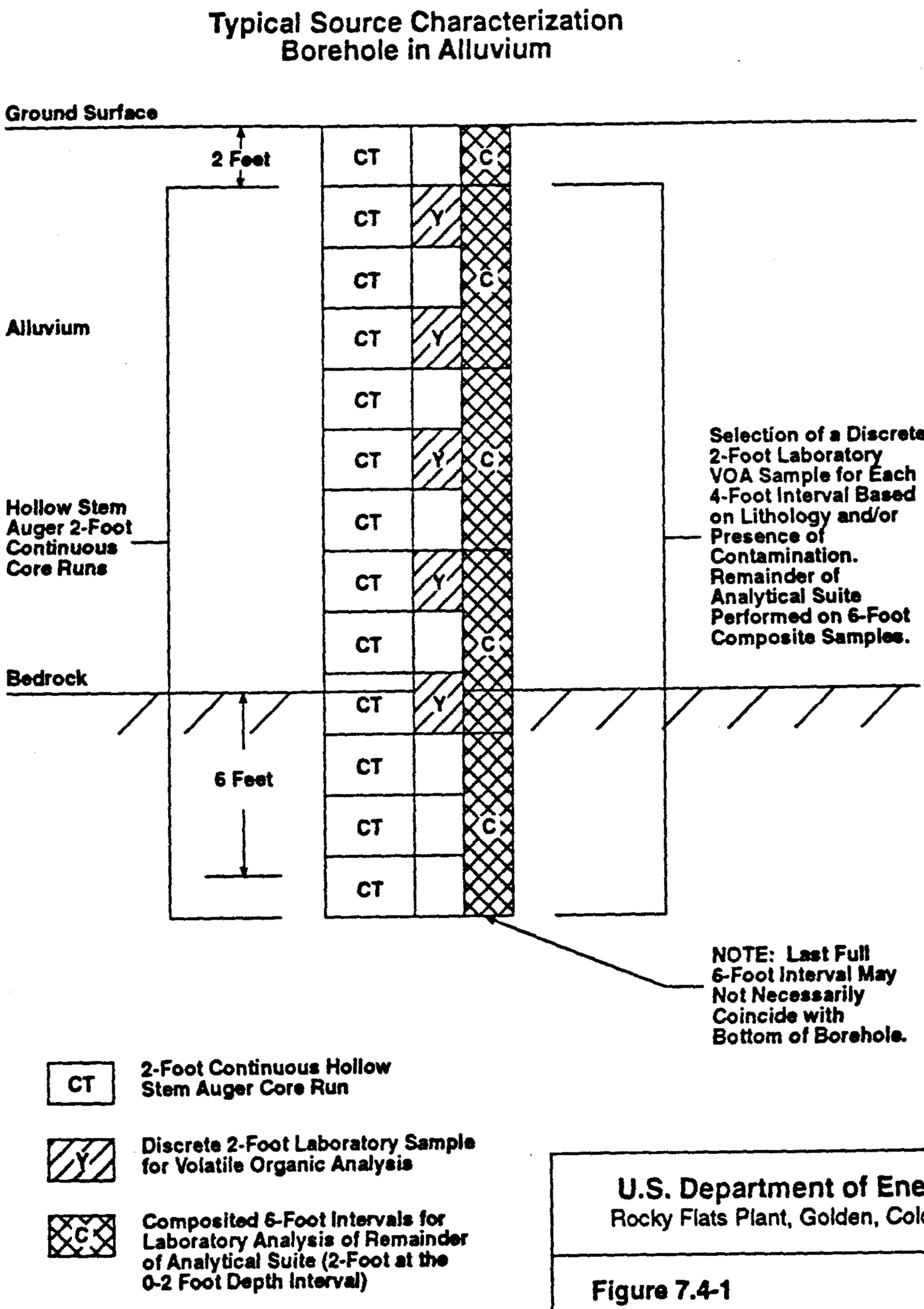
The Stage 3 tank investigation is designed to fully assess the lateral and vertical extent of contamination in vadose zone soils affected by tank releases. It is reasonable to expect that Stage 3 will be implemented in tiers in order to meet this objective, with borings located at increasing distance from the contaminant source until the lateral extent of vadose soils contamination is delineated. The extent of contamination will be determined through comparison of analytical results to values provided in the Final Background Geochemical Characterization Report (EG&G 1991b), or to the most current background data available at the time the FSP is implemented, and to values specified in potential ARARs.

7.4.6 Borehole Drilling, Asphalt Sampling, Concrete Sampling, and Soil Sampling Procedures

Borings will be drilled to determine the geotechnical characteristics of the soil, collect samples for physical and chemical analysis, and install piezometers to determine the elevation of the water table. Before any boreholes are drilled, the location will be cleared in accordance with EMD OP GT.10.

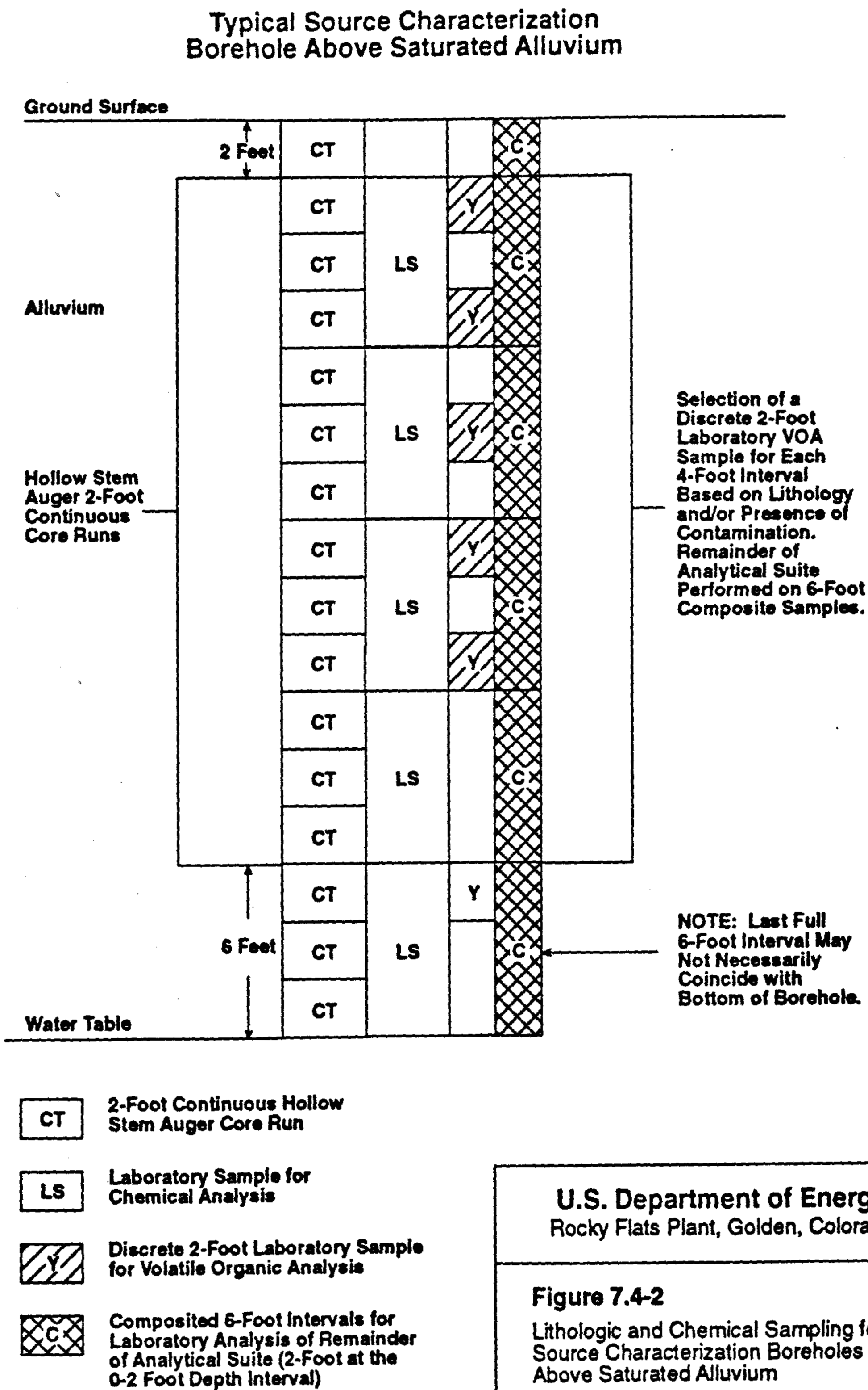
Drilling will be in accordance with EMD OP GT.02 except where material is impenetrable to this method. In the case where auguring is ineffective, rotary drilling will be used in accordance with EMD OP GT.04. Rotary drilling will be used in situations where material is impenetrable, otherwise hollow-stem auguring will be the method of choice. The bedrock borings must be completed in accordance with EMD OP GT.03. At locations with shallow borings where the drill rig cannot enter, hand augers will be used in accordance with guidelines in EMD OPs GT.02 and .08.

All boreholes will be drilled to groundwater or a depth penetrating bedrock by 6 ft (Figures 7.4-1 and 7.4-2).



U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Figure 7.4-1
Lithologic and Chemical Sampling
for Source Characterization
Boreholes in Alluvium



U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Figure 7.4-2

Lithologic and Chemical Sampling for Source Characterization Boreholes Above Saturated Alluvium

All drill cuttings and soil samples will be monitored for radionuclides and organic vapors in accordance with EMD OP FO.15 and EMD OP FO.06. These procedures are described in the Health and Safety Plan. Investigation-derived wastes, such as drill cuttings and residual samples, will be handled according to guidelines in EMD OPs FO.08 and .09.

Before and after drilling and sampling takes place all equipment must be decontaminated in accordance with the procedures outlined in the EMD OPs FO.03 and .04. Decontamination water will be handled according to guidelines in EMD OP FO.07.

All of the borings not completed as piezometers will be grouted and abandoned immediately after drilling in accordance with procedures outlined in EMD OP GT.05. Procedures specified in this EMD OPs are designed to prevent vertical migration of contaminants after abandonment.

Equipment requirements are listed in EMD OP GT.02, Section 5.1; other applicable EMD OPs are listed in Section 4.2 of this EMD OPs.

Soil and bedrock samples will be collected during drilling for visual logging in accordance with EMD OP GT.01 and for chemical and physical analysis in accordance with EMD OPs GT.02 and FO.13. The soil and bedrock samples will be collected using a hollow-stem auger with a continuous core sampler. Continuous core will be collected for geologic descriptions for the entire borehole depth. From this core, discrete samples will be submitted for laboratory VOC analysis beginning 2 ft from the ground surface and continuing every 4 ft to the water table. In addition, a discrete VOC sample will be submitted to the laboratory if staining, discoloration, odor, or other anomaly is observed during drilling. VOC soil samples will be collected in ring samplers that are capped and sealed upon recovery. In addition to the VOC samples, linear composite samples from the core will be submitted to the laboratory for analysis of the remaining chemical parameters from every consecutive 6-ft interval to the water table.

Soil samples for geotechnical analysis require a minimum amount of disturbance and will be collected in thin-walled metal tubes. The thin-walled metal tube will be driven into the undisturbed soils in advance of the hollow-stem auger, removed, and the tube sealed for transport to the laboratory. An EMD Standard Operating Procedure Addendum (SOPA) for this procedure is currently under review. The EMD SOPA was prepared for the Geological Characterization Program.

Soil samples from the vadose zone will be collected for leachability studies during Phase I if radionuclide or nonradionuclide contamination is detected at levels exceeding regulatory thresholds. The soil samples will be collected in accordance with EMD OPs GT.02 and FO.13. The soil samples will be collected using a hollow-stem auger with a continuous core sampler. A sufficient volume of soil will be collected to split into two fractions; one for sieve analysis to determine if the soil requires particle-size reduction (a minimum of 100 grams), and a second for extraction of semivolatiles, metals, and radionuclides (a minimum of 100 grams). The samples can be collected in glass sampling containers. Preservatives will not be added to the samples. The extractable portion of the sample will be cooled and stored at 4°C to minimize loss of semivolatile organics and to retard biological activity. The sampling intervals and depths will be determined after the nature and extent of nonradionuclide vadose zone contamination has been determined.

Asphalt and concrete samples will also be collected at some IHSSs. These will consist of two small diameter (approximately 1 inch) core plugs. The core plugs will be collected using a core drill prior to the drilling of the borehole. The samples will be handled in accordance with EMD OP FO.13. After the asphalt or concrete sample is collected, a rotary hammer will be used to reach the soil surface for sampling.

7.4.7 Sediment Sampling Procedure

Sediment samples will be collected from locations identified in Section 7.3. At each of these locations, a core sampler with a core liner will be used to collect the top 2 inches of bed materials for VOC analysis. Samples for nonvolatile analysis will be collected with a stainless steel scoop. Sampling procedures will follow those outlined in EMD OP SW.6. Sediment materials will be described according to EMD OP GT.01.

7.4.8 Surface Water Sampling Procedure

If surface water is present, surface water samples will be collected at the same time that the sediment samples are collected. Field parameters will be measured following procedures outlined in EMD OP SW.2. Samples will be collected according to procedures specified in EMD OP SW.3.

7.4.9 Installing Piezometers

All piezometers will be constructed through the entire alluvial thickness with new, flush threaded polyvinyl chloride (PVC) (EMD OP GW.6). An auger with an I.D. a minimum 4 inches larger than the outer diameter of the well casing will be used to drill the piezometer boreholes to produce a minimum annular space of 2 inches. Well construction techniques will follow procedures outlined in EMD OP GT.06. Investigation-derived wastes such as drilling fluids, cuttings, and residual samples will be handled in accordance with guidelines outlined in EMD OP FO.08.

Construction techniques for all piezometers will follow procedures contained in EMD OP GT.06. Piezometer casings will be protected by the placement of steel posts around the piezometer, as described in EMD OP GT.06. Pressure grouting procedures will follow guidelines outlined in EMD OP GT.03. Additional equipment and materials that may be needed for piezometer installation are listed in EMD OP GT.06, Section 5.1; other related EMD OPs are cross-referenced in Section 4.2 of this EMD OPs.

The piezometers will be developed no sooner than 48 hours and no longer than two weeks after completion. Water levels will be measured in all piezometers and recorded as outlined in EMD OP GW.1 and the appropriately cross-referenced EMD OPs listed in Section 4.2 of the EMD OPs. After the water levels reach static conditions, the piezometers will be developed utilizing low-energy methods, such as an inertial pump or bottom discharging bailer. Development will follow procedures outlined in EMD OP GW.2.

All development and purge water will be handled in accordance with guidelines outlined in EMD OP FO.08.

7.4.10 Surveying of Sample Locations

The locations of all borings and surface sampling points will be paced and/or taped off prior to sampling or drilling. After sampling, drilling, or well installation, locations will be surveyed using standard land surveying techniques described in the EMD OP GT.17. Horizontal accuracy will be ±0.5 ft for borings and ±0.1 ft for wells. Vertical accuracy will be ±0.1 ft for borings and ±0.01 ft for wells. Three elevations will be determined for each well: ground surface, top of well casing, and top of surface casing.

7.4.11 Tensiometer or Equivalent Installation and Monitoring Procedures

Tensiometers equipped with pressure transducers or equivalent devices will be installed to measure matric potential of water in the vadose zone. The tensiometers will consist of a porous ceramic cup attached to a rigid plastic tube. The internal volume of the system will be completely filled with water. The pores in the cup form a continuum with the pores in the soil. Water will move either into or out of the tensiometer system, until equilibrium is attained across the ceramic cup. Multiple tensiometers allow for the determination of the direction and in some cases, the quantity of water flux from the ground surface to the water table.

Tensiometer arrays may be installed at several IHSSs during Stage 4. Each array will consist of multiple tensiometers buried at 2-ft intervals from 1 ft above the water table to within 2 ft of the ground surface. To minimize the soil disturbance the tensiometers will be installed by pushing them through the bottom of boreholes drilled with small diameter solid-stem augers. The boreholes will be backfilled with natural occurring soils to a compaction slightly greater than the bulk density of the undisturbed soils to reduce surface water infiltration, which results in abnormally low tensions in the backfill and the undisturbed soil.

Water used in the tensiometers must be deaerated and on-site purging may be necessary to prevent the formation of bubbles that can prevent accurate data collection. Purging time will be kept short to minimize wetting of soil adjacent to the porous tensiometer cup. When purging is complete, the system is closed and the soil draws water through the porous cup until equilibrium is established and the pressure is recorded by the pressure transducer and data logger.

The tensiometers will be monitored for at least one annual cycle. The EMD OPs for the installation and monitoring of tensiometers is presently under development and will be available after review and approval by EPA and CDH prior to any OU10 Phase I field work.

7.4.12 BAT® or Equivalent Groundwater Sampling System

The BAT® Groundwater Sampling System will be used to collect grab groundwater samples from the top of the water table. The BAT® sampler consists of a filter tip connected to a hollow extender pipe. Inside the pipe, the filter tip is sealed from the rest of the pipe by a septum. A housing is lowered and raised in the extender pipe by wireline. The housing contains an evacuated vial in its upper end and a spring-loaded, double-ended needle on the lower end.

A sample is collected with the BAT® when the housing is lowered to the filter tip. The spring-loaded, double-ended needle assemblage contracts and the needles pierce the filter tip septum and the septum on the vial. The vial then fills with water. When the vial is filled, it is retrieved with the wireline.

The BAT® sampler can be used with a hollow-stem auger. A borehole is drilled to within 1 to 2 ft of the water table and the BAT® is driven through the end of the auger into the water table. The BAT® sampling will be conducted at locations determined by HNu and OUA screening, outside the IHSS boundaries, downgradient from areas identified as contaminated during the surficial soil sampling.

An EMD OPs will be prepared for the BAT® sampling prior to the start of the OU10 field program. It will be used only after approval by EPA and CDH.

7.5 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected during the Phase I RFI/RI investigation. It also includes discussions of sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation.

7.5.1 Sample Designation

All sample designations generated for the Phase I RFI/RI will conform to the input requirements of the Rocky Flats Environmental Data System (RFEDS). Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sample (e.g., "SB" for soil borings, "SS" for surface soils), a unique five-digit number, and a two-letter suffix identifying the contractor. One sample number will be required for each sample generated, including QC samples. In this manner, 99,999 unique sample numbers are available for each sample medium for each contractor that contributes sample data to the database. Boring numbers will be developed independently of the sample number for a given boring. These sample numbering procedures are consistent with the RFP QAPjP.

7.5.2 Analytical Requirements

Generally, samples from the Phase I RFI/RI will be analyzed for some or all of the following chemical and radionuclide parameters:

- Uranium 233/234, 235, 236, and 238
- TRU elements (plutonium and americium)
- Gross alpha and gross beta
- Tritium
- Total dissolved solids

- TCL purgeable organics
- TCL base/neutral and acid extractable organics
- TCL PCBs
- TAL metals and cyanide
- Anions (groundwater only)
- pH
- Field parameters (water only)

The analytical suites for each OU10 IHSS were developed according to the type of contamination suspected to be present at each site, as summarized in Table 7-3. Table 7-4 lists the specific analytes in the above groups and their CLP detection/quantitation limits. Where sampling and analysis during Stages 1 and 2 indicate the presence of contamination, the quantitation limits of specific analytes should be compared to levels of potential concern in the risk assessment and to ARARs. Subsequent stages of sampling should include special analytical services to attain quantitation limits appropriate for risk assessment and compliance with ARARs. These analyte lists and reporting limits will satisfy the risk assessment and other RFI/RI objectives for soil, sediment, surface water, and groundwater contamination, if present. Nitrates are included because low-level radioactive wastes with high nitrate concentrations (such as nitric acid) may be present. Metals are suspected at many of the IHSSs in OU10; therefore, all of the TAL analytes have been selected for Phase I RFI/RI analysis. Both filtered and unfiltered samples of surface water and groundwater will be collected and analyzed at each location.

In addition to these chemical analytical requirements, 10 to 20 percent of the surficial soil samples at each IHSS will be analyzed for moisture content, grain-size distribution, bulk density, specific density, porosity, and saturated hydraulic conductivity to support exposure assessment modeling. The actual number of analyses will be determined by field personnel on the basis of apparent grain size variability to ensure the collection of representative data. ASTM methods will be used for these physical analyses.

The following isotopes have been selected for analysis in the Phase I RFI/RI: uranium 233/234, uranium 235, uranium 236, and uranium 238. Plutonium is the only TRU element that is used on the site. However, americium, a daughter product of plutonium, has been detected in soil at OU10. Therefore, plutonium and americium have been selected as Phase I radionuclide parameters. Tritium analysis will also be conducted for samples from IHSS 206. Gross alpha and gross beta are included as screening parameters because they are useful indicators of radionuclides.

VOCs and SVOCs have been detected at concentrations above the detection limit in soil and have historically been stored at most of the OU10 IHSSs. Therefore, all VOCs and SVOCs will be included in the Phase I RFI/RI analyses. Any soil samples analyzed on site for volatiles will require that 10 percent be analyzed by an off-site laboratory to verify analytical results.

The analytical parameters for the soil gas surveys at OU10 are listed in Table 7-5. Table 7-5 also lists the detection limits proposed for these parameters during the soil-gas survey.

Soil samples collected for leachability tests will be analyzed using EPA Method 1312, Synthetic Precipitation Leach Test for Soils, or an equivalent method. Method 1312 is presented in the EPA Interim Final RCRA Facility Investigation (RFI) Guidance, Volume II of IV, Appendix F.

7.5.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and by the analyses to be performed. The matrices to be analyzed include soils and sediments; the water matrices for analysis will include surface water and groundwater. Tables 7-6 and 7-7 list the analytical parameters of interest in OU10 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times. Additional specific guidance on the appropriate use of containers and preservatives is provided in EMD OP FO.13.

7.5.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in EMD OP FO.13.

7.6 DATA MANAGEMENT AND REPORTING PROCEDURES

Field data will be input to the RFEDS using a remote data entry module. Data will be entered within 60 days of the completion of sample analysis. The data will undergo a prescribed QC process based on EMD OP FO.14. A sample tracking spreadsheet will be maintained for use in tracking sample collection and shipment.

Table 7-6 Sample Containers, Sample Preservation, and Sample Holding Times for Water Samples

Parameter	Container	Preservative	Holding Time
<u>Liquid Samples - Low to Medium Concentration</u>			
Organic Compounds:			
Purgeable organics (VOCs)	2 x 40 mℓ VOA vials with teflon-lined septum lids	Cool, 4°C[a] with HCL to pH<2	7 days 14 days
Extractable organics (BNAs), pesticides, and PCBs	1 x 4 ℓ amber[b] glass bottle	Cool, 4°C	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 1 ℓ polyethylene bottle	Nitric acid pH<2; cool, 4°C	180 days[c]
Cyanide	1 x 1 ℓ polyethylene bottle	Sodium hydroxide[d] pH>12; cool, 4°C	14 days
Anions	1 x 1 ℓ polyethylene bottle	Cool, 4°C	14 days
Sulfide	1 x 1 ℓ polyethylene bottle	1 ml zinc acetate sodium hydroxide to pH>9; cool, 4°C	7 days
Nitrate	1 x 1 ℓ polyethylene bottle	Cool, 4°C	48 hours
Total dissolved solids (TDS)	1 x 1 ℓ polyethylene bottle	Cool, 4°C	48 hours
Radionuclides	1 x 1 ℓ polyethylene bottle	Nitric acid pH<2	180 days

a Add 0.008 percent sodium thiosulfate (Na2S203) in the presence of residual chlorine.
b Container requirement is for any or all of the parameters given.
c Holding time for mercury is 28 days.
d Use ascorbic acid only if the sample contains residual chlorine. Test a drip of sample with potassium iodine-starch test paper; a blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume.

