

DOE EA-0625

FINAL

**SUBSURFACE
INTERIM MEASURES/
INTERIM REMEDIAL ACTION PLAN/
ENVIRONMENTAL ASSESSMENT
AND DECISION DOCUMENT**

OPERABLE UNIT NO 2

U S DEPARTMENT OF ENERGY

Rocky Flats Plant
Golden Colorado

ENVIRONMENTAL RESTORATION PROGRAM

10 September 1992

Volume I - Text

ADMIN RECORD

REVIEWED FOR CLASSIFICATION/UCNI

By K. P. [Signature]

Date 10/22/92 (HNSD)

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PLAN/ENVIRONMENTAL ASSESSMENT AND DECISION DOCUMENT**

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VOLUME I

U S Department of Energy
Rocky Flats Plant
Golden Colorado

10 SEPTEMBER 1992

FINAL

Prepared by

EG&G Rocky Flats Inc
Rocky Flats Plant
Golden Colorado 80401

ADMIN RECORD

REVIEWED FOR CLASSIFICATION/UCNI
By [Signature]
Date 10/22/92 [Signature]

EXECUTIVE SUMMARY

The subject Interim Measures/Interim Remedial Action Plan/ Environmental Assessment (IM/IRAP/EA) addresses residual free phase volatile organic compound (VOC) contamination suspected in the subsurface within an area identified as Operable Unit No 2 (OU2). This IM/IRAP/EA also addresses radionuclide contamination beneath the 903 Pad at OU2. Although subsurface VOC and radionuclide contamination represent a source of OU2 ground water contamination, they pose no immediate threat to public health or the environment. This is because the extent of the contaminated ground water plume is contained well within the plant boundary and its rate of migration is not expected to result in off site contamination before final remediation of OU2 is implemented (EG&G 1990c).

IM/IRAs are typically used as a vehicle for contaminant migration abatement and/or risk reduction. However, using the IM/IRA to gain site specific remedial information to support final action is also justifiable. For example, the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Directive guidance for ground water remedial actions states (EPA 1989a) "Response measures may be implemented to prevent further migration of contaminants if they will prevent the situation from getting worse, initiate risk reduction, and/or the operation of such a system would provide information useful to the design of the final remedy."

This IM/IRAP/EA identifies and evaluates interim remedial actions for removal of residual free phase VOC contamination from three different subsurface environments at OU2. The term "residual" refers to the non aqueous phase contamination remaining in the soil matrix (by capillary force) subsequent to the passage of non aqueous or free phase liquid through the subsurface. In addition to the proposed actions, this IM/IRAP/EA presents an assessment of the No Action Alternative. This document also considers an interim remedial action for the removal of radionuclides from beneath the 903 Pad. The decision to pursue such an action will be based on the results of treatability studies examining radionuclide removal technologies currently being conducted by the U.S. Department of Energy (DOE). Each of the proposed VOC removal actions involve *in situ* vacuum enhanced vapor extraction technology. The remedial actions are proposed not for reasons of mitigating an immediate threat, but rather for the collection of

information that will aid in the selection and design of final remedial actions that address subsurface residual free phase VOC contamination at OU2. Also the IM/IRA takes advantage of the benefit afforded by a small scale early remedial action at a site where the uncertainties associated with subsurface remediation are great. The purpose is in agreement with a recent recommendation by the EPA OSWER with respect to subsurface remediation (EPA 1989a).

The major recommendation is to orient our thinking so that we initiate early action on a small scale while gathering more detailed data prior to committing to full scale restoration. This guidance also advocates that a proposed action provide system flexibility so that it may be modified to better achieve clean up goals based on information gained during its operation. To achieve this operational flexibility the proposed vacuum-enhanced vapor extraction systems are initially subjected to *in situ* pilot testing. Based on information collected during the pilot study phase of the IM/IRA a determination as to the benefit of continued operation of the vapor extraction and treatment systems (modified as necessary) at OU2 will be made. The Plan discusses general criteria that will be used to conclude pilot testing and to assess the benefit of post pilot operation.

As noted above the primary purpose of the proposed early small scale *in situ* vapor extraction actions is to collect information that will aid in the selection and design of final remedies for OU2. Project success will therefore be gauged by the usefulness of the data collected with respect to final remedial design not by the degree of cleanup achieved. However the anticipated removal of residual free phase VOC contamination during pilot and post pilot operation of the vapor extraction systems provides an additional benefit of the proposed Subsurface IM/IRA. No matter how small the scale removal of residual free phase VOCs from the OU2 subsurface represents a positive environmental impact.