Table 7-7 Sample Containers, Sample Preservation, and Sample Holding Times for Soil Samples

Parameter	Container	Preservative	Holding Time
<u>Soil or Sediment Samples - Low to Medium Concentration</u>			
Organic Compounds:			
Purgeable organics (VOCs)	1 x 4 oz wide-mouth teflon-lined glass vials	Cool, 4°C	7 days 14 days
Extractable organics (BNAs), pesticides, and PCBs	1 x 8 oz wide-mouth teflon-lined glass vials	Cool, 4°C	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 8 oz wide-mouth glass jar	Cool, 4°C	180 days[a]
Cyanide	1 x 8 oz wide-mouth glass jar	Cool, 4°C	14 days
Sulfide	1 x 8 oz wide-mouth glass jar	Cool, 4°C	28 days
Nitrate	1 x 8 oz wide-mouth glass jar	Cool, 4°C	48 hours
Radionuclides	1 x 8 oz wide-mouth glass jar	None	45 days

a Holding time for mercury is 28 days.

7.7 QUALITY ASSURANCE/QUALITY CONTROL 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 ER Program Project Manager to assess the quality of the field sampling effort and the total sample variance as it affects quantitative contaminant assessment. The types of field QC samples to be collected and their application are discussed below. Table 7-8 provides the frequency with which QC samples will be collected and analyzed in Stage 1. The numbers of QC samples should be reevaluated according to the variability displayed by Stage 1 data.

Duplicate samples will be collected by the sampling team for use as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures and equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field preservation blanks of distilled water, preserved according to the preservation requirements (Section 7.5.3), will be prepared by the sampling team and will be used to provide an indication of any contamination introduced during field sample preparation. These QC samples are applicable only to samples requiring chemical preservation (Table 7-8).

Equipment (rinsate) blanks will be collected from final decontamination rinsate to evaluate the success of the field sampling team's decontamination efforts on nondedicated 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 rinsate blanks are applicable to all analyses for water and soil samples (Table 7-8).

Table 7-8 Field QC Sample Frequency

Sample Type	Type of Analysis	Media	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Preservation Blanks	Organics	NA	NA
	Inorganics	NA	1/20
	Radionuclides	NA	1/20
Equipment Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks	Organics	1/20	1/20
	Inorganics	NR	NR
	Radionuclides	NR	NR

NA = Not Applicable
NR = Not Required
1/10 = one QC sampler per ten samples collected

Trip blanks consisting of distilled water will be prepared by the laboratory technician and will accompany each shipment of water 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 the migration of VOCs or any problems associated with sample shipment, handling, or storage. Information from the trip blanks will be used in conjunction with air monitoring data and other information to assess the influence of ongoing waste operations on the quality of data collected.

Procedures for monitoring field QC are provided in the RFP sitewide QAPjP.

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8.0 HUMAN HEALTH RISK ASSESSMENT PLAN

8.1 OVERVIEW

Section 300.430(d) of the NCP (Federal Register, March 8, 1990, p. 8, 709) states that as part of the RI, an HHRA is to be conducted to determine whether contaminants of concern (COCs) identified at the site pose a current or potential risk to human health in the absence of remedial action. This section describes the HHRA components which include:

- Data collection and analysis which includes identification and description of COCs
- Exposure assessment
- Toxicity assessment
- Risk characterization

Figure 8.1-1 illustrates the basic HHRA process and components. The objective of the HHRA is to identify and assess potential human health risks resulting from exposure to site contaminants present in various environmental media. Several objectives will be accomplished under the HHRA task, including identification and characterization of the following:

- Toxicity and levels of hazardous and radioactive contaminants present in relevant media (e.g., air, groundwater, soil, surface water, sediment, and biota)
- Environmental fate and transport mechanisms within specific environmental media and cross-media fate and transport where appropriate
- Potential human and environmental receptors
- Potential exposure routes and extent of actual or expected exposure

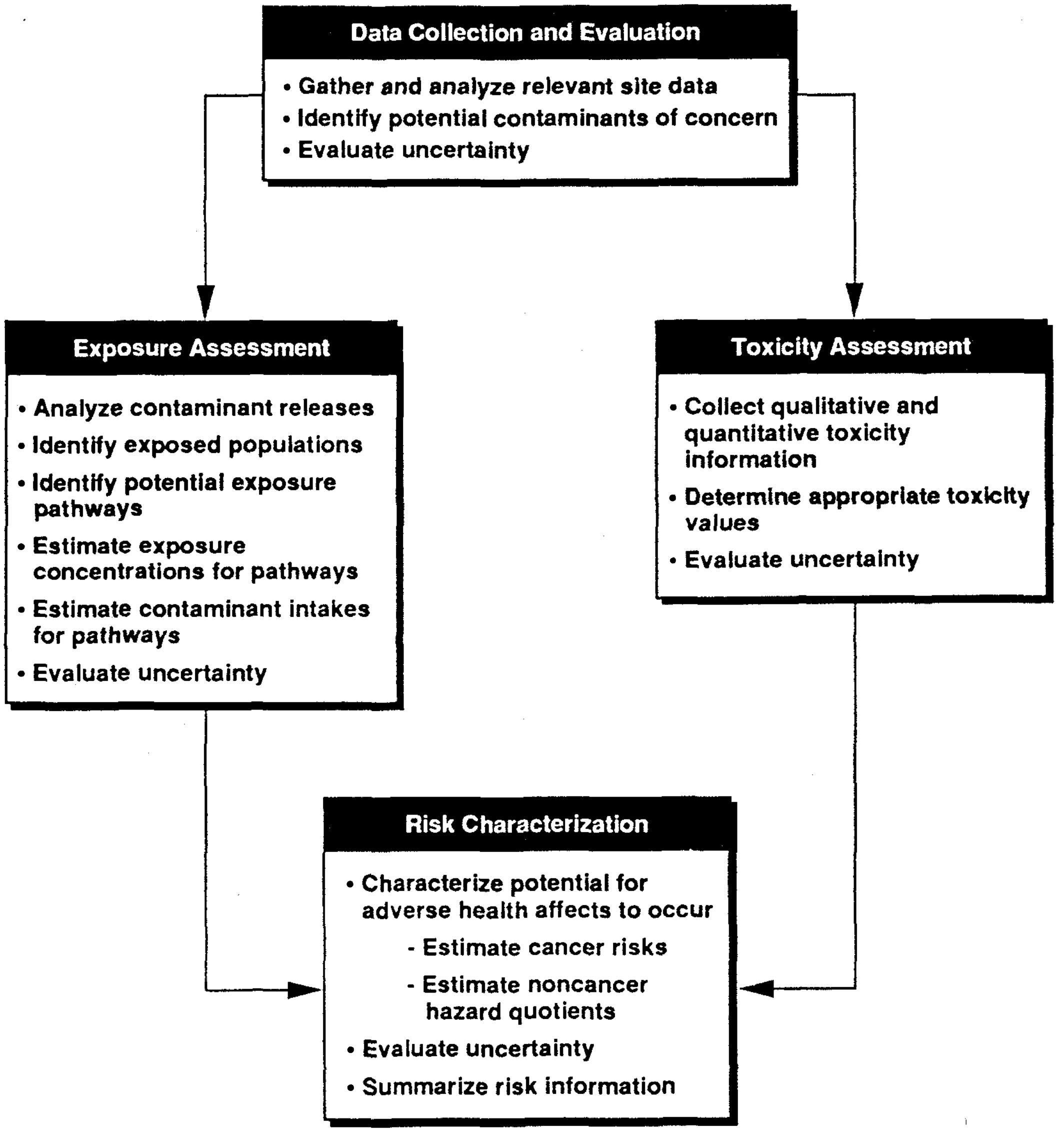

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Figure 8.1-1

Human Health Risk Assessment Development Process

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- Extent of expected impact or threat and the likelihood of such impact or threat occurring (i.e., risk characterization)

- Level(s) of uncertainty associated with the above

Data collection in the Phase I RFI/RI will be limited to source, surficial soil, and vadose zone media. Surface soil will be evaluated regarding the following routes of exposure: inhalation, ingestion, and dermal absorption. This aspect of the risk assessment will be conducted in quantitative terms regarding surface soil exposures. The vadose zone sampling program will not provide enough data to develop a quantitative risk assessment and, therefore, risk will be assessed via qualitative evaluations. The vadose zone will be evaluated regarding the following routes of exposure: inhalation and dermal absorption.

The Phase I HHRA will be IHSS-specific. This work plan defines the general HHRA tasks which will be applied to each IHSS. The FSP was developed to collect data at each IHSS to support the HHRA at that IHSS. This HHRAP has not been formatted to discuss the HHRA at each IHSS in order to avoid unnecessary redundancy.

As required by the IAG, (Attachment 2, VII.D.1) technical memoranda will be prepared for submittal to CDH and EPA on the following:

- A listing of the hazardous substances present at each IHSS will be prepared, with indicator chemicals and the corresponding ambient concentrations of these contaminants identified.

- The present, future, potential, and reasonable exposure scenarios will be identified. In addition, a description of the fate and transport models to be utilized, including data requirements and limitations, will be discussed.

- A summary of the toxicological and epidemiological studies will be prepared that will be utilized to perform the toxicity assessment

This work plan will provide the methodology to be employed in developing the memoranda described above. The FSP will be coordinated with the environmental fate and transport modeling parameters. The modeling uncertainty in conjunction with data limitations will be accountable as defined in the uncertainty assessment sections within this chapter of the work plan. The recommended guidance for researching toxicological information will be closely followed (i.e., IRIS, HEAST, ECAO, Technical Memoranda). IRIS will be the preferred source for toxicological information although the other sources listed will be used if IRIS does not contain the required information. The risk characterization will include estimation of cancer risks and noncancer hazard quotients and, if available, potential synergistic effects, if known. As with each step in the HHRA Process, uncertainty analysis will be conducted as part of the risk characterization.

In order to quantify the potential exposure/dose, a number of references will be utilized including, but not limited to, DOE Order 5400.5 Radiation Protection of the Public and the Environment; the EPA Risk Assessment Guidance for Superfund Human Health Evaluation Manual Part A Interim Final (December 1989); Guidance for Data Useability in Risk Assessment-Interim Final (October 1990); Federal Guidance Report No. 11 Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion (1988); and DOE/EH-0070 External Dose-Rate Conversion Factors for Calculation of Dose to the Public (July 1988) U.S. DOE. The dose calculations will provide an estimate of the committed effective dose equivalent to an individual which can then be compared to the acceptable range of lifetime excess cancer risk as set by Section 300.430(d) of the NCP. The specific intake rates of potentially contaminated media (air, water, and food) will be provided by EPA Region VIII supplemental risk assessment guides, if available. Through combining the predetermined intake rates and future land use scenarios, a quantitative human health risk can be derived. Uncertainty analysis will occur in each step (data collection, exposure assessment, toxicity assessment, and risk characterization) in order to account for an overall uncertainty range.

The HHRA for OU10 will be performed in accordance with EPA and other guidance documents (Table 8-1). These documents are the most recent EPA guidance for HHRAs. EPA manuals are provided as guidance only; professional judgment is used in applying the information presented in these documents.

8.2 DATA COLLECTION AND EVALUATION

The objectives of data collection and evaluation are to gather and analyze all OU10 data relevant to the human health evaluation and to identify potential COCs at the site that are the focus of the risk assessment process (EPA 1989b) and procedures established by the RFP Risk Assessment Technical Working Group, which includes DOE, EPA, and CDH. The data collection and evaluation will address the following key issues:

- Identifying the types of data needed
- Specifying how the data will be used
- Establishing the desired level of certainty for conclusions derived from the analystical data

OU10 consists of sixteen IHSS locations, each having a specified FSP and specific analytical requirements as discussed in Section 7.

Previous site investigations characterizing aspects of RFP and the surrounding area have been performed. Additional sampling and analysis of various media is planned to support the HHRA,

- EPAs Integrated Risk Information System (IRIS) - Office of Research and Development (continuously updated). Agency's primary source of chemical-specific toxicity and risk assessment information. Includes narrative discussion of toxicity database quality and explains derivation of Reference Doses, cancer potency factors, and other key dose response parameters. IRIS presents information that updates data originally presented in Exhibits A-4 and A-6 of the SPHEM (see below). Further information: IRIS Users Support, 513-569-7254 (EPA 1987).

- *Health Effects Assessment Summary Tables (HEAST)* - Office of Research and Development/Office of Emergency and Remedial Response (updated quarterly). Because the IRIS chemical universe (while growing) is currently incomplete, the HEAST has been produced to serve as a "pointer" system to identify current literature and toxicity information on important non-IRIS chemicals. While HEAST data in some cases may be "agency-verified," the information is considered valuable for Superfund risk assessment purposes. Available from Superfund docket, 202-382-3046 (EPA updated quarterly).

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual Part A, Interim Final - Office of Emergency and Remedial Response. This volume provides updated risk assessment procedures and policies, specific equations, and variable values for estimating exposure, and a hierarchy of toxicity data sources. There is an expanded chapter on risk characterization to help summarize information for the decision makers and detailed descriptions of uncertainties in risk assessment (EPA 1989b).

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim - Office of Emergency and Remedial Response. Provides guidance to risk assessors for the development of Preliminary Remediation Goals (PRGs).

- OSWER Directive on Soil Ingestion Rates - Office of Solid Waste and Emergency Response (January 1989), OSWER Directive #9850.4. Recommends soil investigation rates for use in risk assessment when site-specific information is not available. Available from Darlene Williams, 202-475-9810 (EPA 1989a).

- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference - Office of Solid Waste and Emergency Response EPA 600-3/89/013. This report is a field and laboratory reference document that provides guidance on designing, implementing, and interpreting ecological assessments of hazardous waste sites. It includes sections on ecological endpoints, field sampling design, QA, aquatic and terrestrial toxicity and field survey methods, recommended biomarkers, and data analysis (EPA 1989c).

- Risk Assessment Guidance for Superfund - Environmental Evaluation Manual, Interim Final (RAGS-EEM) - Office of Emergency and Remedial Response (March 1989), EPA/540/1-89/001A. Provides program guidance to help remedial project managers and on-scene coordinators manage ecological assessment at Superfund sites (EPA 1989d).

- Exposure Factors Handbook - Office of Research and Development (March 1989), EPA/600/8-89/043. Provides statistical data on the various factors used in assessing exposure; recommends specific default values to be used when site-specific data are not available for certain exposure scenarios. Further information: Exposure Methods Branch, 202-382-5988 (EPA 1989c).

- Superfund Risk Assessment Information Directory (RAID) - Office of Emergency and Remedial Response (November 1986), EPA/540/1-86/061. Describes sources of information useful in conducting risk assessments. Currently under revision.*

- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA - Office of Emergency and Remedial Response EPA/540/G-89/004. this guidance document is a revision of the EPA 1985 guidance. It describes general procedures for conducting an RI/FS (EPA 1988a).

- Superfund Exposure Assessment Manual (SEAM) - Office of Emergency and Remedial Response (April 1988), EPA/540/1-88/001. Provides a framework for the assessment of exposure to contaminants at or migrating from hazardous waste sites. Discusses modeling and monitoring (EPA 1988b).

- CERCLA Compliance With Other Laws Manual - Office of Emergency and Remedial Response. The guidance is intended to assist in the selection of onsite remedial actions that meet the applicable or relevant and appropriate requirements (ARARs) of the Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Clean Air Act (CAA), and other federal and state environmental laws as required by CERCLA, Section 121 (EPA 1988c).

- Guidance for Data Useability in Risk Assessment - Interim Final 1990. EPA/540/G-90/008.

- Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions - OSWER Directive 9355.0-30. April 22, 1991.

the environmental assessment, and to further characterize the site. Environmental sampling and analysis will be conducted in accordance with the QAPjP and QAA. Once all necessary data has been collected and evaluated, reduction in the number of chemical and radiological contaminants identified to a list of COCs will be evaluated in accordance with EPA guidance (EPA 1989b).

According to EPA (1989b), the data collection and evaluation task of the HHRA generally includes the following actions:

Data Collection:

- Review all available site information existing at start of the Phase I RFI/RI to determine basic site characteristics, identify potential exposure pathways and points, and help determine data needs (including modeling needs)

- Address modeling parameter needs to ensure that the data requirements for contaminant release, transport and fate models are incorporated into data collection requirements

- Define background sampling needs to distinguish site-related contamination from naturally occurring or other nonsite-related levels of chemicals

- Conduct a preliminary exposure assessment (identify media of concern, areas of concern, type of chemicals expected, and potential routes of contaminant transport) to collect information for the SAP

- Develop an overall strategy for sample collection to make sure data are appropriate for use in quantitative risk assessment

- Examine QA/QC measures (sampling protocol, sampling devices, QC samples, collection procedures, and sample preservation) important to risk assessment sampling

- Identify any special analytical needs based on review of existing information

- Take active role during work plan development and data collection to ensure risk assessment sampling needs are met

Data Evaluation:

- Collect all data available from previous site investigations and RFI/RI to determine if previous data are suitable for combining into quantitative risk assessment
- Evaluate analytical methods to determine if analytical method results are appropriate for use in quantitative risk assessment
- Evaluate the quantitation and detection limits for all chemicals that may result in elimination of some chemicals from quantitative risk assessment
- Evaluate the quality of the data with respect to qualifiers and codes
- Evaluate quality of the data with respect to blanks to prevent the inclusion of nonsite-related contaminants in the risk assessment
- Evaluate TICs to determine if they should be included in risk assessment
- Compare potential site-related contamination with background to identify nonsite-related chemicals that are found at or near the site
- Identify potential COCs for use in the quantitative risk assessments

In cases where the list of potentially site-related contaminants is lengthy, accepted procedures "...using chemical classes, frequency of detection, essential nutrient information, and a concentration toxicity screen... may be used to further reduce the number of contaminants of concern" (EPA 1989b). Analytical results from operable unit (OU) field sampling will be screened to retain those contaminants which are most likely to contribute significantly to risks to members of the public. These COCs represent the most toxic, persistent, or mobile contaminants identified at an OU.

A flowchart (see Figure 8.2-1) to be used in screening COCs has been developed by the RFP Risk Assessment Technical Working Group (which includes CDH and EPA) from the discussion

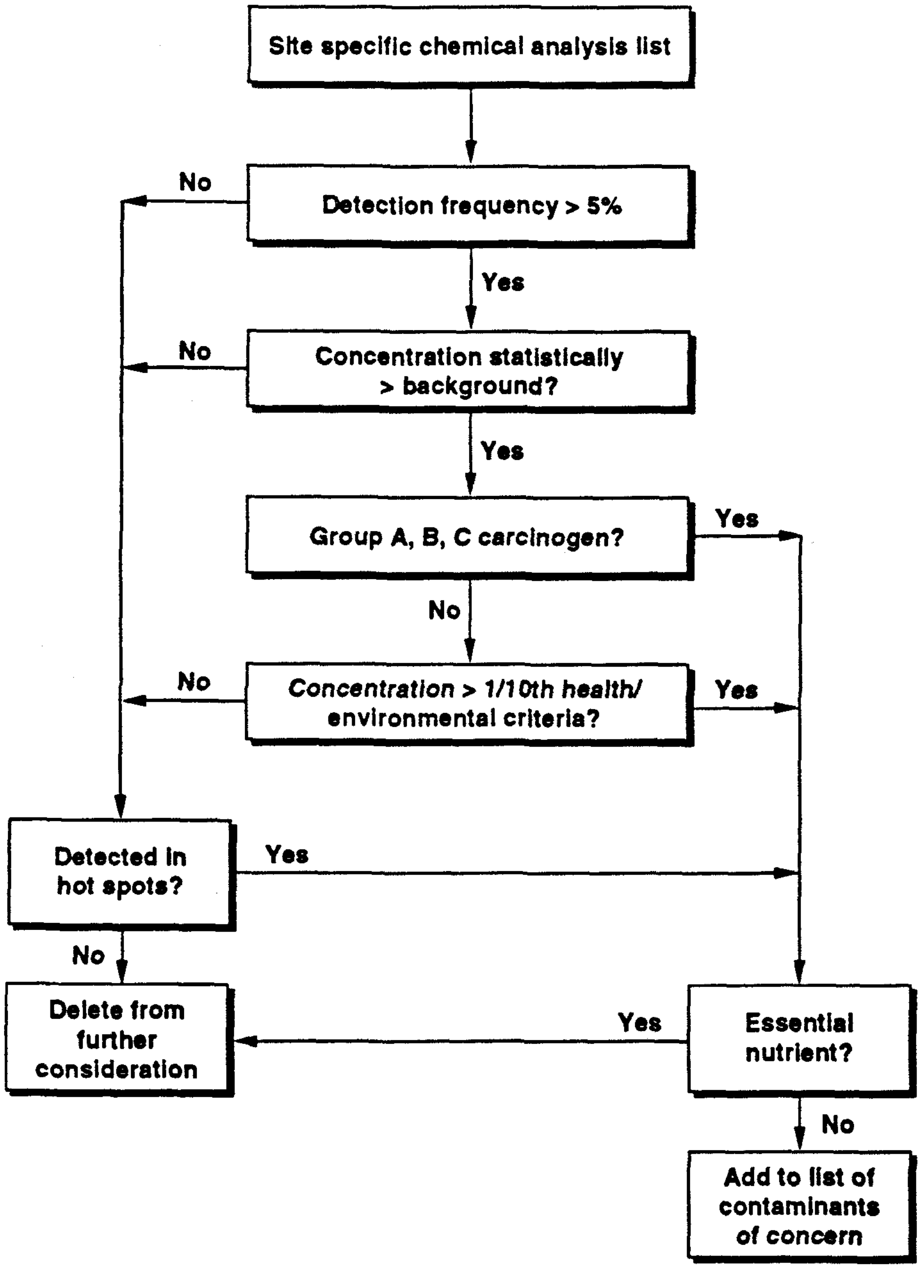

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Figure 8.2-1

Flow Chart of the Protocol for Identification of Contaminants of Concern

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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." Flow to the left indicates contaminants that will be deleted from quantitative risk assessment unless associated with a "hot spot" (defined as 10 times the mean site concentration). Contaminants that the screening process moves to the right of the flowchart will be retained for quantitative risk assessment unless they are identified as essential human nutrients.

The screening process begins with analytical results from the site-specific chemical analysis list set forth in the OU work plan. The data will be evaluated according to RAGS section 5.9.3 to determine if the detection frequency is greater than 5 percent. The chemical will be considered for "elimination from the quantitative risk assessment if: (1) it is detected infrequently in one or perhaps two environmental media, (2) it is not detected in any other sample media, or at high concentrations, and (3) there is no reason to believe that the chemical may be present" (EPA 1989b). 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.

As discussed in RAGS sections 5.8(3) and 10.4.7, remaining contaminants will be screened to determine if the concentration is statistically different from background. This second step in the screening process employs appropriate parametric and nonparametric statistical data evaluation methods (e.g., tolerance intervals, analysis of variance [ANOVA], etc.). Guidance on statistical methods includes RAGS (EPA 1989b), *Guidance for Data Useability in Risk Assessment* (EPA 1990), *Methods for the Evaluation of Cleanup Standards* (EPA 1989f), and *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987). Those contaminants which are not detected at concentrations statistically elevated above background have moved closer to 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 chemical is considered a carcinogen. As indicated on Attachment 1, EPA guidance will be employed to identify chemicals that are classified as Group A, B, or C carcinogens. This screening step does not eliminate a chemical from further consideration. Instead, it automatically identifies carcinogens for inclusion in the risk assessment, even if detected at low concentrations.

Noncarcinogens 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 health/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 K_{oc}, and persistence may be evaluated according to criteria such as half-life and bioaccumulation. For example, as K_{oc} increases, a contaminant is more likely to bind to soil and sediment than to remain in water. In contrast, a contaminant with high solubility is more likely to remain in water than to bind to sediment or soil. 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 (1) essential human nutrients, (2) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (3) 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.

Contaminants retained through the screening process represent the most prevalent, toxic, persistent, or mobile contaminants at an OU. These will be added to the list of contaminants of concern, which will be used in the quantitative risk assessment.

Uncertainty in Data Collection and Evalaution

Four key elements have been identified as objectives of the data collection and evaluation task; an inherent uncertainty needs to be quantified for each:

- Determine what contamination is present and at what level; estimates of the site contamination must be produced with clear descriptions of the degree of confidence associated with each concentration value

- Determine if site concentrations differ significantly from background concentrations; the comparison of data is performed using the null hypothesis at a specified confidence level

- Evaluate whether analytical data are adequate to identify and examine exposure pathways; the sampling and analysis program should result in data of known quality which quantify spatial and temporal variability, and specify an approach for interpreting the magnitude of observed values

- Evaluate whether analytical data are adequate to fully characterize exposure pathways; heterogeneity should be considered, and hot spots need to be identified and characterized

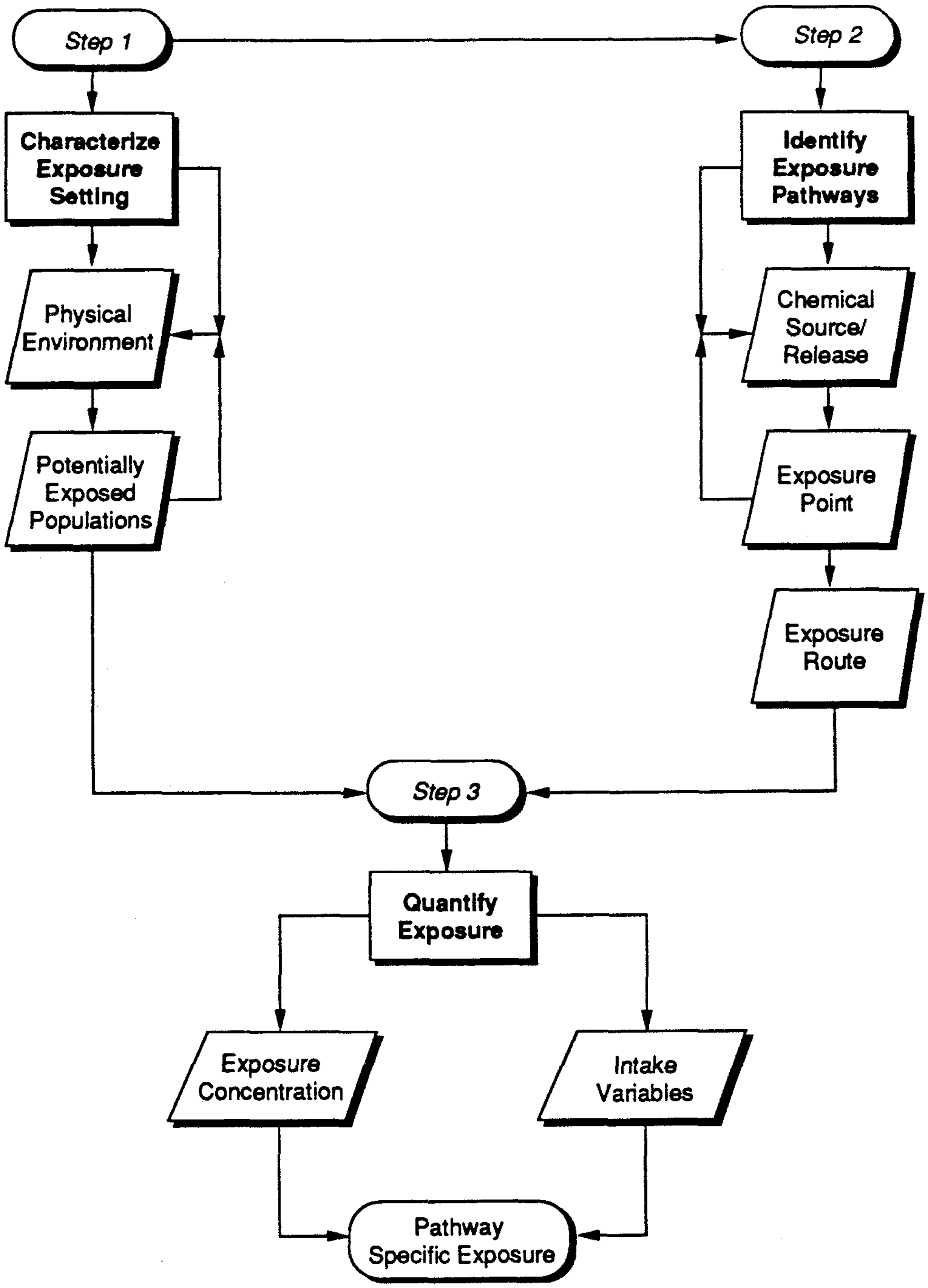
8.3 EXPOSURE ASSESSMENT

Exposure is the contact of an organism (humans, in the case of a health risk assessment) with a chemical or physical agent (EPA 1988b). This includes external exposure to radionuclides. Exposure is measured or estimated by the physical amount of a given contaminant present at either the lungs, intestines, or skin. Exposure occurs when a contaminant has migrated from the site location to a receptor point.

The objectives of the exposure assessment are to identify actual or potential chemical and radiological exposure pathways, characterize potentially exposed populations, and determine the extent of exposure (quantitatively or qualitatively) (EPA 1988a).

The exposure assessment will be conducted per guidance provided in the Superfund Exposure Assessment Manual (EPA 1988b). Figure 8.3-1 shows the steps involved in the exposure assessment. The exposure assessment process includes the following actions:

- Analyze the probable fate and transport of compounds for both present and future uses
- Identify the human populations in the area, typical activities that would influence exposure, and sensitive population subgroups
- Identify potential exposure pathways under current and future land use conditions
- Develop exposure scenarios for each identified pathway and select those scenarios that are plausible
- Identify the exposure parameters to be used in assessing the risk for all scenarios
- Develop an estimate of the expected exposure levels from the potential release of and/or exposure to contaminants



Source: EPA, 1989b

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Figure 8.3-1

Exposure Assessment Process

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An exposure pathway is comprised of the following elements:

- A source and mechanism of radioisotope and chemical release to the environment
- An environmental transport medium (e.g., air, groundwater) for the released constituent
- A point of potential contact for humans or biota with the affected medium (i.e., the exposure point)
- An exposure route (i.e., inhalation of contaminated dust) at the exposure point

Appropriate exposure scenarios will be identified for the site. Scenarios that could potentially be considered include residential, commercial/industrial, recreational, agricultural, and/or ecological research use or open space use. Factors to be examined in the pathway and receptor identification process are discussed below.

8.3.1 Site Conceptual Model

The site conceptual models for OU10 IHSSs are described in Section 2.2 of this work plan and are shown graphically on Figures 2.2.-1 and 2.2-2. The OU10 IHSSs have been grouped together into three categories based on similar characteristics which are subsurface storage, surface storage with a covered surface, and surface storage with an uncovered storage. The conceptual models in Section 2 describe the conceptual models for each of these categories.

The site conceptual models for OU10 will be used to evaluate primary and secondary contaminant sources, release mechanisms, contaminant migration pathways, potential receptors, and associated exposures (EPA 1988a). The exposure pathways relative to contaminant fate and transport mechanisms are characterized using the models. The site conceptual models for OU10 may be revised based on the results of the Phase I RFI/RI. Factors to be examined in the pathway and receptor evaluation process will include the following:

- Location of contaminant source
- Local topography
- Local meteorological data
- Surrounding land use
- Prediction of contaminant fate and migration
- Persistence and mobility of migrating contaminants

For each migration pathway and for current and future conditions, receptors will be identified and characterized. Potential receptors will be defined by the appropriate exposure scenarios.

The potential level of human exposure to the COCs must be determined to assess the potential adverse health effects associated with access to the site. Ingestion, inhalation, and dermal chronic exposures for each population group will be estimated separately. Subsequently, the total chronic intake by each exposure pathway will be calculated by adding the chemical intakes from each pathway for each population group. Exposure concentrations will be estimated using several reasonable exposure conditions to evaluate the range of potential exposure concentrations. The exposure assessment will use the estimated minimum, expected, and RME concentrations. The RME concentrations are defined as the 95th percent confidence limit on average, or the maximum reported concentration, whichever is lower. Depending on data quality and their appropriateness for grouping, data distribution will be used to determine the appropriateness of using geometric or arithmetic means to estimate RME concentrations.

8.3.2 Contaminant Fate and Transport

The site conceptual models identify potential contaminant fate and transport mechanisms. These may include wind dispersion of contaminated soil, volatilization of contaminants from the vadose zone, and contaminant leaching to groundwater and/or surface water. Factors affecting contaminant migration include particle size distribution, soil moisture content, precipitation, infiltration, TOC content, soil pH, solubility, partitioning coefficient, vapor pressure, Henry's Law constant, and the bioconcentration factor. Evaluating these factors will assist in determining whether contaminants would be expected to migrate from the source location to potential receptors.

8.3.3 Potential Receptors

Exposure scenarios developed in the HHRA may include exposure to on-site workers, future human receptors within OU10, and off-site human receptors from potentially contaminated airborne soil particulates and volatile emissions. Exposure scenarios will be selected according to the future land use assessment (e.g., residential, recreational, restricted access) for the site.

8.3.4 Exposure Pathways

Exposure pathway identification involves connecting the contaminant source with a transport mechanism, a point of human exposure, and a human uptake mechanism. Sources will be sites within OU10 that contain the identified COCs. Release mechanisms may include contaminated leachate from soils into either groundwater or surface runoff, airborne soil particulate transport, and volatilization of organic compounds. Human exposure points will be identified during the site characterization. These human exposure points may be located on site or off site. Only complete exposure pathways will be evaluated in the risk assessment. A complete pathway is defined as one that contains each element as previously described; a missing element results in an incomplete pathway.

8.3.5 Exposure Point Concentrations

Concentration of COCs at an exposure point will be estimated using analytical results from the Phase I RFI/RI and available historical data. Models recommended by EPA and CDH may be used to evaluate the potential release and transport of contaminants. Other models may be used based on a performance evaluation with consideration given to site-specific characteristics.

Any models used and data generated through their use will be characterized by the estimated variance developed by an uncertainty analysis. Variance of model output will be reduced to the maximum practical extent. Other contributions of uncertainty to the risk assessment are the exposure factors used in estimating intake and toxicity parameters (i.e., reference dose and cancer slope factors) used to evaluate the effect of an acquired dose to humans. In addition, variance data is lacking for most chemical toxicity factors.

Exposure point concentrations will be estimated for minimum, expected, and reasonable maximum estimated exposure conditions. A goodness-of-fit analysis will be conducted to correctly identify the data distribution and the most appropriate measure of central tendency when appropriate. The reasonable maximum concentration will be the upper 95 percent confidence limit on the appropriate mean, or on maximum likelihood estimate. In calculating the media concentrations, censored data (e.g., data sets with missing values or nondetects) will be treated by appropriate methods such as those described in Statistical Methods for Environmental Pollution Monitoring (Gilbert 1987).

8.3.6 Estimation of Intake

Chemical intakes will be estimated using available, region-specific exposure parameters. Contaminant exposure is normalized for time and for body weight, expressed as milligrams of contaminant per kilogram of body weight per day (mg/kg/day). Radionuclide intake is expressed as total picocuries (pCi). Factors used to estimate intake include exposure frequency, exposure duration, contact rate, chemical concentration, body weight, and average time. These factors are based on the types of exposure (e.g., residential or occupational, ingestion, or inhalation).

The RME and average exposure point concentrations are used with receptor activity patterns to estimate contaminant intake for each exposure pathway. The EPA requires using 95th percentile value for contact rates, 90th or 95th percentile values for exposure duration, and average values for parameters such as body weight. Different parameters are used for children, adult workers, and recreational user exposures based on information provided by EPA (EPA 1989b). The averaging time for carcinogens and noncarcinogens differ.

Other standard intake rates established by EPA will be used, if appropriate, and include the following:

- Soil ingestion rates for children, ages 1 through 6
- Soil ingestion rates for all others (workers and residents more than 6 years of age)
- Inhalation rates based on activity levels

Contaminant rates can also be estimated for dermal exposures. Dermal exposures provide the greatest degree of uncertainty when compared with ingestion and inhalation exposure rates. This uncertainty results form the lack of chemical-specific dermal permeability constants. The estimated contaminant intake through dermal exposures will be compared to intake values calculated for ingestion as the basis for demonstrating the insignificance of dermal exposure relative to other routes of exposure.

Human intake of COCs will be estimated using reasonable estimates of exposure parameters. EPA guidance, site-specific factors, and professional judgment will be applied in establishing exposure assumptions. Using reasonable risk estimates associated with the assumed exposure conditions results in evaluating risk without underestimating the actual risk. Estimated cancer risks and hazard indices are obtained using the intake factor combined mathematically with exposure point concentrations and critical toxicity values.

A technical memorandum will be submitted to EPA and the State of Colorado for review and approval that describes the present, future, potential, and reasonable use exposure scenarios along with a description of the assumptions made and the use of data. This memorandum will be submitted prior to the required submittal of the HHRA for OU10. In addition, a description of the fate and transport models that will be used, including a summary of the data that will be used with these models, will be submitted. Representative data will be used and the limitations, assumptions, and uncertainties associated with the models will be documented (DOE 1991).

Uncertainty Analysis in Exposure Assessment

The ultimate effect of uncertainty in the exposure assessment is an uncertainty estimate of intake. The recommended approach (EPA 1990) to uncertainty analysis in exposure assessment is to explicitly present the range of observed values for chemicals in the environment and the factors used in developing intake estimates. Exposure assessment involves the quantitative evaluation of the exposure concentration of each chemical in each environmental medium, and an assessment of the transport and transformation of the subject compounds. Typically the exposure assessment involves both monitoring data and environmental transport models.

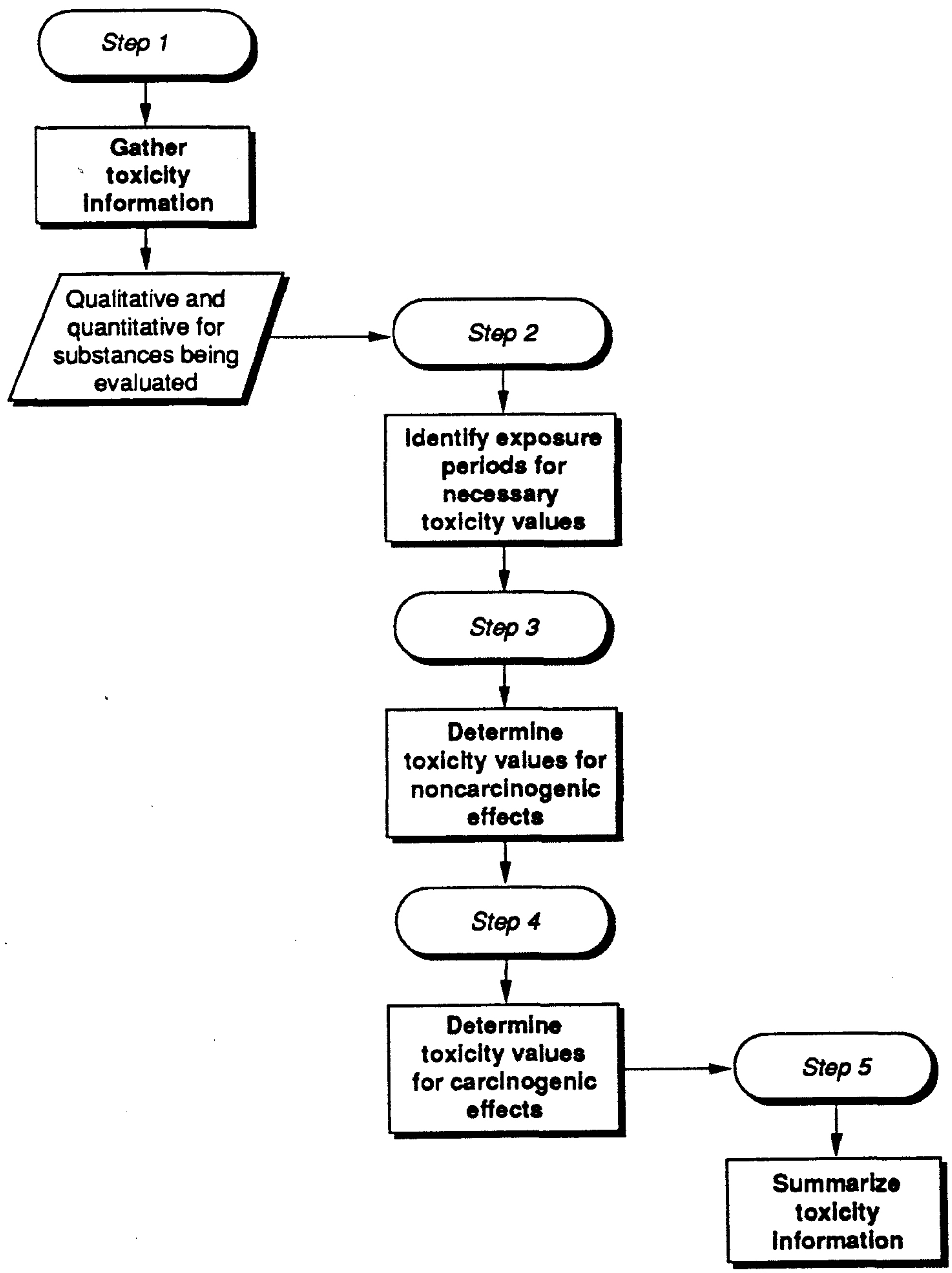
Monitoring data are most appropriately used to estimate current or existing exposure when direct contact with contaminating media is the primary concern. Transport modeling is required to estimate future exposure, or exposure at a distance from the source of release. The selection of an appropriate model matching the complex terrain at RFP, suitable to the geological profile, will be of extreme importance to the exposure assessment. Chemical intakes will be derived using the generic equations as presented in the Risk Assessment Guide (EPA 1990). Each input variable or point estimate will have a range of values. Site-specific selection will be conducted wherever available.

The model uncertainty will be evaluated using the range of parameter values tailored to the IHSS specific conditions at OU10. Standard input variables will be used when site-specific input data is missing. Intake values will be selected so that the combination of all values results in an estimate of reasonable maximum exposure for that pathway. Additional statistical software may be utilized similar to Monte Carlo methodology.

8.4 TOXICITY ASSESSMENT

Toxicity assessment, as part of the Superfund HHRA process considers (1) the types of adverse health or environmental effects associated with individual and multiple chemical and radiological exposures; (2) the relationship between the magnitude of exposures and adverse effects; and (3) the related uncertainties such as the weight of evidence for a contaminant's potential carcinogenicity in humans (EPA 1988a).

EPA provides detailed guidance on performing toxicity assessment for both chemical and radioactive contaminants (EPA 1989b). Figure 8.4-1 shows the steps of a toxicity assessment. In accordance with EPA's risk assessment guidelines, the projected concentrations of COCs at



Source: EPA, 1989b

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Figure 8.4-1

Toxicity Assessment Process

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exposure points will be compared with ARARs to judge the degree and extent of risk to human health and the environment (including plants, animals, and ecosystems). Because many ARARs do not exist for certain media (such as soils), nor are all ARARs necessarily health based, this comparison is not sufficient in itself to satisfy the requirements of the risk assessment process. Moreover, receptors may be exposed to contaminants from more than one medium. As a result, total doses to receptors might exceed risk reference doses (RFDs) and/or might result in an excess cancer risk greater than an acceptable target risk, as defined by EPA (e.g., 10^{-6} to 10^{-4}). Nevertheless, the comparison with standards and criteria is useful in defining the exceedance of institutional requirements. Aside from ARARs, the following criteria will be examined:

- Drinking water health advisories
- Ambient water quality criteria for protection of human health
- Center for Disease Control and Agency for Toxic Substances and Disease Registry soil advisories
- National Ambient Air Quality Standards

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 RfDs 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 EPA's Integrated Risk Information System (IRIS) database. IRIS contains up-to-date health risk and regulatory information and only those RfDs and slope factors that have been verified by EPA. IRIS 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 the EPA's Office of Research and Development, will be consulted to identify interim RfDs and slope factors for radionuclides. The EPA Environmental Criteria and Assessment Office will be consulted if toxicity values are not available from IRIS or HEAST.

In addition to identifying appropriate toxicity values, this section of the HHRA will provide brief toxicity profiles based on recent, published literature for each contaminant evaluated in the HHRA. These profiles will describe the acute, chronic, and carcinogenic health effects associated with site-related contaminants identified at OU10. The quality of these studies and their usefulness in estimating human health risks will be described. A more detailed explanation of the toxic effects of target chemicals will be provided in appendices to the HHRA and the environmental evaluation. Toxicity reference values will also be summarized. For the HHRA, this will include a brief description of the studies upon which selected reference values were based, the uncertainty factors used to calculate RfDs, and the EPA weight-of-evidence classification for carcinogens. For chemicals without EPA toxicity reference values, a literature search, including computer databases, will be conducted for selected compounds. A toxicity value will then (if possible) be derived from this information.

Uncertainty Analysis in Toxicity Assessment

Limitations in the analytical data from environmental samples affect the results of the toxicity assessment. This information assists in identifying the chemicals of concern, exposure pathways and time periods of exposure. As subchronic or chronic RFDs and cancer slope factors for oral and inhalation pathways are selected, included will be the weight-of-evidence classifications. Uncertainty and modifying factors used in deriving RFDs from NOAELs or LOAELs will also be included in the discussion of noncarcinogenic effects.