The Subsurface IM/IRAP/EA has been prepared in accordance with EPA OSWER guidance advocating the use of Observational/Streamlined Approach methodology for managing uncertainties associated with subsurface restoration. In developing the proposed actions reasonably conceivable deviations in site conditions at OU2 have been identified and contingency plans have been developed to manage any associated impacts.

The IM/IRAP/EA first provides project and Observational/Streamlined Approach background information. This information is followed by a description of the general extent of contamination within OU2 and the specific environmental issues associated with subsurface VOC contamination. A regulatory analysis identifying applicable or relevant and appropriate requirements (ARAR) for the proposed Subsurface IM/IRA is then presented. This regulatory analysis is based on DOE's current understanding of the ARAR philosophy as applied to this IM/IRA. CDH has expressed some concerns regarding this regulatory analysis; their comments are presented at the end of this Executive Summary (letter from Gary Baughman to Frazer Lockhart dated 12 March 1992). DOE expects to resolve all ARAR issues prior to finalizing the IM/IRA/EA. The IM/IRAP/EA subsequently presents *in situ* vacuum-enhanced vapor extraction actions to be pilot tested in each of the three primary OU2 Areas: 903 Pad, Mound, and East Trenches. Each of the proposed actions are critiqued with respect to their expected effectiveness, implementability, and environmental impact.

The subsurface actions proposed at the 903 Pad and East Trenches areas are expected to involve dewatering to allow induced vapor flows to contact any residual free phase VOC contamination in soils currently beneath the water table. Dewatering may also be required at the Mound Area. The IM/IRAP/EA includes the use of the South Walnut Creek Basin Surface Water Treatment Facility to treat contaminated ground water recovered during the pilot testing phase. The IM/IRAP/EA also provides brief descriptions of other existing or planned Rocky Flats Plant (RFP) water treatment facilities that may potentially be used during post pilot IM/IRA operation in the event that the South Walnut Creek Basin facility becomes capacity limited.

After presentation and evaluation of the proposed actions, the IM/IRAP/EA provides a detailed assessment of the No Action Alternative followed by an analysis of the cumulative environmental impacts resulting from all previously approved RFP IM/IRAs and the proposed Subsurface IM/IRA at OU2.

The IM/IRAP/EA concludes with a discussion of the plan for implementing the proposed subsurface actions. Implementation includes the preparation of a Pilot Test Plan for each of the proposed actions. The Test Plans will include all of the detailed design, installation, operation, and test procedures necessary to execute the pilot tests. A Pilot Test Report will also be

prepared at the conclusion of all three pilot tests. The report will present an evaluation of test data and offer recommendations concerning post pilot operation of an *in situ* vacuum-enhanced vapor extraction system at each of the three OU2 IM/IRA sites.



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RE Operable Unit 2 Draft Proposed Subsurface Interim Measure/
Interim Remedial Action Plan/Environmental Assessment and Decision
Document March 2, 1992

Dear Mr Lockhart

The Colorado Department of Health (CDH) Hazardous Materials and Waste Management Division (the Division) has received the above referenced document submitted by DOE. This document includes both a discussion of Applicable or Relevant and Appropriate Requirements (ARARs) in Section 3.2.1 and a presentation of the proposed ARARs for groundwater contaminants in Appendix C. These sections represent the very serious differences in approach to determining ARARs that exist between DOE and CDH.

These differences outlined below are so serious that we will allow this document to be released to public comment only if this letter in its entirety is included in the document as a part of the Executive Summary. This allows us to make our concerns on the ARAR issue clear to the public while allowing the already much delayed IM/IRA schedule to proceed. We would also like to point out that if these issues are not resolved the Division will be unable to approve a final version of the document on August 28 1992 as is currently planned.

After a review by the Hazardous Materials and Waste Management and Water Quality Control Divisions of CDH and the Office of the State Attorney General it was determined that inadequate or incorrect treatment was given to the following:

- Because of the uncertain chemistry of the groundwater that may be recovered beneath the pilot study areas a

comprehensive list of chemical-specific ARARs needs to be proposed. This list could include the Target Analyte List (TAL) Metals and the Target Compound List (TCL) Volatiles and Semi-Volatiles but should include any constituents for which there are standards.

- The Colorado Water Quality Control Act is applied consistently throughout Colorado by the Water Quality Control Commission (WQCC). The resulting standards differ by stream segment for a variety of reasons including different classified uses needing protection and variations in natural background water quality. Therefore even though Rocky Flats has segment-specific standards for Walnut Creek and Woman Creek the state statute and regulations and the methodology for arriving at these standards are generally applicable throughout the state. In addition segment-specific standards are enforceable through State and Federal statutes and through NPDES permits. Therefore all WQCC standards should be included in this document as ARAR.