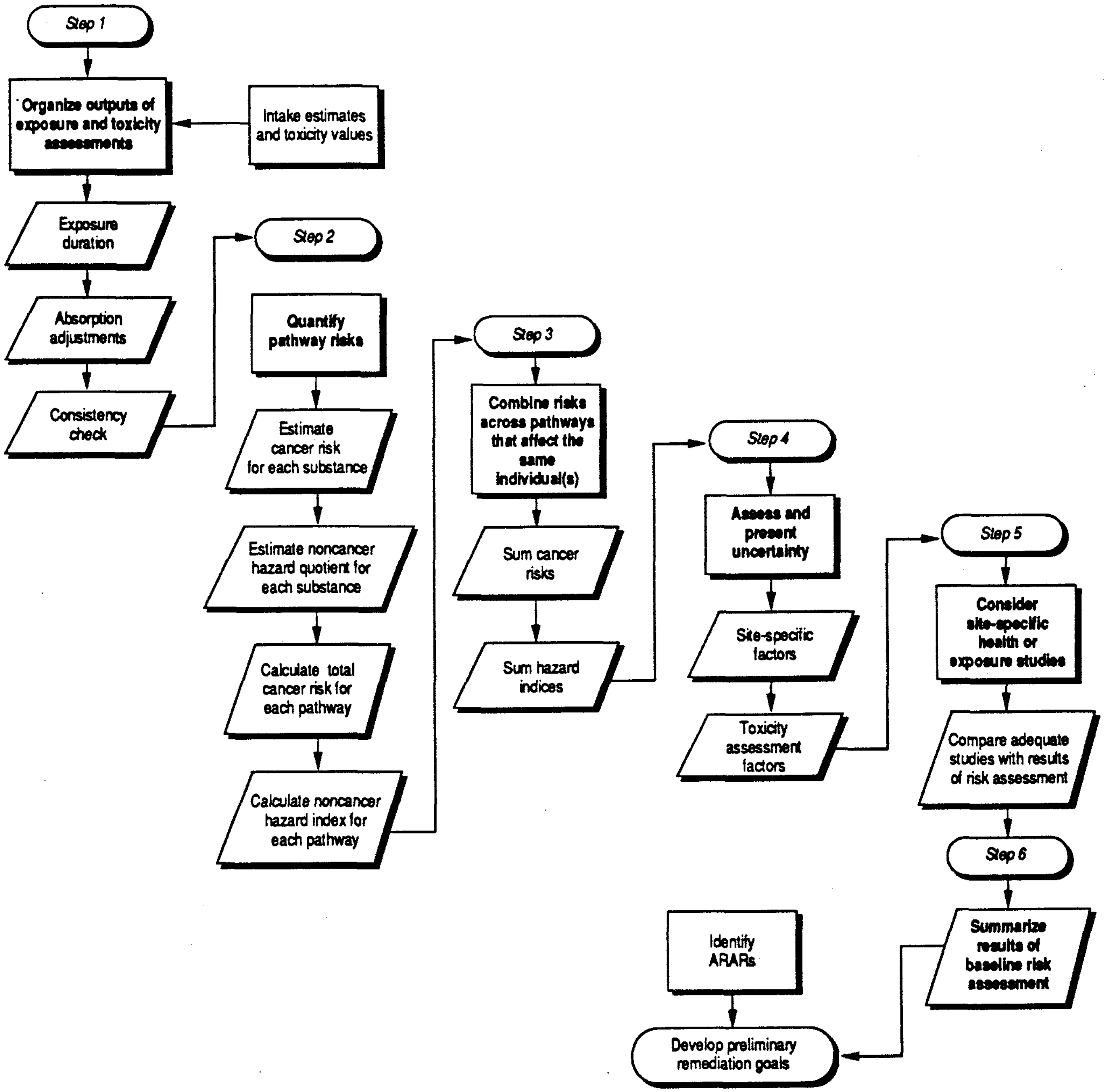
8.5 RISK CHARACTERIZATION

Risk characterization involves integrating radiological and chemical exposure and toxicity assessment information to quantitatively and qualitatively estimate the risk of adverse health effects. Risk characterization will be performed in accordance with EPA guidance (EPA 1989b) and per DOE Order 5400.5. Figure 8.5-1 shows the Risk Characterization Process.

Noncarcinogenic risk will be evaluated by comparing the estimated daily intake of a contaminant at an exposure point to its 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 chemicals, EPA's hazard index approach will be used. This method assumes dose additivity. Hazard quotients (individual chemical intake divided by the chemical RfD) are summed to provide a hazard index, and if the index exceeds 1, a potential for health risk is suggested. If a hazard index exceeds 1, where possible, chemicals may be segregated by similar effect or target organ to determine the potential health risks. Separate hazard indices may be derived for each effect if sufficient information or target organ specificity is available.

The potential for carcinogenic effects will be quantified by calculating excess lifetime cancer risks from the lifetime average exposure and cancer slope factor. These will be upper bound estimates because methods used to estimate slope factors are regarded as upper bounds on potential cancer risks rather than accurate representations of true cancer risk.

Both cancer and noncancer risks will be estimated by using RME and average contaminant intake values 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.



Source: EPA, 1989b

U.S. Department of Energy
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Figure 8.5-1

Risk Characterization Process

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In addition, risks may be added across exposure routes to assess the potential for additive affects.

Not all contaminants at OU10 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.

Uncertainty Analysis in Risk Characterization

Uncertainties in toxicological measures and exposure assessment are greater than uncertainties in environmental analytical data and usually have a more significant effect ont he uncertainty of the risk assessment (EPA 1990). A sensitivity analysis should be conducted to bound the results of the risk assessment. Combining probability distributions using Monte Carlo techniques is recommended by the Superfund Exposure Assessment Manual (SEAM) (EPA 1988c). Risk Assessment is a best estimate for potential (present and future) risk and the potential for adverse non-carcinogenic effect in humans have limitations which need to be clearly stated.

9.0 ENVIRONMENTAL EVALUATION

9.1 INTRODUCTION

Where sufficient ecological attributes exist on an Operable Unit (OU) to justify the effort, an environmental evaluation (EE) at Rocky Flats Plant (RFP) consists of sampling and evaluation of various terrestrial and aquatic ecosystem components. Terrestrial ecosystem field sampling may be conducted for large and small mammals, birds, reptiles, amphibians, arthropods, and vegetation. Aquatic ecosystem field sampling may be conducted for periphyton, benthic macroinvertebrates, plankton, and fishes. Surface and subsurface soil characterization and surface water characterization data are obtained from remedial investigations conducted at the OU and, in some cases, from studies specified in the EE work plan for the OU.

An ecosystems approach is used to integrate the data resulting from the analysis of field and laboratory data. This approach is comprehensive in that it initially integrates all ecosystem components, then progressively focuses on aspects of the system such as populations, structure, productivity, or diversity that are potentially affected by contamination. The result is an evaluation of the nature and extent of contamination in biota, its relationship to abiotic sources, and the type and extent of adverse effects at the ecosystem, population, and community levels of biological organization.

The industrial area of RFP has been developed such that only fragmented biotic populations in non–functional ecosystems current exist in the area. Those habitat units or ecosystems that do occur are greatly reduced in size, as are their associated biotic components. Therefore, the Risk Assessment Technical Working Group has developed a generic EE Work Plan (EEWP) reduced in focus and scope so that its requirements are proportional to the depauperate system under consideration. As such, this modified EEWP will vary greatly from a typical EE done in an area with viable habitat or ecosystems. Because the industrial area has few pristine ecological attributes at risk within its own boundaries, ecological risk in this context is viewed as the probability for biological vector (target taxa and/or their predators) transport of potentially toxic quantities of bioaccumulating contaminants outward from the Industrial area, either to another operable unit or elsewhere.

For the purposes of this EEWP, "study area" is defined as the 163 hectare (400 acre) industrial area within the outer perimeter fence, plus those portions of any industrial area OUs which lie outside the perimeter fence, as well as the 40 hectare (100 acre) Protected Area within the industrial area. An EEWP developed for application to study area operable units consists of two stages

STAGE 1

- A survey for migratory bird foraging, breeding, and nesting habitat, which will yield a final study area habitat survey report.

- A survey for the presence of threatened and endangered species or their critical habitat to ensure compliance with the Endangered Species Act (ESA)[50 CFR Part 402]. Only if there is habitat suitable for these species within the study area will this study yield a final study area biological survey report. This report will be consistent with RFP administrative and operations procedures (NEPA.12 and FO.21) for the protection of threatened, endangered, and special concern species.

STAGE 2

- An ecotoxicological investigation to determine, in the absence of significant ecological values within the Study area, the potential for dispersal of contaminants via biotic activities, from the Area into adjacent watersheds, drainages, or OUs.

Stage 1 tasks will be undertaken once for the entire study area and the results obtained incorporated into all other Industrial area OU RFI/RI reports. Stage 2 will be restricted to the Industrial area and will be delayed until a reasonable amount of data on bioaccumulating or bioconcentratiing COCs and their spatial distribution in the study area are be available. Because of variations in the types and concentrations of COCs throughout the study area, information resulting from Stage 2 may be too specific to an OU for general inclusion in other study area RFI/RI documents.

9.1.1 Data Quality Objectives

DQOs for all study area EE activities were determined to be as follows:

- Qualitatively describe the ecological setting of the study area with specific reference to endangered species and migratory bird habitat concerns.
- Using a COC selection criteria specifically tailored for study area sites and the list of contaminants identified during scoping and documented by the Phase I abiotic sampling program, define contaminants that are of concern to biota.
- Identify specific exposure points, transport media, and exposure point concentrations potentially available to biota.
- Identify mechanisms and pathways for uptake of COCs by biota.
- Empirically determine through tissue analysis whether uptake of contaminants has occurred in selected biota collected within the study area.
- Identify mechanisms and pathways for biotic transport of COCs beyond the boundaries of the study area.
- Summarize the assumptions, uncertainties, and qualifications appropriate to the overall process of exposure assessment and contamination characterization.

Specific DQOs for particular sampling methodologies are provided in Section 9.2.5 of OU10 environmental evaluation field sampling plan.

Industrial area criteria for identifying COCs and key receptor species were reviewed with the ongoing RFP Risk Assessment Technical Working Group, comprised of representatives from DOE, EPA, CDH, U.S. Fish and Wildlife Service, and Colorado Division of Wildlife. This group ensures an integrated effort and provides a means for obtaining input from regulatory agencies and natural resource trustees throughout the preliminary planning and implementation tasks.

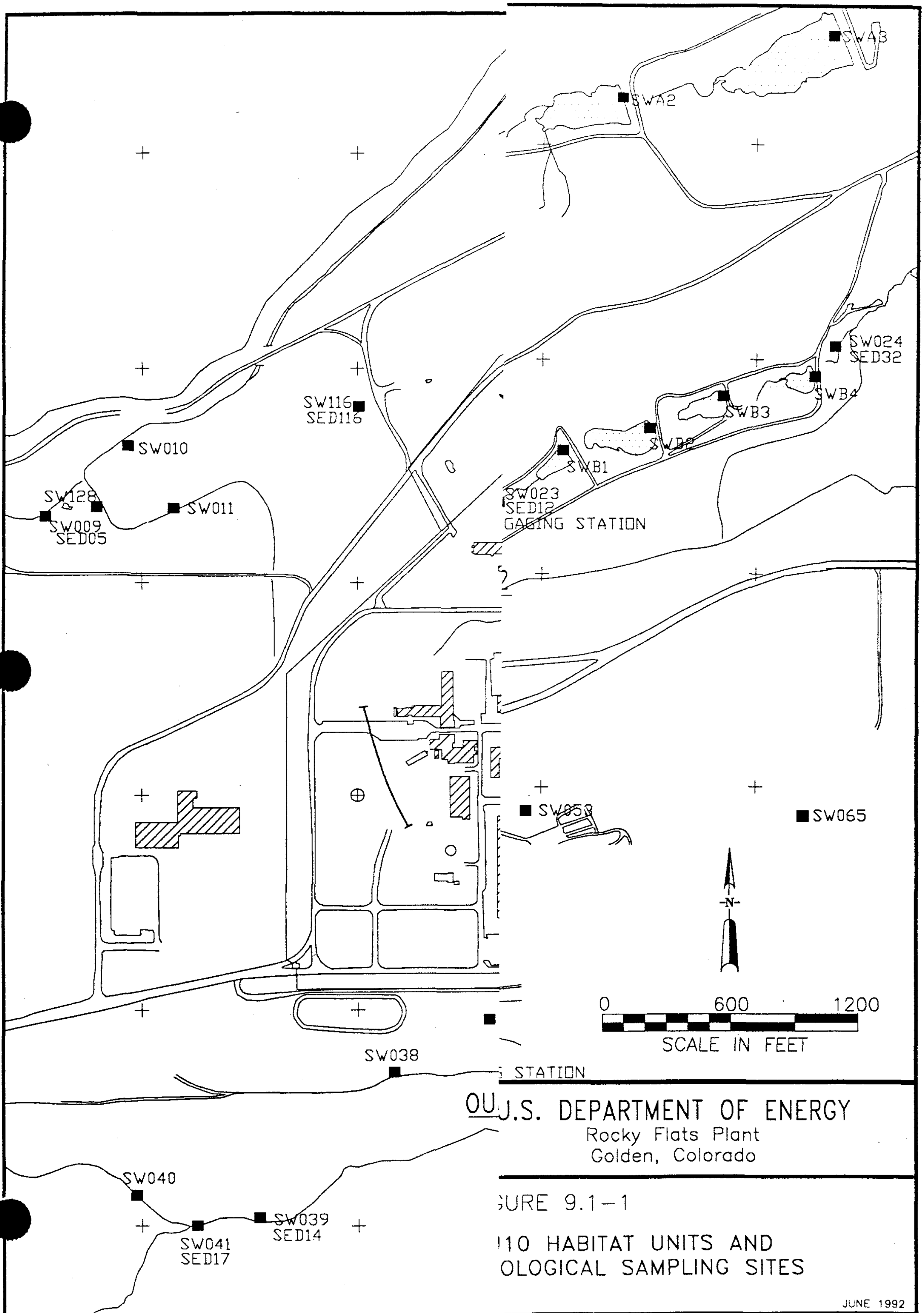
Coordination with this group will continue throughout all study area EE activities. Approved procedures for monitoring and controlling data quality were identified in the Ecology Standard Operating Procedures Manual (EG&G 1991c) and in the site-wide QAPjP (EG&G 1991d). The SOPs also provide the criteria for taxon specific sampling approach and design.

9.2 SITE DESCRIPTION

OU10 consists of highly disturbed and developed sites that are typically surrounded by other OUs having similar degrees of alteration. As a result, neither aquatic nor terrestrial ecosystems are well developed in OU10. Section 2.1 provides detailed physical characterization of OU10.

In planning the OU10 EE and its coordination with other ongoing programs, several sources of pertinent information were located. EE data collection is currently underway at three OUs with proximity to some of the OU10 IHSS (Figure 9.1-1): OU1 (881 Hillside) adjacent to IHSS 177, OU2 (903 Pad, Mound, and East Trenches Area) adjacent to IHSS 213, and OU5 (Woman Creek Drainage) downgradient from OU1 and OU2. Data from OU6 (Walnut Creek) may be available in time for comparison with information from IHSS 124, 124.1, 124.2, 124.3, 174, 176, 206, all of which are upgradient from Walnut Creek. Evaluation of data from these OUs may aid in understanding contaminant migration into or from OU10. IHSS 174 is surrounded by areas sampled under the wildlife/vegetation baseline study, which may provide a basis for ecological comparison. The remaining IHSS, while they may be upgradient or upwind from an OU or a sampled surface water station, are surrounded by too much asphalt for them to have a reasonably identifiable connection with data from these locations.

Preliminary reviews of available data show some organics to be present above detection limits in soil, inorganics to be present in surface water and soil, metals to be present in surface water and surficial soil, and radionuclides to be present in surficial soil (see Section 2.2). The validity of the levels reported is currently being evaluated as part of the RFI/RI effort. Few of the potential contaminants are likely to be accumulated or concentrated by potential biological



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receptors if present at sufficient concentrations.

To date, the heavy metals reported in OU10 are: aluminum, arsenic, barium, beryllium, cadmium, calcium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, vanadium, and zinc. These have all been detected in surficial soils. Cadmium, lead, mercury, and vanadium were detected at elevated levels at one or more IHSS. Limited surface water and groundwater samples and few sediment samples have been collected at OU10. Cadmium was also detected above background in all surface water samples at IHSS213 and 214. The occurrence of these metals at elevated levels does not necessarily imply that they are available for assimilation in all organisms or that they transfer to successive trophic levels. The potential for adverse effects to occur is dependent on a number of physicochemical factors including-physiological and ecological characteristics of the organism,forms of dissolved trace metals,forms of trace metals in ingested solids, and chemical and physical characteristics of water (Jenne and Luoma 1977). Brief summaries of information from the AWQC document (EPA 1986) and other available toxicological literature on these metals of likely concern will be evaluated against site-specific concentrations data in the selection of COCs and key receptor species.

In OU10, several radionuclides have been detected: americium241; plutonium239, 240; uranium-233, 234; and uranium238. All of these have been detected in surficial soil. In this medium, americium, plutonium, and uranium were reported at elevated levels. Limited surface water and groundwater samples and a few sediment samples have been analyzed from OU10. Gross alpha and gross beta have also been detected in surface water, but are below background value.

9.3 RESOURCE AND HABITAT DESCRIPTION

Terrestrial and aquatic species in the RFP area have been described by several researchers: Quick 1964, Weber et al. 1974, Winsor 1975, Clark 1977, Clark et al. 1980, CDOW 1981, 1982a, and 1982b. Many of these reports are summarized in the sitewide final EIS (DOE 1980). In addition, terrestrial and aquatic radioecology studies conducted by Colorado State University and

DOE (Johnson et al. 1974, Little 1976, Hiatt 1977, Paine 1980), along with annual monitoring programs at RFP, have provided information on the occurrence and relative distribution of plants and animals in the area. More recent data on species distribution and abundance was obtained from the Baseline Vegetation/Wildlife Studies and EEs underway at OU1 (881 Hillside), OU2 (903 Pad, Mound, and East Trenches), and OU5 (Woman Creek) which are scheduled for completion in FY92-93.

Initial site visits were conducted in the study area between June and September 1991 to inventory current site conditions, nature and extent of terrestrial and aquatic ecosystems, plant and animal species, and habitats. The study area for the EE was defined preliminarily to help scope the investigations and field sampling plan, as well as to physically locate the OU10 study area in relationship to North and South Walnut Creek (OU6), Woman Creek (OU5), 881 Hillside (OU1), Solar Evaporation Pond (OU4), 903 Pad, Mound, and East Trenches (OU2), and PondB-2 (part of OU6). Other OUs within the control area have been designated, but no known study areas have been delineated.

The initial site visit determined the extent of the ecosystems and habitats present on the site, and the relationship of the OU10 study area to other OUs. The ecosystems and habitats at the OU10 study area are within the industrial portion of the site with buildings, roads and other infrastructure to support the operations. The area has been highly altered by construction and operation of the waste lines and other surrounding buildings and facilities. There are no pristine natural ecosystems present, although OU10 has some vegetation established by planted trees and landscaping around buildings and natural seeding (mostly weed species) and some wide ranging and hardy animals.

No systematic assessment of vegetative cover or animal species was conducted during the initial site visit. Observations were made on the types of vegetation present and on the presence or signs of animals. The following comments are based on observations taken during the initial site visit and general information from other reports. Habitats in the study area were identified in accordance with SOP 5.11 (DOE 1990). Habitats at OU10 and the study area are greatly influenced by the industrial site and its use, and are all disturbed types. Industrial buildings and facilities (type #520) occupy the majority of the study area surface. The main habitat type outside of the industrial portion on OU10 is disturbance/barren land habitat (type #420) with a few areas of cheatgrass/weedy forbs habitat (type #410). There were no other habitat types observed during the initial site visit, with the exception of small areas of short marsh (type #020) around seeps north of the 700 buildings.

9.3.1 Terrestrial Habitat

Terrestrial ecosystems in developed areas at the site are highly modified by the industrial complexes. Signs of ecological succession, indicated by the first stages of revegetation by plants and invasion by small animals, occurs at only several small locations within OU10. Typically, weedy vegetation has re-colonized suitable habitat around the waste lines and tanks. However, control and management procedures against weeds has limited plant growth. Very few arthropods and other invertebrates were observed on plants, although birds and small mammals occasionally visit the OU 10 area. Ubiquitous small mammals such as deer and house mice are expected, and cottontail rabbits were observed within the area.

The weedy species found at most sites in the study area included kochia *(Kochia scoparia)*, yellow sweet clover *(Melilotus officinalis)*, white sweet clover *(Melilotus albus)*, knot weed *(Polygonum sp.)*, daisy fleabane *(Erigeron strigosus)*, scorpionweed *(Phacelia heterophylla)*, Russian knapweed *(Centaurea repens)*, goatsbeard *(Tragopogon dubius)*, wooly plantain *(Plantago sp.)*, Canada thistle *(Cirsium arvense)*, musk thistle *(Carduus nutans)*, peppergrass *(Lepidium sp.)*, bindweed *(Convolvulus arvensis)*, ragweed *(Ambrosia sp.)*, sunflower *(Helianthus sp.)*, mullein *(Verbascum thapsus)*, verbena *(Verbena bracteata)*, toadflax *(Linaria dalmatica)*, ragwort *(Senecio sp.)*, dock *(Rumex sp.)*, common St. John's-wort *(Hypericum perforatum)*, salsify *(Tragopogon dubris)*, quackgrass *(Agropyron repens)*, filaree *(Erodium cicutarium)*, yucca *(Yucca* *glauca)*, buffalograss *(Buchloe dactyloides)*, and prickly lettuce *(Lactuca serriola)*. These species also often formed an ecotone between the asphalt and more suitable habitats.

Meadow sideslopes were found to contain smooth brome *(Bromus inermis)*, Japanese brome *(Bromus japonicus)*, redtop *(Agrostis stolonifera)*, crested wheatgrass *(Agropyron cristatum)*, gumweed *(Grindelia squarrosa)*, velvety guara *(Guara parviflora)*, and cottonwoods *(Populus sargentii)*. Low areas receiving drainage contained common cattail *(Typha latifolia)* and narrowleaved cattail *(Typha angustifolia)*. A moist area near IHSS 176 contained sand bluestem *(Andropogon hallii)*, sand dropseed *(Sporobolus cryptandrus)*, redtop, eriogonum *(Eriogonumsp)*., red threeawn *(Aristida longiseta)*, crested wheatgrass, mullein, ragwort, yellow and white sweet clover, ragweed, thistle, and sunflower.

A dry upland in the vicinity of IHSS 213 contained bluegrass *(Poa sp.)*, needle-and-thread *(Stipa comata)*, smooth brome *(Bromus inermis)*, junegrass *(Koeleria pyramidata)*, foxtail *(Setaria viridis)*, western wheatgrass *(Agropyron smithii)*, as well as some of the more weedy species such as toadflax, mullein, allysum *(Alyssum sp.)*, plantago, sunflower, goatsbeard, dandelion *(Taraxacum officinale)*, daisy fleabane, and geranium *(Geranium caespitosum)*. A spruce tree *(Picea pungens)* had been planted near the north end of the site. Within the Property Protection Area (PPA) is a dry weedy upland area surrounded by extensive grassland areas. The following species are present: rush *(Juncus sp.)*, foxtail, Russian knapweed *(Centaurea repens)*, peppergrass, geranium, Canada bluegrass *(Poa compressa)*, and *Gaillardia sp.* Plantings adjacent to several of the buildings included horticultural varieties of juniper *(Juniperus virginiana)* and spruce trees.

9.3.2 Aquatic Habitat

Extensive aquatic ecosystems are lacking within the study area due to its location at the head of a drainage. There are no streams or natural bodies of water that are not in overlap with those in other OUs. To the north and east are the drainages of North and South Walnut Creek; Woman

Creek and OU1 to the south. Both of these drainages have terrestrial and/or aquatic ecosystems that could be impacted by contaminants migrating from OU10. Two small marshy seeps with cattails were observed just north of the Buildings 771 and 774.

9.3.3 Biota

Plant and animal species observed and known to be present on the OU10 study area have reduced numbers of individuals and community diversity compared to the buffer zone. Restricted numbers of individuals and reduced diversity are a result of the large amount of surface and space occupied by the industrial facilities, bare areas, and intense management for weeds and insects. Plant species are weedy forbs and hardy grasses with no shrubs or trees, other than planted landscape trees. Animal species are those adapted to disturbed or industrially developed areas or are wide ranging and highly mobile. The higher trophic levels of consumers and predators are few, and those present are few in numbers. These consumers and predators are occasional visitors and are not restricted to the ecosystems at OU10.

Flying over the study area, and occasionally perched on structures within it were a number of bird species: barn swallow *(Hirundo rustica)*, house finch *(Carpodacus mexicanus)*, vesper sparrow *(Pooecetes gramineus)*, western meadowlark *(Sturnella neglecta)*, American robin *(Turdus migratorius)*, western kingbird *(Tyrannus verticalis)*, Say's phoebe *(Sayornis saya)*, house sparrow *(Passer domesticus)*, common grackle *(Quiscalus quiscula)*, starling *(Sturnus vulgaris)*, raven *(Corvus corax)*, killdeer *(Charadrius vociferus)*,and common nighthawk *(Chordeiles minor)*.

Bees, damselflies, dragonflies, and grasshoppers were observed in the area, as were a plains gartersnake *(Thamnophis sirtalis)* and desert cottontails *(Sylviladus audubonii)*.

9.3.4 Wetlands

Wetlands have been identified north of OU10 on the slopes below the 700 series buildings. These occur mostly as isolated seeps that support hydrophytic vegetation species including broadleaf cattail *(Typha latifolia)*, baltic rush *(Juncus balticus)*, and various bulrushes *(Scripus spp.)*. These may be evaluated by releve plots for collection of phyto-sociological data on density and species composition.

9.3.5 Species of Concern and Habitats

In general, use of the OU10 study area or the study area by species of concern is discouraged due to lack of suitable habitat and/or prey. Endangered species of animals potentially present in or near RFP site include the black-footed ferret *(Mustela nigripes)*, two subspecies of peregrine falcon *(Falco peregrinus tundris* and *F. p. tanatum)*, and bald eagle *(Haliaeetus leucocephalus)*.

Black-footed ferrets are not known to occur in the vicinity of RFP, although there are historical reports of their presence in the Denver area. Their critical habitat is primarily associated with colonies of their major food item, prairie dogs. There are no black-footed ferret colonies within the OU10 study area, although two small black-tailed prairie dog colonies are located about 1,500 meters northeast and 2,000 meters east of OU10 and aggregate to about 10 and 5 hectares, respectively. Each contained fewer than 40 individuals. Ferrets may be associated with prairie dog colonies above a certain size; however, given the small size of these colonies, it is extremely unlikely that *M. nigripes* is present.

Bald eagles occur occasionally in the RFP area, primarily as irregular visitors during the winter or migration seasons. As winter residents, they may be seen around lakes and rivers; the closest known nesting pair is located at Barr Lake, 40 km east of RFP. Although RFP lacks habitat suitable for bald eagle nesting, this species has been observed flying over the northeast quadrant of the buffer zone. Records of observation show that one pair has been feeding over the northeast quadrant of the buffer zone and one pair has been feeding at Great Western Reservoir, approximately 0.9 km east of RFP. None have been observed roosting or hunting on RFP, nor have they been observed in proximity to OU10.

Peregrine falcons may occur as migrants. Two individuals of this species were observed at RFP in early fall; one flying from west to east near the west gate, the other perched on a powerline near Pond B-5 attempting to capture a killdeer inbound to the pond. The Peregrine Falcon Recovery Plan discourages land-use practices and development that may adversely alter the character of the hunting habitat or prey base within a 16 km radius of a nesting cliff. As there are two such cliffs within 8 and 11 km of RFP, the entire plant site is within the area of protection of potential foraging habitat. However, no nesting activities have been observed at RFP and no nesting or foraging activities have been observed on or in proximity to OU10. In 1991, a pair was reported as nesting approximately 10 km to the northwest of RFP. It is possible that the hunting territory of the nesting peregrines will include RFP, although suitable habitat and prey are lacking at OU10.

Other federal candidate animal species that are potentially present at RFP include the white-faced ibis *(Plegadis chichi)*, mountain plover *(Charadrius montanus)*, long-billed curlew *(Numenius americanus)*, Preble's meadow jumping mouse *(Zapus hudsonius preblei)*, ferruginous hawk *(Buteo regalis)*, Swainson's hawk *(Buteo swainsonii)*, and swift fox *(Vulpes velox)*.

To date, the Preble's mouse, ferruginous hawk, and Swainson's hawk have been documented at RFP. One *Z. h. preblei* was confirmed as having been captured and released in a rehabilitation habitat-type transect (in OU1 at MR02A) about 200 meters south of the study area during the spring 1991 sampling season. Ferruginous hawks were observed adjacent to the study area in the winter, spring, and early summer of 1990-91. A juvenile male was resident in the vicinity for a 6week period in early late spring and early summer 1991; nesting was not documented. This individual was observed hunting primarily in the riparian zone of Woman Creek and along OU1 (881 Hillside), directly south of the study area. Most observations of this species have been in association with prairie dog colonies southeast of RFP. A pair of Swainson's hawks attempted to nest in early June 1991 in a cottonwood about 2,000 meters southeast of the study area. The nest was abandoned for unknown reasons in early July 1991. During this period, members of the pair were not observed hunting in the vicinity of RFP, although other observations of this species have been documented infrequently, but widely, on the RFP site.

Only one endangered plant species, the Diluvium (or Ute) Lady's Tresses *(Spiranthes diluvialis)* is potentially present in or near RFP. Appropriate habitat for *Spiranthes diluvialis* includes wet soils in the company of a variety of mesic native and introduced grasses and forbs. Populations of the plant have been found along Clear Creek in Jefferson County to the south and near South Boulder Creek in Boulder County to the north of RFP. There are a small marshy areas around seeps adjacent to the study area that may be suitable habitat for this species.

Other federal candidate or state species of concern plants that are potentially present at RFP include the Colorado butterfly plant *(Gaura neomexicana var. coloradensis)*, forktip threeawn *(Aristida basiramea)*, and toothcup *(Rotala ramosior)*. The forktip threeawn was reported along Woman Creek in 1973 and, in 1991, just south of the west access road used to enter the plant site, growing on gravel scars bordering an old roadway, 500 meters west of the study area. This gravel habitat can apparently support the species when other plants are absent and adequate moisture can accumulate. Given these habitat preferences, it is possible that this species may be found in the study area, although none have been observed there. Appropriate habitat for the Colorado butterfly plant includes the transition zone between wetland bottoms and the drier uplands associated with wet meadow habitat. The toothcup was reported in a temporary pool approximately 6 km east of Boulder. Given a lack of suitable habitat for these species in the study area, there is little probability that the species would occur in or near OU10.

9.4 HABITAT AND BIOTA SURVEYS (STAGE 1 TASKS)

Data gathered during initial industrial operable unit site assessments will be expanded through conduct of a more detailed, qualitative survey throughout the study area. This survey will provide the following information:

- A more comprehensive view of the types and areal extent of habitat within the study area and vicinity.

- A determination as to the presence or absence of migratory and raptor bird species, including waterfowl and passerine species.

- A determination as to the presence or absence of foraging, breeding, or nesting habitat for migratory and raptor bird species, including waterfowl and passerine species.

- A determination as to the presence or absence of species of concern for which habitat exists.

- A determination as to the presence or absence of foraging, breeding, or nesting habitat for species of concern.

- Data on the species, numbers, and movement patterns of small mammals living in or near the study area, including an assessment of the presence or absence of the Preble's mouse within the study area.

- Data on the histopathology of selected tissues from small mammals and unfledged birds living in or near the study area.

All references to methodologies used for ecological surveys at RFP are specified in the Standard Operating Procedures (SOP) Manual: Volume 5.0, Ecology (EG&G 1991c). These SOPs have been approved for use on CERCLA/RCRA investigations by EPA, CDH, the U.S. Fish and Wildlife Service, and the Colorado Division of Wildlife (CDOW).

9.4.1 Species of Concern Compliance List

Table 9-1 lists all of the species of concern (SOC), both federal and state, that may be present at RFP. Species that have been documented at RFP are marked with a "Y" in the "RFP" column. Species that have some probability of being present within the industrial area due to either a sighting or the presence of suitable habitat are marked with a "Δ" in the "SITE" column; surveys will focus on these species. Species not marked in this table have been screened from consideration at this time due to a lack of suitable habitat, although some may be brought back into consideration if surveys reveal the presence of suitable habitat.

Table 9-1 LIST OF SPECIES OF CONCERN WITH HABITAT PREFERENCE

Group	Common Name	Scientific Name	Status	RFP	Site	Habitat	Time
Plants	Forktip Threeawn	Aristida basiramea	cs	Y	Δ	xeric uplands with sandy soils and open barrens	year-round blooms?
	Colorado Butterfly Plant	Gaura neomexicana var. coloradensis	C2,cs			transition between wetland bottoms and drier uplands above wet meadows	year-round blooms Jul-Sep
	Toothcup	Rotala ramosior	cs			obligate wetland species	year-round blooms?
	Diluvium Lady's Tresses	Spiranthes diluvialis	E,cs		Δ	moist swales dominated by grasses, wetlands dominated by sedges, rushes, and cattails	year-round blooms late Jul-Aug
Amphibians and Reptiles	Northern Leopard Frog	Rana pipens spp.	C2,cu	Y?		breeds in marshes and intermittant ponds, forages in riparian and mountain meadows	year-round breeds Mar-Jun
	Texas Horned Lizard	Phrynosoma cornutum	C2,ng			arid and semiarid open country, xeric uplands	year-round forage in am
Fish	Plains Topminnow	Fundulus sciadicus	C2			streams, lakes	year-round spawn sp & esm
	Common Shiner	Notropis cornutus	cs			streams, lakes	year-round spawn sp & esm
Birds	Peregrine Falcon	Falco peregrinus	E,e	Y	Δ	nest in cliffs, forage in upland and wetland areas	year-round sp & fl
	Bald Eagle	Haliaeetus leucocephalus	E,e	Y		perch trees near body of water, riparian areas, or wetlands	year-round sp & fl
	White-faced Ibis	Plegadis chichi	C2,ng			near streams, meadows, ponds, and agricultural fields	migrant sp, esm, fl
	Ferruginous Hawk	Buteo regalis	C2,ng,cs	Y	Δ	breeds in shortgrass prairie, croplands, mountain meadows, parks	year-round
	Whooping Crane	Grus americana	E,e			forages in marshes, cropland (grain fields), and sagebrush	migrant sp & fl
	Harlequin Duck	Histrionicus histrionicus	C2			open water	migrant sp & fl
	Western Snowy Plover	Charadrius alexandrius nivosus	C2,ng,cs			prefers lakes and reservoirs	migrant sp & fl
	Mountain Plover	Charadrius montanus	C2,ng,cs			xeric upland, shortgrass prairie	breeds esp-fl
	Piping Plover	Charadrius melodus	T,t			forages on open water or wet open ground	migrant sp & fl
	Long-billed Curlew	Numenius americanus	C3,ng,cs			grassland, lakes, reservoirs or marshes	migrant sp & fl
	Least Tern	Sterna antillarum	E,e			forages on open water or wet open ground	migrant sp & fl
	Black Tern	Chlidonias niger	C2,ng			breeds in marshes, uses marshes and open water for migration	breeds esp-em migrates sp & fl
	Swainson's Hawk	Buteo swansonii	C3C,ng	Y	Δ	nests in trees/shrubs, forages in grassland, ag land, riparian areas, and greasewood	year-round breeds lwn-sp
	Yellow-billed Cuckoo	Coccyzus americanus	C3B,cu,ng			riparian lowland, transition areas	breeds esp-em migrates sp & fl
Mammals	Swift Fox	Vulpes velox	C2, cu			shortgrass prairie, arid areas with loose soils	year-round breeds wn
	Black-footed Ferret	Mustela nigripes	E,e			prairie dog colonies	year-round
	Prebles Meadow Jumping Mouse	Zapus hudsonius preblei	C2,cs	Y	Δ	moist fields, brush, brushy field, marsh, thick veg woods	breeds lsp-esm forage sp & sm
	Fringed Myotis	Myotis thysanodes	C2,ng			old buildings	breeds sp forage sm

Key:

(E) endangered species (federal)
(T) threatened species (federal)
(P) proposed to list (federal)
(e) endangered species (state)
(C1) Federal Category 1 (propose to list)
(C2) Federal Category 2 (appropriate to list but no data)
(C3) Federal Category 3 (formerly proposed)
(t) threatened species (state)
(ng) Colorado State nongame species
(cs) Colorado State species of concern
(cu) Colorado State undetermined species
(Y) Species documented to be present
Δ Species potentially present

9.4.2 Literature Review

A comprehensive literature review was performed as part of the RFP baseline biological inventory program. This literature review involved surveying available pertinent documents and data to provide a synoptic background description of the wildlife and vegetation resources on site. Information extracted during this process was summarized in the form of an annotated bibliography that will be used to support interpretation of survey results.

A recent report, Threatened and Endangered Species Evaluation, Rocky Flats Plant (EG&G 1991b), provides a broad picture of potential SOC species at RFP and contains a literature review for those species, which include migratory bird species. Literature searches have been performed for all of the additional species, including migratory bird species, on the SOC Species Compliance List (Table 9-1) and this information is included as Attachment 2 in Identification and Reporting of Threatened and Endangered and Special Concern Species, EMD Administrative Procedures Manual (3-21000-ADM), Procedure NEPA.12 (EG&G 15 October 1991).

9.4.3 Expert Consultations

EG&G has discussed the potential occurrence of *Spiranthes diluvialis, Aristida basiramea, Zapus hudsonius preblei, Gaura neomexicana*, and other SOC species with Dr. Fred Harrington (Ebasco Environmental), who currently serves as Field Supervisor for the sitewide biological baseline studies and for the OU1 EE. In addition, EG&G has obtained the services of Dr. David Buckner (ESCO Associates) to conduct surveys specifically for *Spiranthes diluvialis* and/or its habitat. Dr. Buckner is a locally recognized expert in the life history and habitat preferences of this particular species, and has done similar work for the Army Corps of Engineers and the U.S. Fish and Wildlife Service. EG&G may also call upon the services of Dr. Jim Fitzgerald, a mammalogist at the University of Northern Colorado, who can provi de guidance with regards to the life history, habitat preferences, and trapping requirements of *Zapus hudsonius preblei.*

9.4.4 Ecological Field Investigations

All surveys will take place between the beginning of April and the end of September 1992 (the "study period"), to coincide with the height of the summer season when there will be the greatest probability of encountering plant and animal species using habitats on or near the study area. Surveys for *Spiranthes diluvialis* will occur twice during August to coincide with the peak flowering period for this species. These investigations will cover the entire istudy area and the results obtained will be applied to the preparation of RFI/FI Phase reports for all other study area OUs.

9.4.4.1 Habitat Presence Verification

This task will involve a comprehensive survey and mapping of types and extent of habitats, particularly habitats that could support species of special concern such as migratory birds. Habitat types in the study area were cursorily described during the initial site assessment in June and September 1991, at which time four habitat types were enumerated. A more recent Rocky Flats Vegetation Map (June 1992) details a total of seven habitat types within the study area.

During Stage 1, a more accurate assessment of the types and areal extent of habitat within the istudy area will be undertaken. Habitats in the study area will be identified in accord with SOP 5.11. Survey results will be used to validate or correct the Rocky Flats Vegetation Map, as well as to limit other survey efforts in that: bird surveys (Section 9.4.4.2) will not be performed if it is not possible to verify the existence of suitable migratory bird or raptor foraging habitat within the study area and vegetation surveys (Section 9.4.4.3) will not be performed if it is not possible to verify the existence of either: (a) suitable migratory bird or raptor breeding or nesting habitat (b) suitable species of concern habitat, or (c) specifically, suitable *Spiranthes diluvialis* habitat within the study area. Soil series will not be mapped because of the heavily disturbed nature of the soil surface within the study area.

9.4.4.2 Birds

Qualitative methods will be employed during this survey to determine which bird species are present, their number, their general behavior, and the habitat in which they were observed. Special attention will be given to the presence and/or use of habitats by raptors and migratory birds, including waterfowl and passerine species. Opportunistic observations of bird nests and raptor nests will also be recorded. Birds species in the study area will be surveyed in accord with SOP 5.7. If initial qualitative surveys suggest that avian utilization of the study area is greater than might be expected, quantitative sampling methods may also be employed.

9.4.4.3 Vegetation

The objectives of the vegetation survey are to assess the extent, quality, and structure of habitat available to migratory bird species and small mammals. In addition, this survey program may provide data for description of site vegetation characteristics, determination of impacts to plant communities, identification of potential exposure pathways from contaminant releases to higher trophic-level receptors, and selection of target taxa for contaminant analysis during Stage 2, and identification of any protected plant species or habitats. Qualitative methods will be employed to determine plant species present by community type, as well as data on abiotic features. Terrestrial and aquatic vegetation in the study area will be surveyed in accord with SOP 5.10. If initial qualitative surveys suggest that terrestrial or aquatic vegetation communities in the study area are more complex than might be expected, quantitative sampling methods may also be employed.

Qualitative sampling will involve compiling a comprehensive species list for each community type (as identified in Section 9.4.4.1) by traversing all appropriate portions of the study area at least twice throughout the growing season, and describing abiotic features such as substrate, topography, and soil moisture that could influence composition and structure. The releve method (also known as the sample-stand or species-list method) will be used since the area is too limited for cover transects (Section 6.3.1, SOP 5.10).

Diluvium Lady's Tresses survey

Directed surveys for this species will be conducted at all points near or within the study area where potential habitat for this species exists. These surveys will be conducted by a locally recognized expert in the life history and habitat preferences of this particular species.

9.4.4.4 Mammal Population Characterization

During Stage 1, general field surveys will be conducted to collect data on terrestrial wildlife in the study area. Objectives for this general work are to describe existing wildlife habitats in the area; develop food web models, including contributions from vegetation; identify potential contaminant pathways through trophic levels; identify target taxa for collection and tissue analysis during Stage 2; and provide a general description of the community.

Small mammal (primarily cricetine or microtine rodents), and possibly larger mammal (cottontail rabbits) populations, will be surveyed throughout the study area for their presence or absence. Mark-recapture or other population assessment methods will be employed to gain an understanding of their population characteristics and movement patterns. Small mammals in the study area will be live-trapped in accord with SOP 5.6, larger mammals in accord with SOP 5.5. Trap grids will be established, at stations within the study area congruent with those intended for later ecotoxicological work (c.f., Section 9.5.2.1), using rat-sized Sherman non-collapsible live traps (25 x 8 x 8 centimeters) placed at 10 meter intervals. Grid size and length of trapping sessions may vary at each station. Captured animals will be ear-tagged and released, and capture locations noted. Species population levels, including 95% confidence limits, will be estimated using a modification of the Overton iterative extension of the Schnabel method. Total rodent populations for each station will be estimated from combined species capture-recapture data. This information will be used during Stage 2 to guide ecotoxicological sampling efforts.

Preble's Meadow Jumping Mouse survey

Directed surveys for this species will be conducted at all points within the study area where either potential habitat for this species exists or where it is possible that this species is foraging. A locally recognized expert will provide guidance regarding the life history, habitat preferences, and trapping requirements of this species. It is anticipated that destructive trapping techniques ("Museum Specials") may be required to provide a reasonable probability of capture for this species. Any destructive trapping for this species will occur only after all live trapping for the determination of population characteristics has been completed.

9.4.4.5 Preliminary Ecotoxicological Investigations

The use of museum special traps during the *Z. h. preblei* survey will undoubtedly result in the inadvertent collection of specimens of other small mammal species. Any such fortuitous specimens will be either used to initiate histopathological investigations of selected organs and tissues in order to develop baseline pathology data, or appropriately preserved for use in ecotoxicological investigations following selection of the target analyte list (see Section 9.5.1.3)

9.4.5 Reports

The Stage 1 EEWP effort will produce three discrete reports: (1) a final study area habitat survey report, which will ensure compliance with the MBTA and FWCA, (2) a final study area biological survey report (if there is habitat suitable for threatened and endangered species within the istudy area), which will ensure compliance with the informal consultation requirements of the Endangered Species Act, and (3) a technical memorandum describing the outcome of the small mammal investigations and developement of a histopathological database. These reports will comprise the EE portion of the baseline risk assessment in the Phase I RFI/RI report.

9.4.5.1 Final Industrial Area Habitat Survey Report

This report will discuss the findings of the field survey work relative to the presence or absence of migratory bird or raptor species and/or the habitat required for their foraging, breeding or nesting activities. Should such species or habitat be present within or near the study area, an analysis of potential impacts resulting from site characterization activities will be presented. Where appropriate, the discussion will cover effects on water-related activities, wildlife benefits and losses, or possible conservation measures and conclude with a determination by RFP as to the impact of site characterization activities. Should a substantive report emerge from this Stage 1 effort, the information contained therein will be available for preparation of future mitigation reports analyzing potential impacts resulting from proposed site remediation activities.

9.4.5.2 Final Industrial Area Biological Survey Report

This report will discuss the findings of the field survey work relative to the presence or absence of compliance-listed species (Table 9-1) and/or the habitat required for their foraging, breeding or nesting activities. Should such species or habitat be present within or near the study area, an analysis of potential direct, indirect, or cumulative impacts resulting from site characterization activities will be presented. This analysis will conclude with a determination by RFP as to the impact of site characterization activities on compliance-listed species. The presence of a federal threatened or endangered species within or near the study area will also trigger the mandatory consultation process with the U.S. Fish and Wildlife Service as stipulated by 50 CFR 402 and 321000-ADM-NEPA.12, Identification and Reporting of Threatened and Endangered and Special Concern Species. Should a substantive report emerge from this Stage 1 effort, the information contained therein will be available for preparation of future mitigation reports analyzing potential impacts resulting from proposed site remediation activities.

9.4.5.3 Small Mammal Population Technical Memorandum

This is intended as a brief report describing results obtained from the small mammal live-trapping and mark-recapture survey. Information contained in this memorandum will provide a basis for design and/or modification of proposed Stage 2 ecotoxicological investigations.

9.5 ECOTOXICOLOGICAL INVESTIGATION (STAGE 2 TASKS)

Stage 2 ecotoxicological tasks may be performed during either Phase I or Phase II of an RFI/RI investigation. It is anticipated that an ecotoxicological investigation will be conducted as soon as a reasonable list of bioaccumulating or bioconcentrating COCs is compiled for the study area.