- A goal qualifier indicates that 'the waters are presently not fully suitable but are intended to become fully suitable for the classified use. It is important to note that the goal qualifier for classified uses results in only a temporary modification to numerical standards. The possible active lifetime of this IM/IRA will almost certainly outlast the current temporary modifications. Therefore the goal qualifier cannot be used to abrogate certain standards to TBC status.

We strongly urge DOE to revive and expedite the site-wide ARAR discussions. The issues presented above will certainly be a part of these discussions and resolution depends on continuing communication.

If you have any questions regarding these matters please call me at 331-4847 or Joe Schieffelin of my staff at 331-4421.

Sincerely



Gary W. Baughman

Unit Leader Hazardous Facilities Unit
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cc Charlotte Robinson AGO
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GLOSSARY OF ACRONYMS

| | |
|------------------|---|
| Am | Americium |
| ARA | Applicable or Relevant and Appropriate Requirement |
| AS | Analytical Sampling Location |
| AT | Analytical Transmitter |
| BH | Borehole |
| CAA | Clean Air Act |
| CCl ₄ | Carbon Tetrachloride |
| CDH | Colorado Department of Health |
| CEARP | Comprehensive Environmental Assessment and Response Program |
| CEDE | Committed Effective Dose Equivalent |
| CEQ | Council of Environmental Quality |
| CERCLA | Comprehensive Environmental Resource Compensation and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| CMS | Corrective Measures Study |
| COE | U S Army Corps of Engineers |
| CWA | Clean Water Act |
| d/m/g | disintegrations per minute per gram |
| DNAPL | Dense Non Aqueous Phase Liquid |
| DOE | U S Department of Energy |
| DOT | U S Department of Transportation |
| DQO | Data Quality Objective |
| DRCOG | Denver Regional Council of Governments |
| EA | Environmental Assessment |
| EPA | U S Environmental Protection Agency |
| ER | Environmental Restoration (Program) |
| ERHSPP | Environmental Restoration Health and Safety Program Plan |
| ESA | Endangered Species Act |
| FFACO | Federal Facility Agreement and Consent Order |
| FI | Flow Indicator |
| FR | Federal Register |
| FS | Feasibility Study |
| ft/ft | feet per foot |
| GAC | Granular Activated Carbon |
| HA | High Alarm |
| HEPA | High Efficiency Air Particulate |
| HI | Hazard Index |
| HS | Health and Safety (Department) |
| IAG | Inter Agency Agreement |
| IHSS | Individual Hazardous Substance Site |
| IM/TRAP | Interim Measures/Interim Remedial Action Plan |

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GLOSSARY OF ACRONYMS (continued)

| | |
|-----------|--|
| LI | Level Indicator |
| mg/l | milligrams per liter |
| mrem | milli radiation equivalent man |
| NCP | National Contingency Plan |
| NEPA | National Environmental Policy Act of 1969 |
| NPDES | National Pollutant Discharge Elimination System |
| 1 1 1 TCA | 1 1 1 Trichloroethane |
| OSA | Operational Safety Analysis |
| OSWER | Office of Solid Waste and Emergency Response |
| OU2 | Operable Unit No 2 |
| PA | Protected Area |
| PCE | Tetrachloroethene |
| pCi/g | picocurie per gram |
| pCi/l | picocurie per liter |
| PI | Pressure Indicator |
| PPCD | Plan for Prevention of Contaminant Dispersion |
| PSHSP | Project Specific Health and Safety Plan |
| Pu | Plutonium |
| PVC | Polyvinyl Chloride |
| QA/QC | Quality Assurance/Quality Control |
| RCRA | Resource Conservation and Recovery Act of 1986 |
| rem | radiation equivalent man |
| RFI | RCRA Facility Investigation |
| RFP | Rocky Flats Plant |
| RI | Remedial Investigation |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SID | South Interceptor Ditch |
| SOP | Standard Operating Procedure |
| TCE | Trichloroethene |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TI | Temperature Indicator |
| U | Uranium |
| USC | United States Code |
| USFWS | U S Fish and Wildlife Coordination Act |
| UV | Ultra violet |
| VOC | Volatile Organic Compound |
| µg/l | micrograms per liter |

SECTION 1 INTRODUCTION

The subject Interim Measures/Interim Remedial Action Plan/ Environmental Assessment (IM/IRAP/EA) addresses residual free phase volatile organic compound (VOC) contamination suspected in the subsurface within an area identified as Operable Unit No 2 (OU2). This IM/IRAP/EA also addresses radionuclide contamination beneath the 903 Pad at OU2. Although subsurface VOC and radionuclide contamination represent a source of OU2 ground water contamination, they pose no immediate threat to public health or the environment because the extent of the contaminated ground water plume is contained well within the plant boundary and its rate of migration is not expected to result in off site contamination before final remediation of OU2 is implemented (EG&G 1990c).