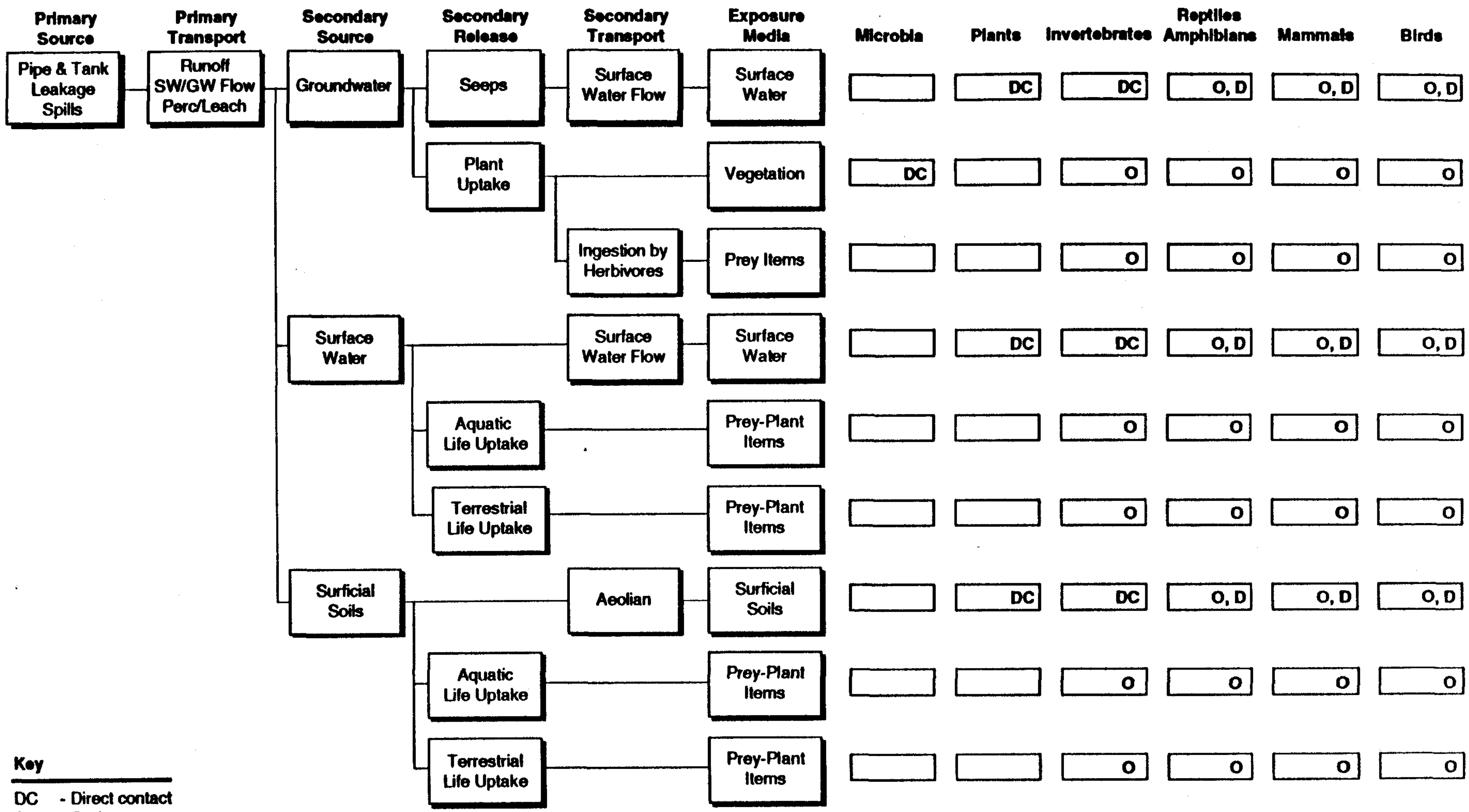
Ecotoxicological investigations to be performed at study area OUs will be significantly less complex than those performed in more ecologically robust OUs. A guiding assumption for study area OUs is that few, if any, contaminant susceptible ecological features will exist within the study area. The study area will be treated as a potential source for contaminants, rather than as a point of impact for contaminants. Therefore, investigations proposed for study area OUs will focus on determining the potential for biotic uptake and transport of contaminants from the study area into adjacent watersheds, drainages, or operable units.

9.5.1 Objectives

Investigative tasks will consist of developing a site-specific Conceptual Exposure Model to identify potential exposure pathways for on-site biota, developing a site-specific Conceptual Biota Transport Model to identify potential biotic off-site transport pathways, selecting biologically active COCs (target analytes), selecting of representative target taxa, directly measuring target analytes within target taxa, and conducting histopathological investigations of selected organs and tissues to develop baseline pathology data.

9.5.1.1 Conceptual Exposure Model

A biota-specific model (Figure 9.5-1) will be used to qualitatively identify the actual or potential pathways by which various biological receptors at or near the study area might be exposed to site-related chemicals or radionuclides. It will help to focus the search for potentially exposed habitats or taxa within the study area. The model identifies the following five mandatory elements for a valid exposure pathway; chemical/radionuclide source, mechanism of release to the environment, environmental transport medium (e.g., soil, water, air) for the released



Key

DC - Direct contact
O - Oral
D - Dermal
GW - Groundwater
SW - Surface water
Perc - Percolation

Key Assumptions

1. COCs are primarily metals.
2. Addition of volatiles or semivolatiles will cause addition of volatilization pathways.

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Figure 9.5-1

Industrial Area Conceptual Exposure Model

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chemical/radionuclide, point of potential biological contact (exposure point) with the contaminated medium, and biological uptake mechanism and absorption (dose) at the point of exposure.

Surficial soil samples will be of prime importance for determining source contaminants for on-site biota. The uppermost layer is a major source of nutrients and contaminant uptake for on-site vegetation. It is also a potential source for contaminants ingested by soil dwelling animals and invertebrates and their predators. Soil samples from all depths are related to surface water and groundwater regimes. Fluids moving through soils can leach contaminants, transport them through available flow paths, and deposit them in downgradient environments. Contamination in soil and groundwater at a depth of greater than 6 meters maximum depth of burrowing animals and plant root penetration) will not be considered as affecting biota. Contamination at these depths may be considered if other RFI/RI studies suggest that they may reach the surface.

Surface water from the study area flows toward North Walnut, South Walnut, and Woman Creeks. Surface water drainage and runoff is collected from buildings and roads by water collection and diversion structures (drains and ditches) that run into a series of three detention ponds along these creeks. Once impounded in these ponds, the water is treated and released. Surface water and sediment samples are collected on a regular basis as part on ongoing sitewide investigations.

Groundwater generally flows to the east of the study area in two connected groundwater systems. In the surficial materials, groundwater flow diverges in two directions: Northeast toward North Walnut Creek and east-southeast toward South Walnut Creek. In weathered bedrock, the groundwater also flows to the northeast and southeast. These flows are influenced by topography, facilities construction and grading, seasonal recharge, and the surface of the bedrock. Inorganic constituents and radionuclides have been measured in the vicinity of the Solar Evaporation Ponds and 881 Hillside. The groundwater has been found to contain VOCs, elevated total dissolved solids and nitrates, and some radionuclides. The study area is one potential source for contaminants in the groundwater. There is a potential for contaminants in groundwater to reach vegetation in wetlands around seeps and impact the biota in this habitat.

The chance of sediments in the study area being subject to disturbance by aquatic biota is considered very remote since little habitat exists. Therefore, sediments were not considered to be a viable exposure pathway for aquatic biota; the aquatic biota component was excluded from the conceptual exposure model. However, this exclusion may be reversed since a preliminary report indicated PCB (Aroclor 1254) contamination near the PPA; other modifications will result should PCB contamination be found elsewhere in the study area (EG&G 1991e).

9.5.1.2 Conceptual Biota Transport Model

A Biota Transport Model (BTM) predicts the probability of contaminant loads dispersing outward in biotic vectors from OUs located in an study area. The model provides data on the biotic dispersal of contaminants to complement data on contaminant transport in abiotic media. BTM development must rely on a combination of information sources to establish values for the parameters involved. Such sources include published life history data on target taxa and associated predators, empirical data from traplines and sweeps deployed on the study area boundaries, immigration trapline data from adjacent OUs, and professional judgement.

A BTM, or some more sophisticated variation of the concept it embodies, could be used to estimate biotic transport of contaminants from an OU, as an adjunct to abiotic transport data. Development and validation of any BTM will be unnecessary if two specific conditions cannot be met within the study area: (1) bioaccumulating target analytes are found in target taxa at above background levels and (2) life history and/or ecological data demonstrate that these taxa can or do move beyond the study area boundaries.

9.5.1.3 Target Analytes

Given the depauperate nature of the biota communities present in the study area, the disparate nature of the taxa present, and the limited character of the food webs present, target analyte selection criteria have been limited to the following criteria (which vary slightly from criteria employed at more ecologically robust OUs):

1) Occurrence: the known or suspected occurrence of a bioavailable chemical in environmental media will be ascertained from: existing data regarding abiotic media (soil, water, air), biota, waste stream identification and disposal practices, process analyses to identify potentially hazardous substances used in large quantities, or historical accounts of use or accidental release.

2) Ecotoxicity: a chemical will be considered for inclusion on the list of target analytes if, at levels detected within the study area, it is known to exhibit bioaccumulation, significant bioconcentration factors (BCFs) (>0.03 for terrestrial species; >300 for aquatic species), adherence to skin or fur, or accumulation in lung tissue.

3) Extent of Contamination: a chemical will be considered for inclusion on the list of target analytes if it is widely distributed, occurs in ecologically sensitive areas such as wetlands or seeps that may serve as a drinking water source for wildlife, or occurs in localized areas of high concentration ("hot spots").

The following list of target analytes was prepared based on contaminant information presented in Sections 2.0 and 9.2.2 and on the above three criteria: arsenic, cadmium, chromium (IV), copper, lead, mercury, PCBs, plutonium-238, plutonium-239/240, selenium, silver, uranium-238, uranium-235, and zinc.

9.5.1.4 Target Taxa

Given the depauperate communities present in the study area, the disparate distribution of the taxa present, and the limited character of the food webs present, target taxa selection criteria have been limited to the following (which vary slightly from criteria employed at more ecologically robust OUs):

- Have a reasonable home range within or near the study area.
- Be present in sufficient numbers (or sizes) to allow collection of sufficient

biomass for tissue analysis.

- Not be a threatened, endangered, or special concern species (c.f., Table 9-1).
- Display morphological anomolies.
- Have a reasonable probability (based on published information, results from Stage 1 studies or results from EE work at other OUs) of having a target analyte or analytes present in its tissues.
- Have a reasonable probability (based on published information, results from Stage 1 studies, or results from EE work at other OUs) of displaying an aberrant histopathology due to contaminant exposure

All habitats extant in the industrial area are disturbed, small, and limited in the number of taxa and trophic levels present. The most likely terrestrial food chains are: (a) weedy vegetation Æ small mammals or small birds, (b) weedy vegetation Æ insects Æ small mammals or small birds, (c) weedy vegetation Æ small mammals or small birds Æ predator, or (d) weedy vegetation Æ insects Æ small mammals or small birds Æ predator. Aquatic habitats are also extremely limited and are likely to contribute only insect taxa with aquatic life stages to a food web. Winged adult forms of these insects will enter terrestrial food chains as indicated in (b) and (d) above.

Taking into consideration the above selection criteria and food web structure within the study area, target taxa for use in ecotoxicological investigations will be limited to small mammals (mice and voles), large mammals (cottontail rabbits), and small birds (eggs or unfledged nestlings). For Stage 2 ecotoxicological activities, all taxa will be sampled by destructive techniques in order to supply tissue samples for contaminant concentration mesurements and histopathological preparations.

Small mammals are primarily species of rodents in the following families: Cricetidae (New World rats and mice), Muridae (Old World rats and mice), Heteromyidae (pocket mice and kangaroo rats), and Zapodidae (jumping mice). In a broader sense, the term is also applied to Soricidae (shrews), Geomyidae (gophers), and Sciuridae (smaller ground squirrels). Small mammals are an important component of ecological investigations and contaminant pathways analyses because they are generally abundant and easily captured, occupy small home ranges and thus reflect habitat quality or contamination of a specific area, live in intimate contact with the soil and thus are maximally exposed to surficial contaminants, include species with a wide range of diets, including leafy tissue, seeds, and invertebrates, and are a primary prey component for a variety of predators including weasels, foxes, coyotes, owls, hawks, kestrels, and snakes.

Large mammals, for the purposes of this study, are defined as all mammals other than bats that are not subject to sampling under the small mammal live trapping program. The taxa of interest here are Lagomorphs (rabbits and hares), particularly cottontail rabbits which have been observed in the study area.

Perching birds (Passeriformes) are the major taxonomic group of birds occurring within the study area at RFP. Bird abundance and richness are good indicators of habitat quality, including factors such as the availability of food, cover, and nesting sites. Avian communities may be impacted by exposure to environmental contaminants, either directly through contact with hazardous materials or indirectly via contaminant transport in the food web. Perching birds (including "songbirds") are the most appropriate group for ecotoxicological investigations due to their greater numbers, wider distributions, and smaller home ranges than larger species. They also exhibit more intimate contact with the study area environment and greater home range fidelity than do migrant species.

Deer, coyotes, fox (other large mammals possibly present in the study area), raptors, and migratory birds will have only occasional contact with the study area due to their high mobility and, therefore, sampling of these taxa is unlikely. Amphibians are also unlikely to be sampled largely due to a lack of habitat suitable for these taxa. Habitat exists for certain reptiles, but these taxa may not be present in sufficient numbers to allow or justify destructive sampling.

Using the above considerations and criteria, the following list of target taxa was compiled: SMALL MAMMALS: deer mouse (*Peromyscus maniculatus*), house mouse (*Mus musculus*), meadow vole (*Microtus pennsylvanicus*); LARGE MAMMALS: desert cottontail (*Sylvilagus audubonii*); BIRDS (eggs & un-fledged nestlings only): house finch* (*Caprodacus mexicanus*), house sparrow (*Passer domesticus*), American robin*(*Turdus migratorius*). Samples of migratory birds (*) listed in 50 CFR Part 10(B)(1) will be collected by meeting the substantive requirements of 50 CFR Part 21 (1), Migratory Bird Permits. These species, which are important to the structure and function of the food webs present on the study area, will be the only ones utilized for ecotoxicological investigations.

9.5.2 Field Sampling

Objectives of the Stage 2 field sampling program are to collect tissue samples for measurement of target analyte concentrations in terrestrial organisms, collect site specific data on biota and important abiotic parameters, collect tissue samples to support histopathological investigations, and provide data for verification and validation of the conceptual models. As indicated in Section 9.5.1.4, terrestrial sampling will be limited to small mammals (mice and voles), large mammals (cottontail rabbits) and birds.

All of the field sampling activities will be accomplished in compliance with the Ecology Standard Operating Procedures (EG&G 1991c) developed for sampling biota as part of the EE process at RFP. These SOPs include discussion of purpose and scope, responsibilities and qualifications, references, equipment, and execution of protocols. Sampling procedures for the following organisms are included in SOPs 5.1 through 5.11, respectively: periphyton, benthic macroinvertebrates, plankton, fishes, large mammals, small mammals, birds, reptiles and amphibians, terrestrial arthropods, and terrestrial vegetation. In addition to SOPs on specific taxonomic groups, procedural SOPs (5.11 through 5.15, respectively), have been prepared for identifying habitat types, sampling soil for soil description, developing ecology field sampling plans, assigning species codes, and assigning of wildlife habitat codes. Additional procedural

SOPs are still being developed.

9.5.2.1 Mammals

Small mammals will be collected using the live trapping techniques described in SOP 5.6. Trap grids or lines (size and shape to be field determined) will be set for four consecutive nights in the spring (April through May) and early fall (September through October), providing the population will support this intensity. A trapping strategy and technique will have to be developed for the collection of cottontail rabbits. Traplines will be established at seven points along the perimeter of the study area and at five points within the study area.

To collect individuals for tissue analysis, each individual of the designated target taxon will be randomly assigned to a particular analytical suite. Collection will continue until all of the required sample quantity is obtained. If composite samples are required, each individual will be randomly assigned to a sample, and collection will continue until six samples of the appropriate quantity are obtained. If multiple trapnights are required to obtain adequate sample quantity, individuals will be frozen as soon as possible, but no later than 4 hours after collection. Only adult males and nonlactating females will be collected for tissue analysis.

Animals collected for tissue analysis will be sacrificed by placing them in a sealed container with Metafane-saturated cotton, by induced hypothermia, or by cervical separation. The dead animal will be placed in a glass sample container in a cooler with Blue® or dry ice for no more than 4-hours. After 4hours, samples must be immediately shipped to the analytical laboratory or placed in a freezer overnight or until shipped. Labeling, handling, and shipping of small or large mammals for laboratory analysis should be generally consistent with SOP 1.13. Samples collected for tissue analysis must follow the sample preparation and packaging specified by the laboratory protocols for the target analytes.

QA/QC will follow procedures defined in SOP 5.0. Any variance from the SOP will be described and an explanation provided. QA/QC for tissue sample collection should be accomplished by collection of collocated duplicates, in accordance with the QAPjP. Samples collected for tissue analysis will follow the preparation and packaging procedures specified in laboratory prot ocols for the target analytes and should be generally consistent with SOP 1.13. Special attention will be given to minimizing chance of harm to animals not intended for tissue analysis and to avoid injury to workers from animal bites or scratches.

9.5.2.2 Birds

Eggs and un-fledged nestlings will be collected from established nests using manual or net techniques in the spring (April through May), providing the breeding population will support this intensity. Collection will take place at ten points within the study area providing nests exist within a 45 meter (150 foot) radius of these points.

To collect individuals for tissue analysis, each individual of the designated target taxon will be randomly assigned to a particular analytical suite. Collection will continue until all of the required sample quantity is obtained. If composite samples are required, each individual will be randomly assigned to a sample, and collection will continue until six samples of the appropriate quantity are obtained. If multiple nest visits are required to obtain adequate sample quantity, individuals will be frozen as soon as possible, but no later than 4 hours after collection. Only eggs and un-fledged nestlings will be collected for tissue analysis.

Un-fledged nestlings collected for tissue analysis will be sacrificed by placing them in a sealed container with Metafane-saturated cotton, by induced hypothermia, or by cervical separation. The dead animal or egg will be placed in a glass sample container in a cooler with Blue® or dry ice for no more than 4 hours. After 4 hours, the samples must be immediately shipped to the analytical laboratory or placed in a freezer overnight or until shipped. Labeling, handling, and shipping of birds for laboratory analysis should be generally consistent with SOP 1.13. Samples collected for tissue analysis must follow the sample preparation and packaging specified by the laboratory protocols for the target analytes.

Un-fledged nestlings collected for histopathological examination will be sacrificed by placing them in a sealed container with Metafane-saturated cotton, by induced hypothermia, or by cervical separation. The dead animal or egg will then undergo initial processing the field, in accordance with procedures provided by the histopathology laboratory, to ensure timely gross preservation of tissues. Preserved samples will be shipped to the histopathology laboratory within 24 hours of collection.

QA/QC will follow procedures defined in SOP 5.0. Any variation from the SOP will be described and an explanation provided. QA/QC for tissue sample collection should be accomplished by collection of collocated duplicates according to the QAPjP. Samples collected for tissue analysis will follow the preparation and packaging procedures specified in laboratory protocols for the target analytes and should be generally consistent with SOP 1.13. Special attention will be given to minimizing chance of harm to animals not intended for tissue analysis and to avoid injury to workers from animal bites or scratches.

9.5.3 Laboratory Analysis

Tissues samples collected for target analyte analysis will be processed in accordance with SOPs and/or recognized laboratory practices appropriate to the type of tissue and target analyte involved. Analysis of tissue contaminant concentrations will provide direct proof that target taxa carry a body burden of target analytes, as well as a measure of the relationship between environmental concentrations and target taxa contaminant loads.

Histopathological tissue samples will be processed for light microscopic examination in accordance with SOPs and/or recognized laboratory practices appropriate to the type of tissue or organ involved. Consideration should be given to staining techniques that are differentially sensitive to various target analytes or that discriminate against a particular suspected pathologic feature.

9.5.4 Ecological Risk Assessment

Because the study area is known to have no ecological attributes at risk within its own boundaries, ecological risk in this context is viewed as the probability for biological vector transport of potentially toxic quantities of bioaccumulating or bioconcentrating contaminants outward from a study area OU, either to another OU or elsewhere. Therefore, unlike more typical ecological risk assessments, the study area risk assessment will address the following chain of logic:

(a) Are target analytes accumulating or concentrating in target taxa at levels that may pose a threat either to that target taxa or their prey species?

IF YES, THEN

(b) Are the contaminated target taxa capable of migration beyond the study or study area boundaries?

OR

(c) Are contaminated target taxa (if any) prey for highly mobile species that move beyond the study or study area boundaries?

ELSE

(d) There is presumed to be no risk of contamination of off-site biota by target taxa inhabiting the study area.

If conditions (a) and [(b) or (c)] are fulfilled, the conceptual biota transport model will be populated with measured target analyte concentration values. Quantitative estimates of off-site transport masses may be calculated by converting the conceptual model into a logic diagram and assigning probabilities to the steps in the model. These quantitative estimates will be made available to EEs being conducted at adjacent OUs to serve as input source terms for contaminants reaching these other OUs via the biota.

9.5.4.1 Remediation Criteria

Remediation criteria will be developed for contaminants for which a significant probability of transport is detected. Criteria will address remediation of the contaminant source so that remaining environmental concentrations and forms are not available for uptake and transport by target taxa or other ecological receptors. "Acceptable" environmental concentrations will be estimated using exposure assessments to calculate contaminant concentrations in abiotic media below which ecotoxicological effects are not expected to occur. The acceptable (no effects) criteria levels will be used in conjunction with ARARs to evaluate potential adverse effects from biotic transport of COCs. This approach will be integrated with the human health risk assessment process and will assist in development of potential remediation criteria.

9.5.4.2 Operable Unit Coordination

Work within the study area will be coordinated with the human health risk assessment s, adjacent off-site OU EE activities, and the site characterization studies for contaminants in abiotic environmental media. Potential sample sites for biota and contaminants will be coordinated with the FSP for soil, water, and sediments within the study area and, to avoid duplication, the FSP will be tied into those for OU1, OU4, OU2, OU5, and OU6. COCs selected for study area EEs will suggest similar surveys, measurements, and sample collections on adjacent OUs. Information developed for other OUs will be compared with information developed for the study area.

Currently, there is a poorly understood potential for transport of groundwater, surface water, sediments, and surficial soils from the study area to the OU5 or OU6 drainages. Should this occur, there may be potential impacts to biota outside of the studyarea. This potential for transport by groundwater, surface water, sediments, and surficial soils will be fully evaluated during the Phase II RFI/RI process.

Approved by:

Manager, Remediation Programs   12/8/93   RFI Project Manager   12/8/93

QUALITY ASSURANCE ADDENDUM

This section consists of the Quality Assurance Addendum (QAA) for Phase I investigations at Operable Unit No. 10 (OU10), 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 OU10 Work Plan (OU10 WP).

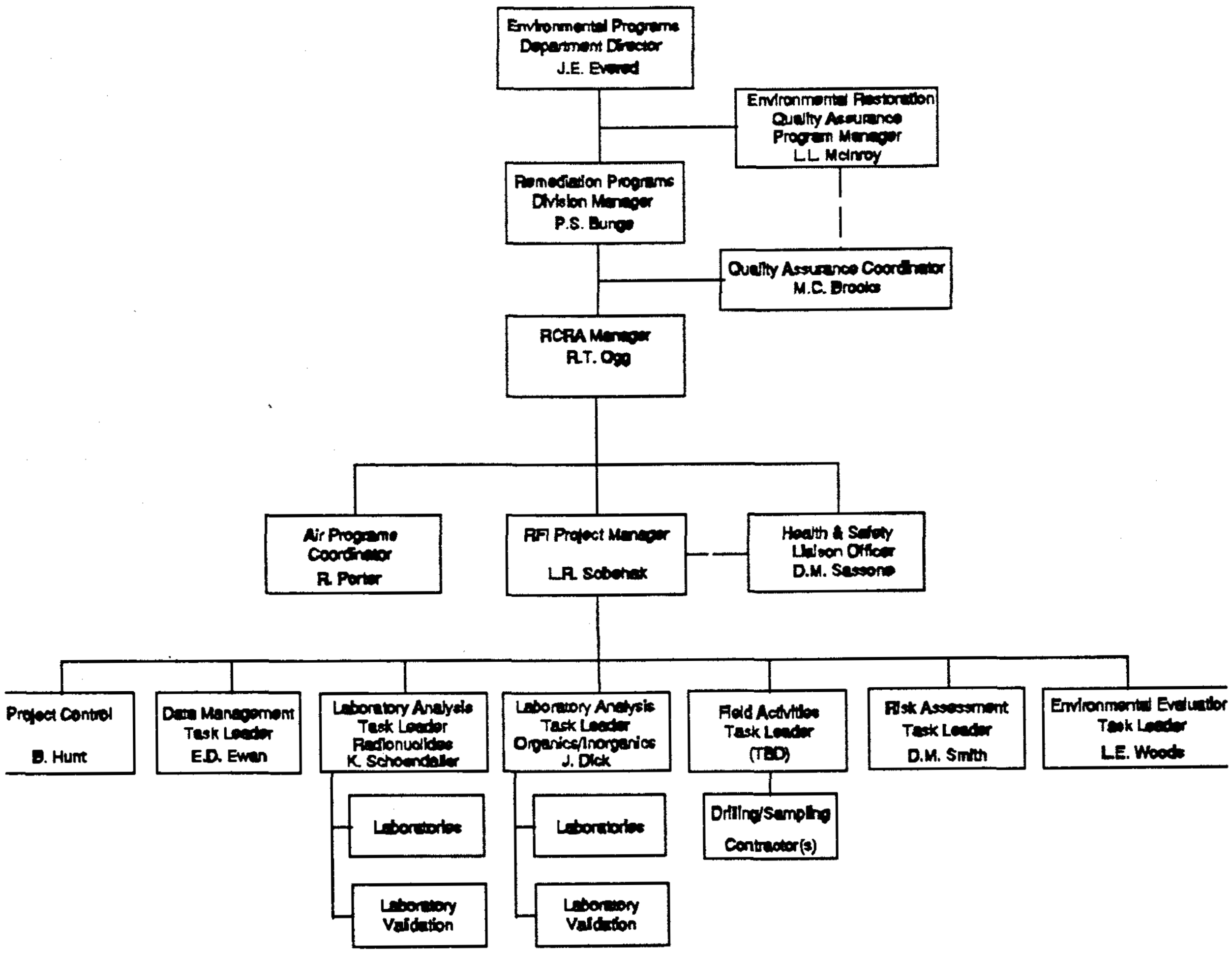
OU10 is one of 16 operable units (OUs) identified for investigations under the Rocky Flats Plant (RFP) Interagency Agreement (IAG). OU10 contains 16 individual hazardous substance sites (IHSSs), which are described in Section 2 of the OU10 WP. The OU10 WP describes the Phase I characterization of source materials and soils at OU10 IHSSs. The OU10 WP was prepared in accordance with the Federal and State of Colorado regulations and guidance documents identified in the Introduction (Section 1.0).

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 OU10 WP. The specific EMD personnel who will interface with the Contractors and who will provide technical direction are shown in Figure 10-1.

FIGURE 10-1. PROJECT MANAGEMENT FOR OPERABLE UNIT 10 OTHER OUTSIDE CLOSURES, PHASE I RFI/RI



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 wall as the IAG, which specifies that a QAPjP for IAG-related activities be developed in accordance with the Environmental Protection Agency (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 OU10 Phase I activities, unless specified otherwise in this QAA. Where site-wide actions are applicable to OU10 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 OU10 Phase I activities that may not have been addressed on a site-wide basis in the QAPjP. Many of the QA requirements specific to OU10 are addressed in the OU10 WP 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 OU10 investigations are specified within the respective procedures. The EMD OPs (which have been referred to as SOPs in the QAPjP and the OU10 WP) are identified in Table 10.1.

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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 OU10 WP describes the investigation activities that will be implemented during the Phase I characterization of the OU10 IHSSs. The OU10 WP 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 OU10 WP is considered the investigation control plan for OU10 Phase I RFI/RI activities.

10.3.2 Data Quality Objectives

Data needs and data quality objectives (DQOs) for OU10 Phase 1 investigations are addressed in Section 4, and Section 9.2.1 for the Environmental Evaluation (EE) data. Identification of data needs and objectives assist decision makers in determining what the quality of the data should be, which in turn dictates the type of quality controls that are necessary to ensure that data of appropriate quality is generated. The DQOs for the OU10 Phase I investigations were established in accordance with Appendix A of the QAPjP. Data quality can be measured in terms of precision, accuracy, representativeness, comparability, and completeness (also referred to as PARCC parameters). These parameters are defined in Appendix A of the QAPjP.

PARCC parameter goals are established prior to initiating investigations in order to assist decision makers in determining if DQOs for measurement data have been met. Historical precision and accuracy measures for EPA Contract Laboratory Program (CLP) analytical methods have been determined. These historical measures have been selected as the goals for all Analytical IV and V data. (Analytical levels are defined and discussed in Appendix A of the QAPjP.) The precision and accuracy goals for Analytical Level IV and V data for EPA Target Analyte List, Target Compound List, and several indicator analytes are listed in Appendix B of the QAPjP. Precision and accuracy goals for Analytical Level I and II data, which consists of field screening and analysis measurements, have been established for several parameters and are also presented in Appendix B of the QAPjP. Table 4-1 of the OU10 WP identifies the analytical levels for each type of data to be generated during Phase I investigations. Goals for representativeness, comparability, and completeness for the RFP ER Program investigations, including OU10 Phase I investigations, are discussed in Appendix A of the QAPjP.

The ecological characterization activities described in Section 9 are considered screening activities that, typically, require Analytical Level I and II data. These characterization data will then be used, along with the OU10 RFI/RI characterization and source contamination data, to develop the conceptual model for the EE study. Data quality for these characterization activities will be controlled by adhering to the field sampling operating procedures in implementing the EE Field Sampling Plan (Section 9.3).

The conceptual model developed for the OU10 ecosystem will assist investigators in identifying site-specific target species, contaminants of concern, and potential exposure pathways. Additional DQOs for the contamination assessment tasks (Tasks 4 through 7 of Section 9) and the ecotoxicological studies (Task 8) will then be developed following steps recommended by the EPA in EPA/600/3-89/013, Ecological Assessments of Hazardous Waste Sites: A Field Guide and Laboratory Reference Document, and EPA/540/G-90/008, Guidance for Data Usability in Risk Assessment. The ecosystem characterization data and preliminary aquatic toxicity investigation data that will be obtained by implementing the EE Field Sampling Plan are needed to develop these additional DQOs.

10.3.3 Sampling Locations and Sampling Procedures

Sampling locations and frequencies for radiation, soil gas, asphalt/concrete, soil, sediment, surface water, and groundwater for each IHSS are addressed in Section 7.3 and summarized in Table 7-1. Sampling equipment and procedures for this sampling are identified in Section 7.4. Sampling locations and frequencies for the EE program, consisting of vegetation, periphyton, benthic macroinvertebrate, fish, and small mammals sampling, are addressed in Section 9.3. EE surveying and sampling procedures are identified in Section 9.4.

The operating procedures that are applicable to OU10 Phase I field activities and the particular activities to which they are applicable are summarized in Table 10.1.

10.3.4 Analytical Procedures

The analytical program for OU10 Phase I RFI/RI investigation is discussed in Section 7.5. The analytes of interest and the specified detection limits are identified in Table 7.2. The analytical methods that shall be adhered to are those that are specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B. These methods are referenced in Section 3.0 of the QAPjP. Specific analytical methods for each analyte identified in Section 7.5 are referenced in Appendix B of the QAPjP.

10.3.5 Equipment Decontamination

Non-dedicated sampling equipment (i.e., sampling equipment that is used at more than one location) shall be decontaminated between sampling locations in accordance with OPS-FO.03, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, hydrogeologic/geologic testing, boring, sample collection, etc. shall also be decontaminated as specified in 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 OU10 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 OU10 are addressed in Section 7.6 and identified in Table 7-6. 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 7.2. 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 7-2. The Laboratory Analysis Task Leader (Figure 10-1) is responsible for verifying these criteria and shall be responsible for checking to see if they are met and for qualifying data.

10.3.7.2 Laboratory QC

Laboratory QC procedures are used to provide measures of internal consistency of analytical and storage procedures. 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 (Figure 10-1) for review and verification.

10.3.8 Quality Assurance Monitoring

To assure the overall quality of the RFI/RI activities discussed in the OU10 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. Intervals will also be based on the schedule contained in Section 6.0. At a minimum, each of the field sampling activities described in Sections 7.3 and 9.3 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 OU10 WP describes the activities to be performed. The OU10 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 and the OU10 WP shall be documented through preparation of Document Change Notices (DCNs), which will be prepared, reviewed, and approved in accordance with requirements specified in Section 5.0 of the QAPjP. (Note: DCNs were referred to as Procedure Change Notices in Revision 0 of the QAPjP).

10.6 DOCUMENT CONTROL

The following documents will be controlled in accordance with Section 6.0 of the QAPjP:

- "Phase I RFI/RI Work Plan for Other Outside Closures, Operable Unit No. 10"
- "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. 10, Other Outside Closures, Phase I RFI/RI Activities
- EMD Operating Procedures (all operating procedures specified in the QAPjP, this QAA, and to-be-developed laboratory SOPs).

10.7 CONTROL OF PURCHASED ITEMS AND SERVICES

Contractors that provide services to support the OU10 WP activities will be selected and evaluated as outlined in Section 7.0 of the QAPjP. This includes preaward 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 during the OU10 investigations that have the ability to affect the quality of the data shall be inspected upon receipt.

10.8 IDENTIFICATION AND CONTROL OF ITEMS, SAMPLES, AND DATA

10.8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for water and soil samples are presented in Tables 7-4 and 7-5. Requirements for EE samples are included here in Table 10.2.

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 inputting the data into a database is considered a process that requires control. The process is controlled through a series of written procedures that govern and document the work activities. A process diagram is shown in Section 8.0 of the QAPjP.

TABLE 10.2

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size*
SAMPLES FOR METALS ANALYSES				
TERRESTRIAL VEGETATION				
- Metals Determined by ICP**	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Metals Determined by GFAA***	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	5 g
Periphyton and Benthic Macroinvertebrates				
- Metals Determined by ICP	6 mos.	Freeze & ship w/dry ice	Plastic	25 g
- Metals Determined by GFAA	6 mos.	Freeze & ship w/dry ice	Plastic	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Plastic	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Plastic	5 g

TABLE 10.2

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size*
SAMPLES FOR RADIONUCLIDE ANALYSES				
Terrestrial Vegetation				
- Uranium 223, 234, 235, 238 Americium 241 Plutonium 239, 240	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	1 kg
Periphyton and Benthic Macroinvertebrates				
- Uranium 233, 234, 235, 238 Americium 241 Plutonium 239, 240	6 mos.	Freeze & ship w/dry ice	Plastic	1 kg

* Sample size may vary with specific laboratory requirements.

**ICP = Inductively Coupled Argon Plasma Emission Spectroscopy. Metals to be determined include Ba, Cr, Cu, and Fe.

***GFAA = Graphite Furnace Atomic Absorption Spectroscopy. Metals to be determined include As, Cd, Li, Pb, Se, and Sr.

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 OU10 WP.

10.12 CONTROL OF MEASURING AND TEST EQUIPMENT (M&TE)

10.12.1 Field Equipment

Specific conductivity, temperature, pH, and dissolved oxygen content, chlorine, turbidity, and alkalinity of water samples shall be measured in the field. Field measurements will be taken and the instruments calibrated as specified in OPS-SW.02, Field Measurements of Surface Water Parameters. Measurements shall be made using the following equipment (or EG&G-approved alternates):

- Temperature: mercury-filled, teflon-coated, safety-type thermometer (VWR catalogue No. 6107-832 or equivalent), or digital readout thermistor (VWR Catalogue No. 61017-562 or equivalent)
- Specific Conductivity: HACH 44600 Conductivity/TDS Meter
- Dissolved Oxygen: HACH or YSI Model 57 Dissolved Oxygen Meter
- pH: HACH One pH Meter (this meter may also be used for temperature measurements)
- Chlorine and Turbidity: HACH DR2000 spectrophotometer
- Alkalinity: HACH digital titrator

In addition to the field measurements for water quality, field measurements for radiation, soil gas, and VOCs in ground water will also be made. The following instruments will be used for these measurements.

- Radiological field readings for field survey grid locations and drill cuttings, core, and samples: A high purity germanium detector or equivalent. Use, calibration, and maintenance according to manufacturer's instructions. EMD OPS-F0-16, Field Radiological Measurements will be revised to include procedures for the use, calibration, and maintenance of the high purity germanium detector.
- Field readings for soil gas and VOCs in groundwater: A portable photoionization detector (PID), HNU Systems P1-101 or equivalent. Use, calibration, and maintenance according to OPS-FO.15, Photoionization Detectors (PIDs) and Flame Ionization Detectors (FIDs).

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 are 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 OU10 RFI/RI activities include, but are not limited to:

- Field Logs and Data Record Forms (e.g., sample collection notebooks/logs for water, 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 QAPM shall develop a surveillance schedule with the surveillance intervals based on the importance and complexity of each sampling/analytical activity. Intervals will also be based on the schedule contained in Section 6.0.

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 OU10 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 OU10 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 OU10 WP activities. Operating procedures applicable to the use of the database storing environmental data can be found in OPS-FO.14, Field Data Management.

Project Manager 12/8/93 Date

Approved By: for W.S. Busby 8-Dec-93
Manager, Remediation Project Date

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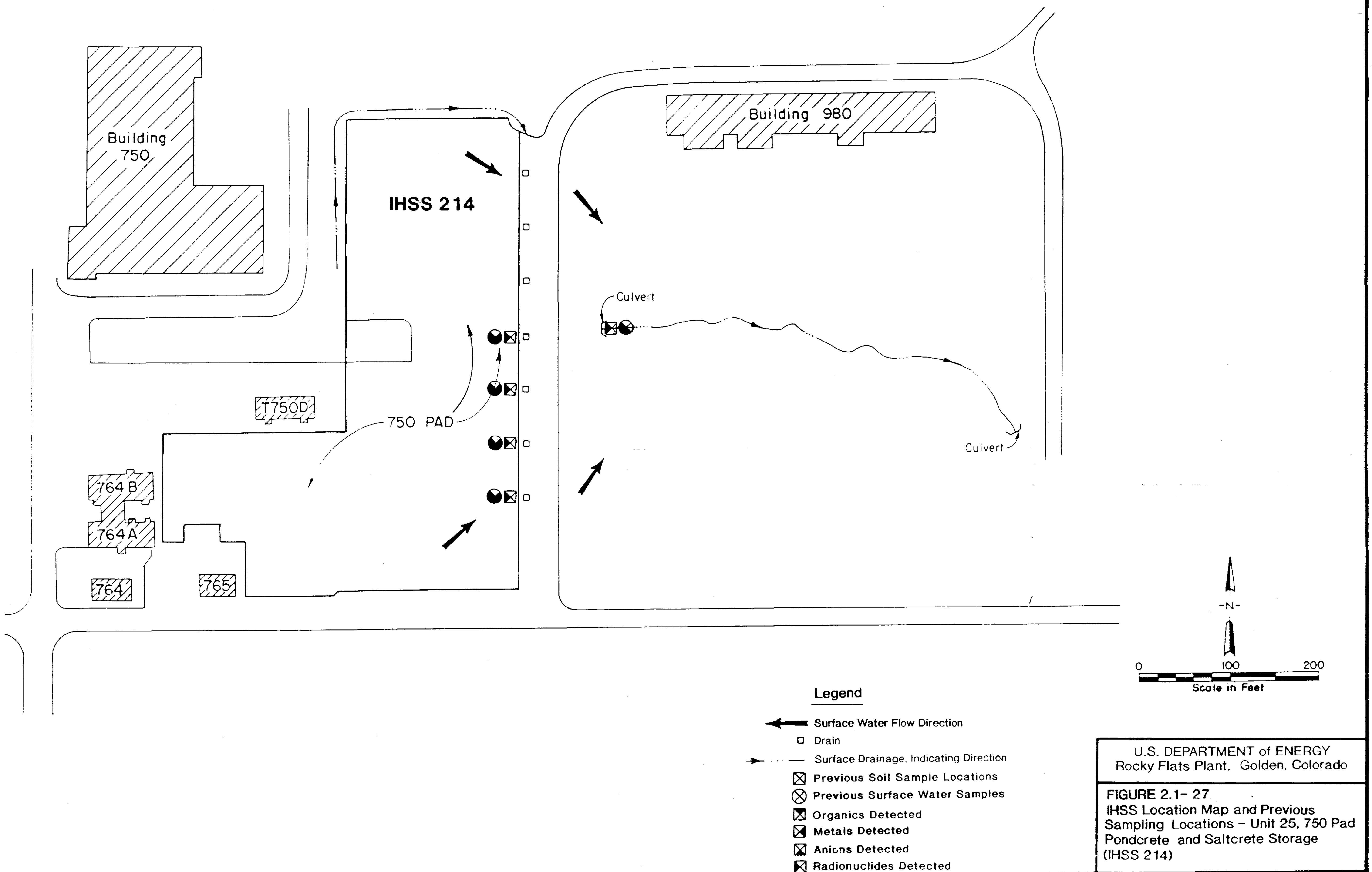

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Rocky Flats Plant, Golden, Colorado

FIGURE 2.1- 27
IHSS Location Map and Previous Sampling Locations – Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214)

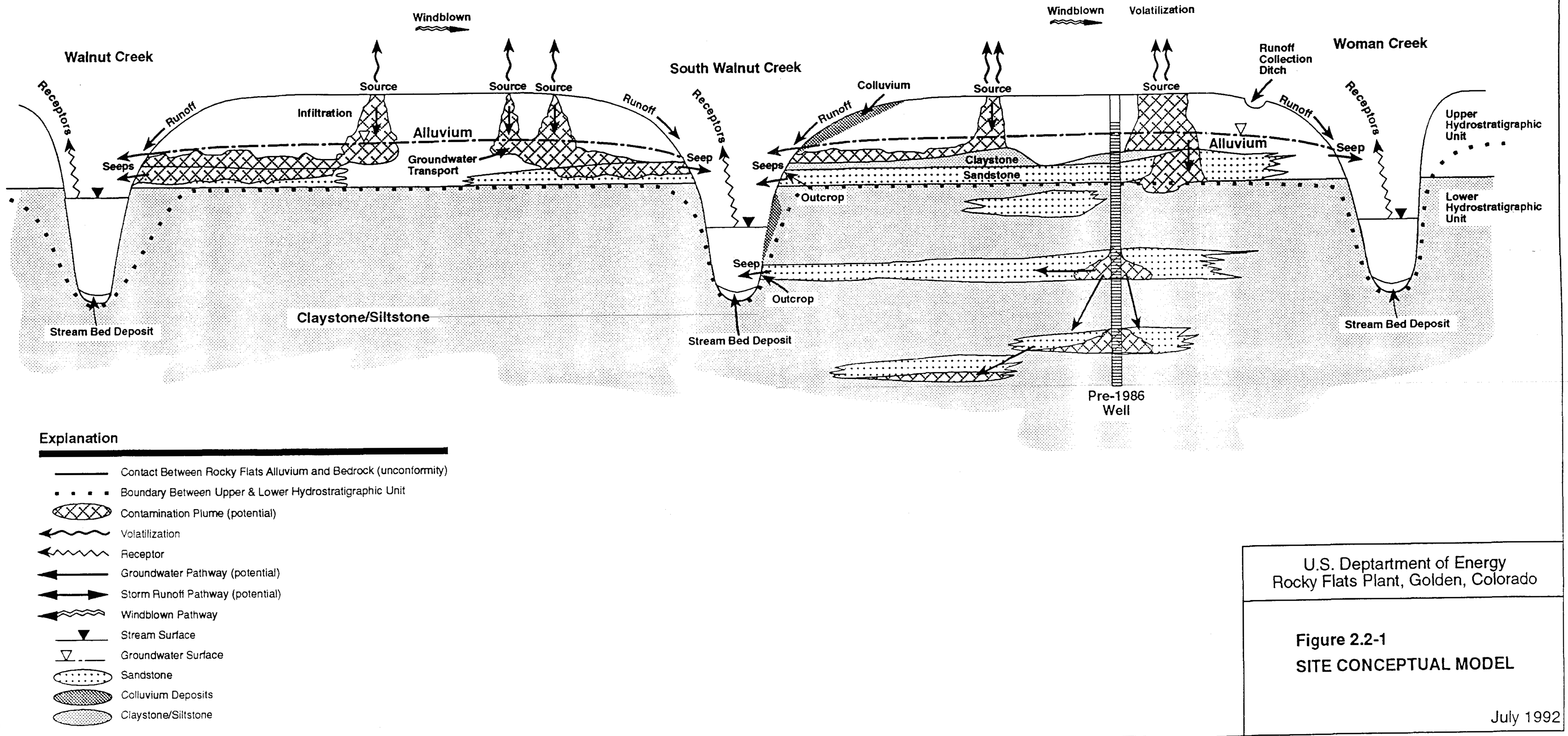

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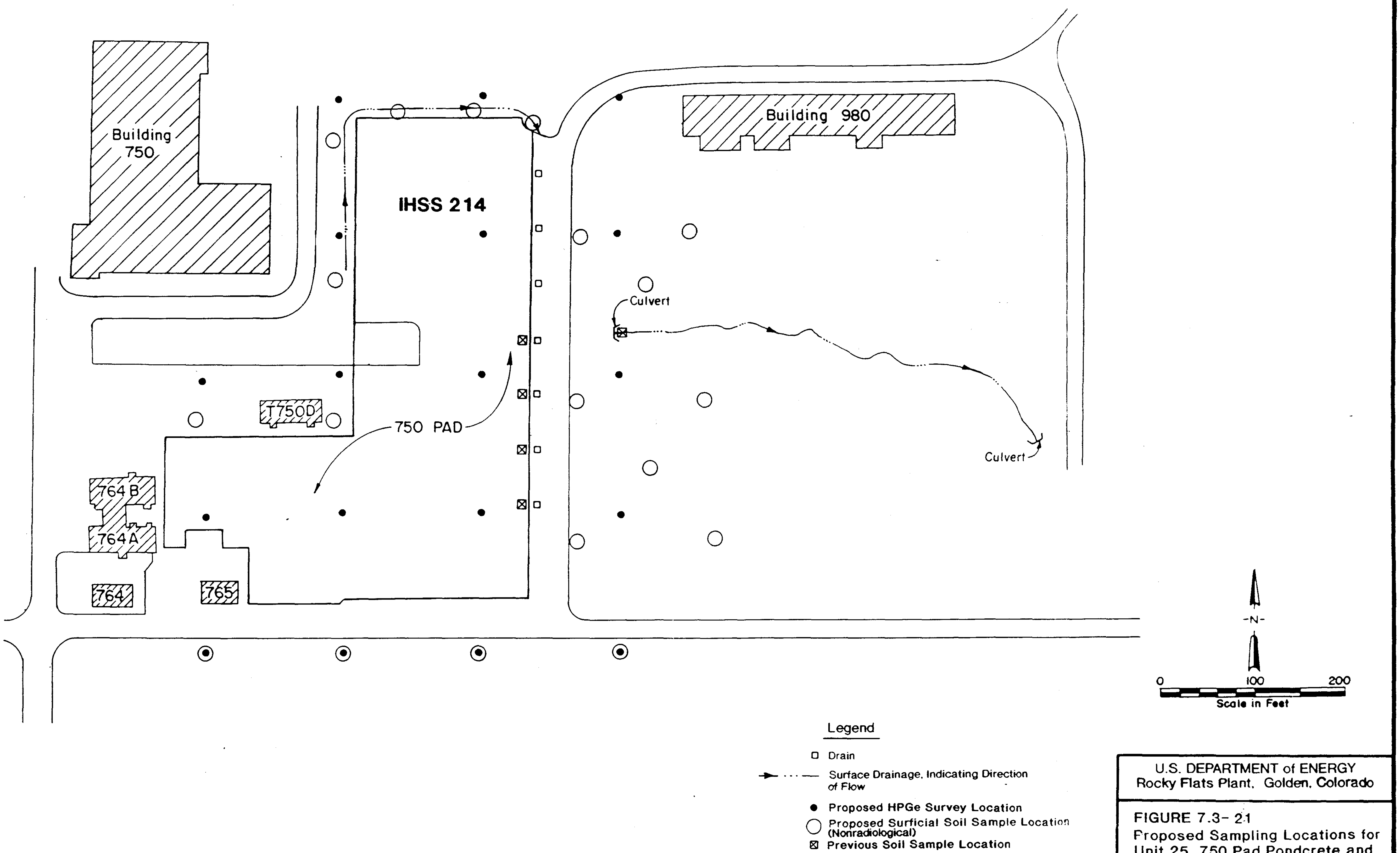
Figure 2.2-1
SITE CONCEPTUAL MODEL

July 1992



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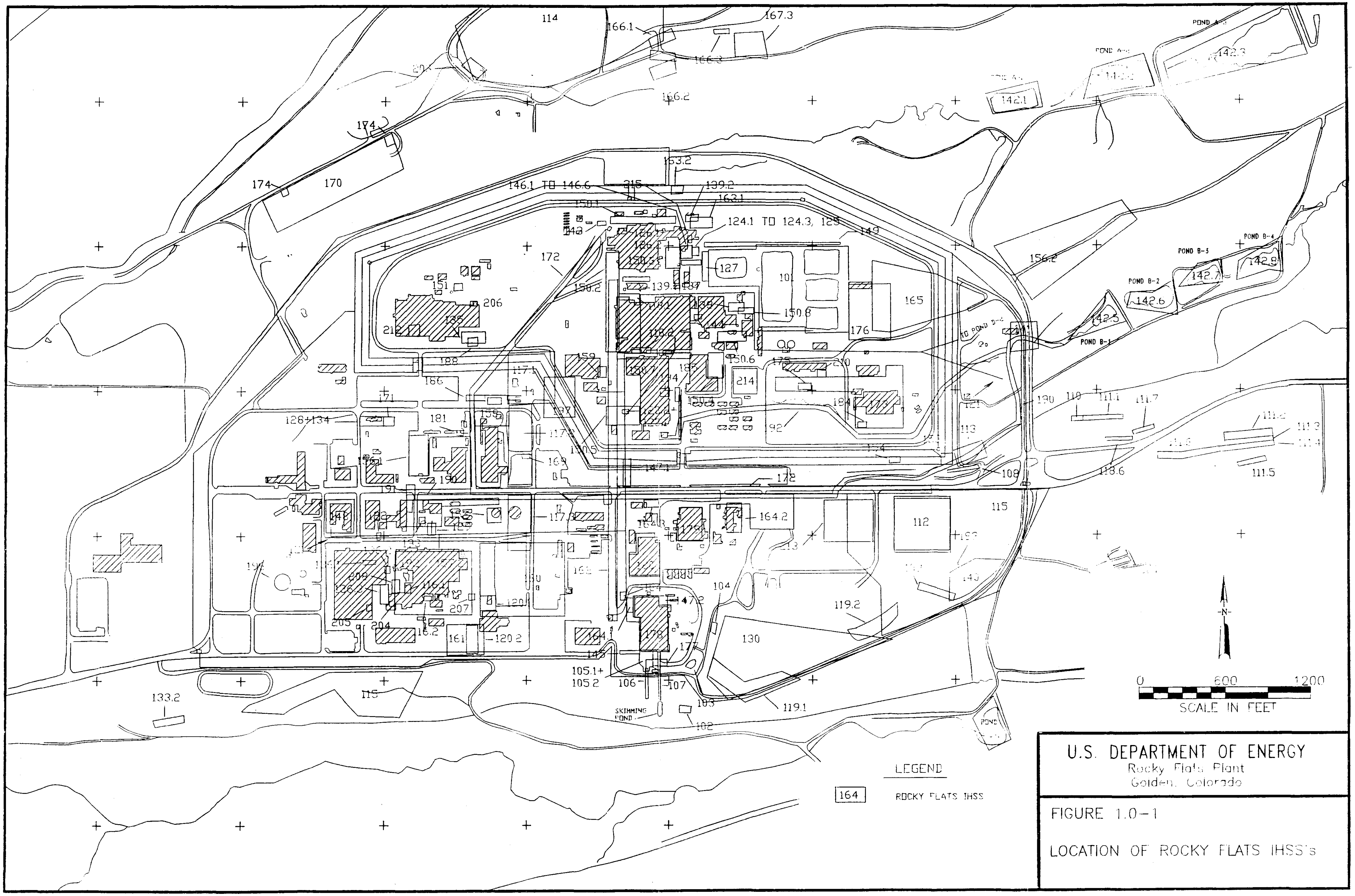
Rocky Flats Plant, Golden, Colorado

FIGURE 7.3-2.1
Proposed Sampling Locations for Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214)



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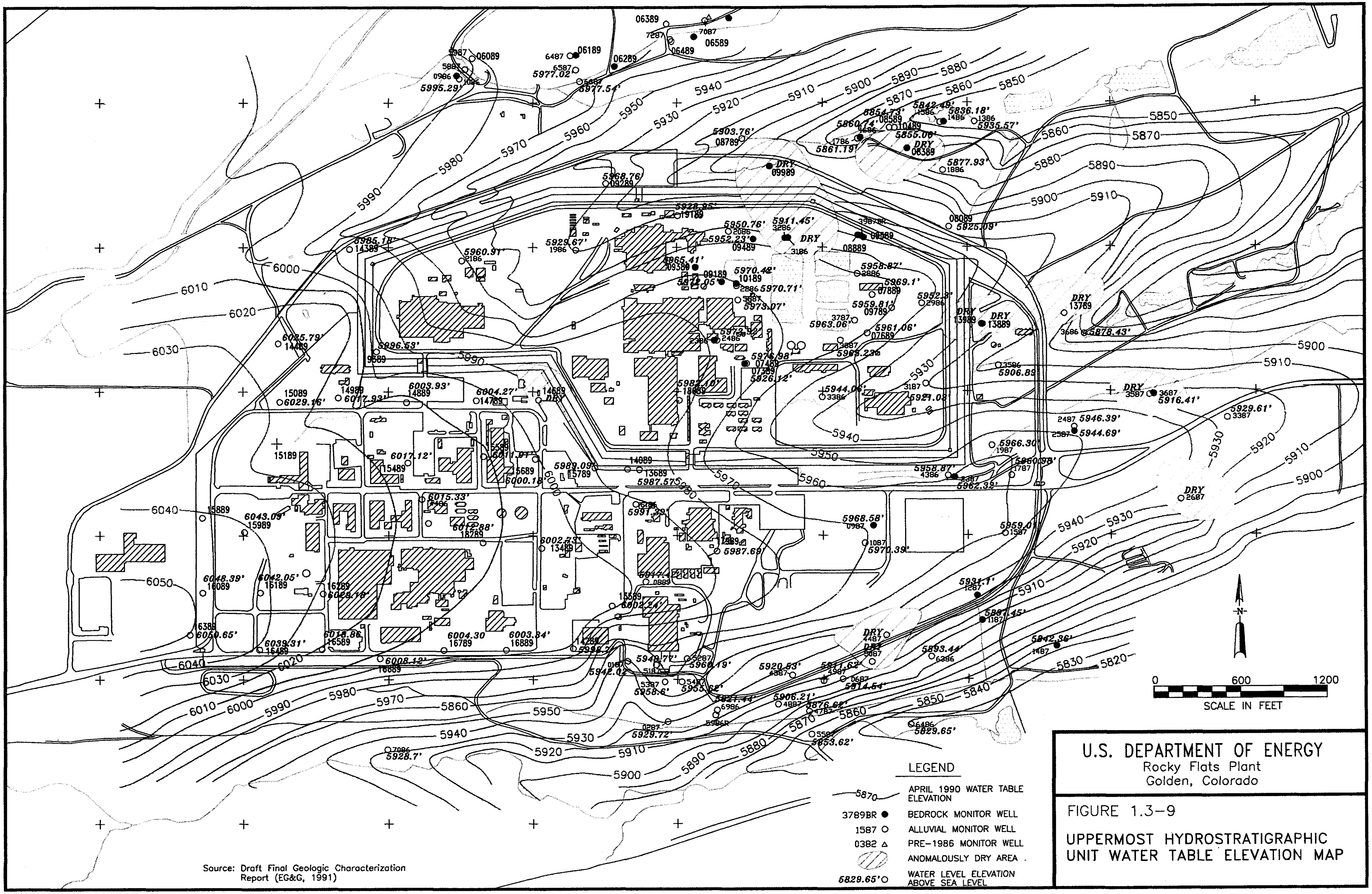
Rocky Flats Plant
Golden, Colorado

FIGURE 1.0-1

LOCATION OF ROCKY FLATS IHSS's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Rocky Flats Plant
Golden, Colorado
FIGURE 1.3-9
UPPERMOST HYDROSTRATIGRAPHIC UNIT WATER TABLE ELEVATION MAP
LEGEND
5870 APRIL 1990 WATER TABLE ELEVATION
3789BR ● BEDROCK MONITOR WELL
1587 ○ ALLUVIAL MONITOR WELL
0382 △ PRE-1986 MONITOR WELL
ANOMALOUSLY DRY AREA
5829.65'○ WATER LEVEL ELEVATION ABOVE SEA LEVEL
0 600 1200
SCALE IN FEET
N
Source: Draft Final Geologic Characterization Report (EG&G, 1991)

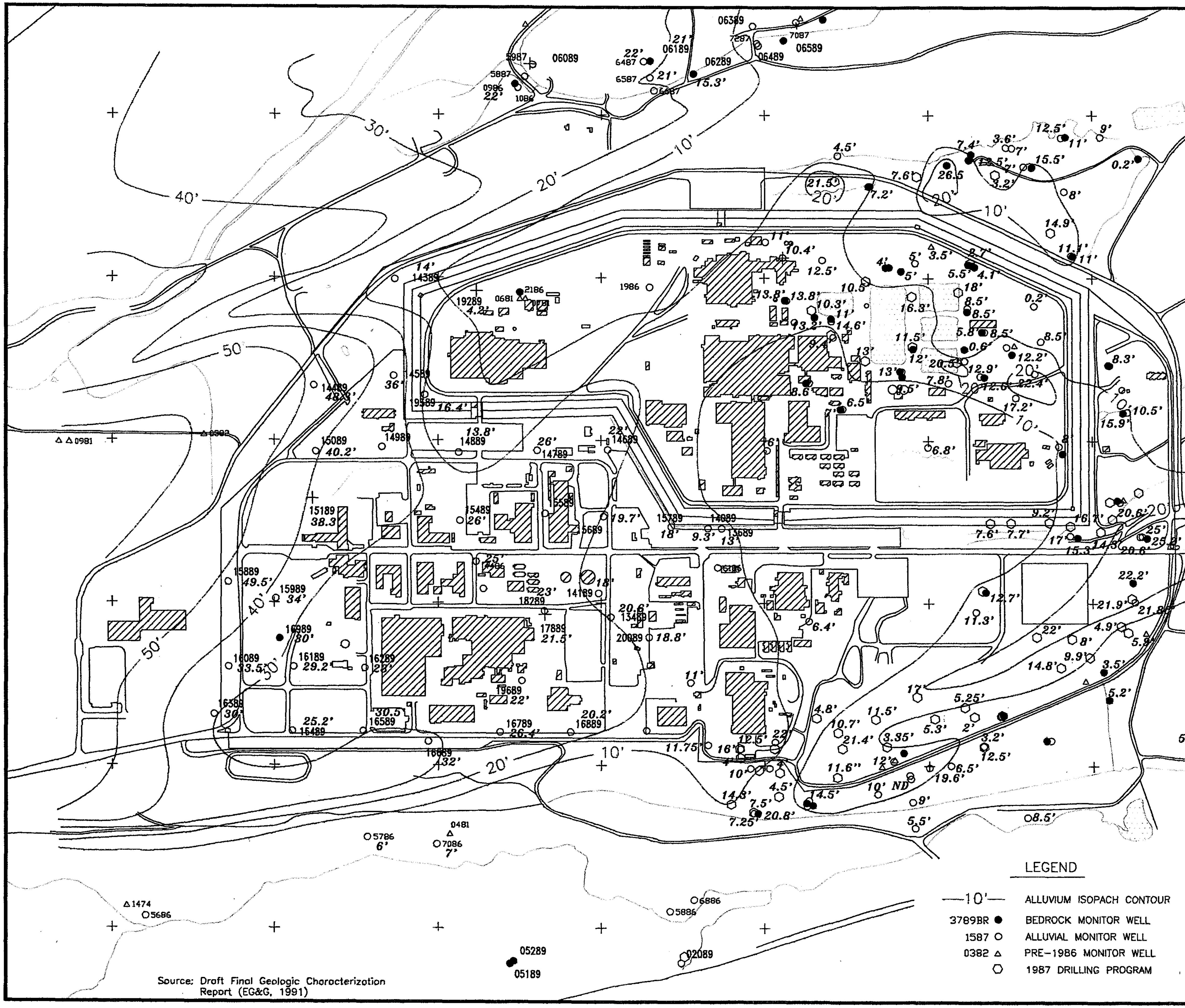

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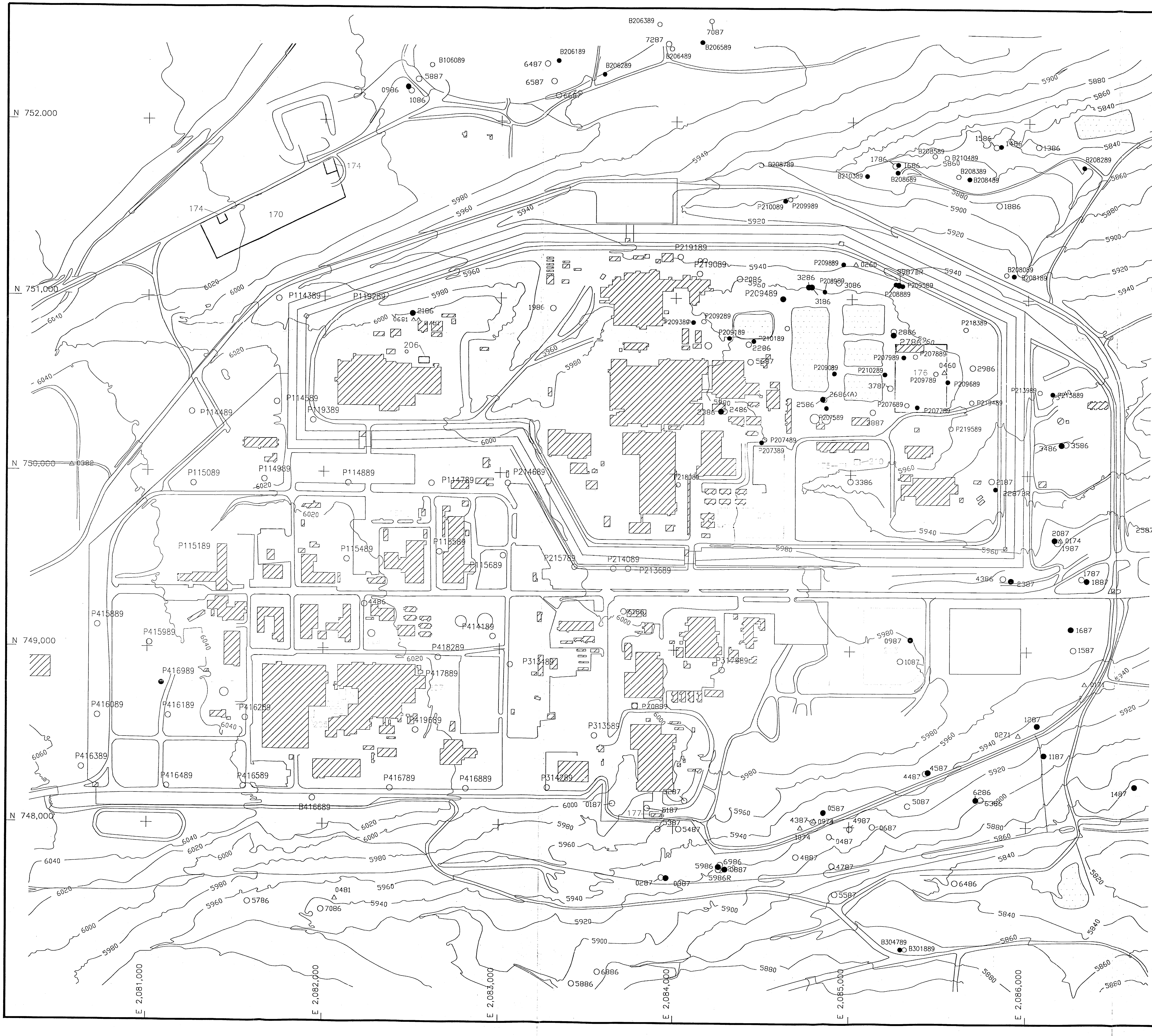
FIGURE 1.3-10
ROCKY FLATS PLANT
ALLUVIUM ISOPACH

Source: Draft Final Geologic Characterization Report (EG&G, 1991)



LEGEND

214	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
3789BR ●	BEDROCK MONITOR WELL
1587 ○	ALLUVIAL MONITOR WELL
0382 △	PRE-1986 MONITOR WELL
—5920—	TOPOGRAPHIC CONTOUR CONTOUR INTERVAL = 20'
~	STREAM

-N-

0 200 400 600 800 1000

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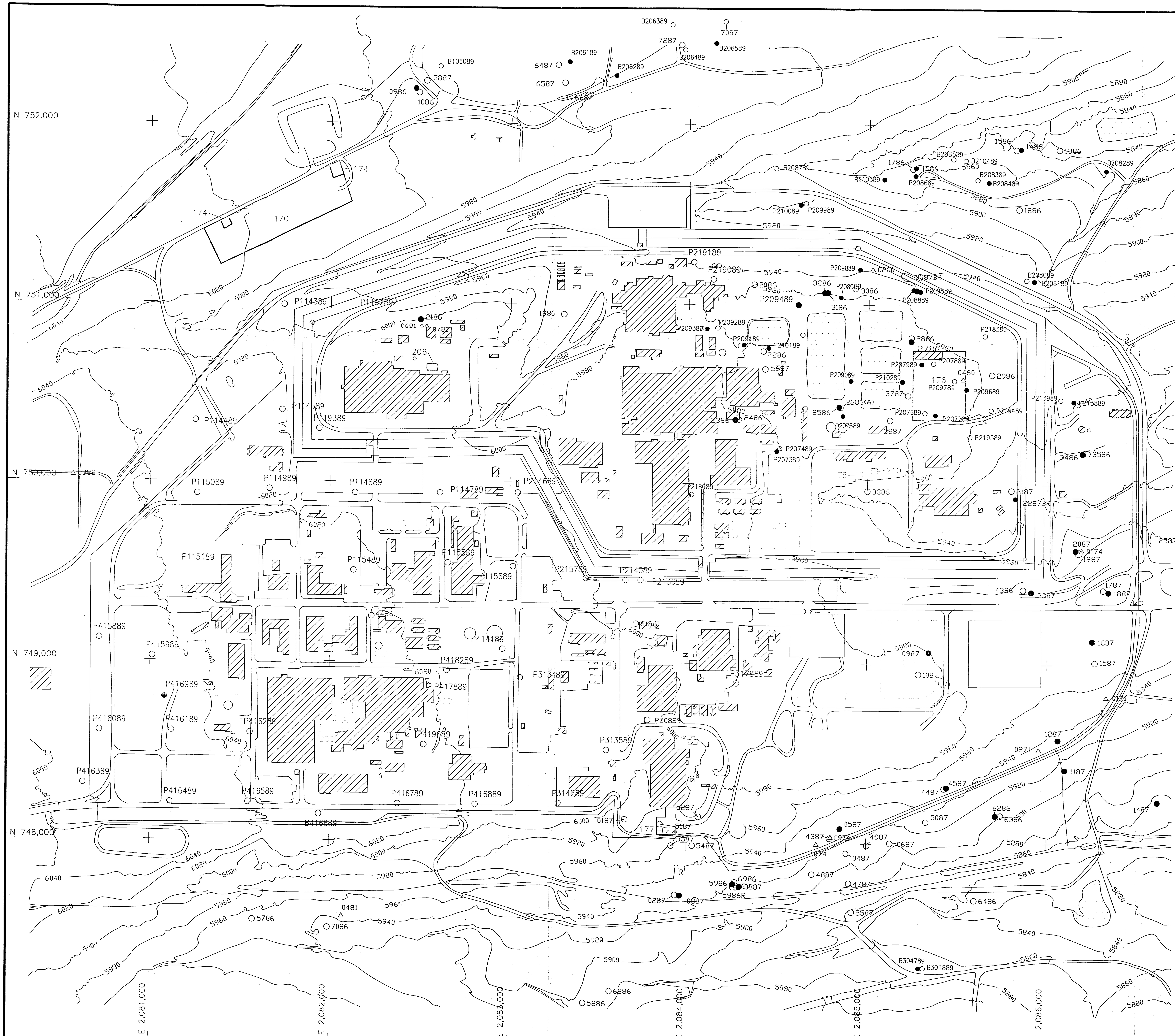
Rocky Flats Plant, Golden, Colo.

PLATE 1
General Location Map of OU10 Individual Hazardous Substance Sites

SEPT. 30, 1991



LEGEND

214	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
3789BR ●	BEDROCK MONITOR WELL
1587 ○	ALLUVIAL MONITOR WELL
0382 △	PRE-1986 MONITOR WELL
—5920—	TOPOGRAPHIC CONTOUR CONTOUR INTERVAL = 20'
~	STREAM

-N-

0 200 400 600 800 1000

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Rocky Flats Plant, Golden, Colo.

PLATE 1

General Location Map of OU10 Individual Hazardous Substance Sites

SEPT. 30, 1991