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As noted above the primary purpose of the proposed early small scale *in situ* vapor extraction actions is to collect information that will aid in the selection and design of final remedies for OU2. Project success will therefore be gauged by the usefulness of the data collected with respect to final remedial design not by the degree of cleanup achieved. However the anticipated removal of residual free phase VOC contamination during pilot and post pilot operation of the vapor extraction systems provides an additional benefit of the proposed Subsurface IM/IRA. No matter how small the scale removal of residual free phase VOCs from the OU2 subsurface represents a positive environmental impact.

OU2 is defined in the final Federal Facility Agreement and Consent Order (FFACO) (DOE 1991a) commonly known as the Inter Agency Agreement (IAG) and is comprised of 20 Individual Hazardous Substance Sites (IHSS) that are known in aggregate as the 903 Pad Mound and East Trenches Areas.

This IM/IRAP/EA is an integrated Comprehensive Environmental Response Compensation and Liability Act/Resource Conservation and Recovery Act/National Environmental Policy Act (CERCLA/RCRA/NEPA) document. Documentation prepared pursuant to CERCLA is integrated with NEPA values in accordance with DOE Order 5400.4. The document has been prepared to conform with the National Contingency Plan (NCP) (FR Vol 55 No 46 8813 40 CFR 300.415[b][4]) and to the NEPA of 1969 as implemented by regulations promulgated by the President's Council on Environmental Quality (CEQ) (40 CFR 1500.1508) and DOE Implementing Procedures [57 FR 15122 (24 April 1992) (to be codified in 10 CFR 1021)]. This IM/IRAP/EA is also based on EPA OSWER Directive No. 9355.3-03 which emphasizes the benefits of early small scale remedial actions to collect critical site information that would otherwise not be available to remedial action planners and designers. The Subsurface IM/IRAP/EA is also prepared in accordance with EPA OSWER Directive 9355.3-06 which advocates the use of Observational/Streamlined Approach methodology for managing uncertainties associated with subsurface restoration. (DOE's integration of NEPA and CERCLA documentation is not intended to represent a statement on the legal applicability of NEPA to environmental restoration activities conducted under CERCLA.)

1.1 PROJECT BACKGROUND

In March 1987 a Phase I Remedial Investigation (RI) under the Environmental Restoration (ER) Program (formerly known as the Comprehensive Environmental Assessment and Response Program [CEARP]) began at OU2. The investigation consisted of the preparation of detailed topographic maps, radiometric and organic vapor screening surveys, surface geophysical surveys, a soil gas survey, a boring and well completion program, soil sampling and surface and ground water sampling. Phase I field activities were completed at OU2 during 1987 and a draft RI report was submitted to the EPA and the Colorado Department of Health (CDH) on December 31, 1987 (Rockwell International 1987a). Phase I data did not allow adequate definition of the nature and extent of contamination for the purpose of conducting a baseline risk assessment and a feasibility study of remedial alternatives pertaining to contaminated media.

A draft Phase II RI Work Plan that presents the details and rationale for further field work to achieve these objectives was submitted to the regulatory agencies in June 1988 (Rockwell

International 1988c) This draft Work Plan was subsequently revised and submitted as a final Phase II RCRA Facility Investigation/Remedial Investigation Feasibility Study (RFI/RIFS) Work Plan in April 1990 (EG&G 1990c) The plan was approved by EPA in May 1990 The Work Plan specifies for boreholes to be drilled into waste sources to characterize any waste materials remaining in place and to assess the maximum contaminant concentrations in soils directly beneath the sites In addition ground water monitor wells will be installed adjacent to some of the boreholes to characterize ground water quality directly beneath the sites Additional alluvial monitoring wells will be installed to further characterize and monitor ground water flow and quality in alluvial materials at OU2 Field work for installation of the alluvial monitoring wells began in October 1991 and is expected to be completed in the Spring of 1992 Bedrock monitoring wells will be completed in subcropping Arapahoe sandstone where it is encountered

A draft IM/IRAP for contaminated ground water at OU2 was submitted in December 1989 (Rockwell International 1989b) The plan was prepared based on limited knowledge of the nature and extent of ground water contamination Regulatory agency review of the document determined that although an IM/IRA for ground water is required by the 1989 Agreement in Principle between DOE and CDH insufficient information existed on the nature and extent of ground water contamination to pursue effective ground water remediation at that time In order to facilitate early evaluation of the need for an IM/IRA for ground water at OU2 the final Phase II RFI/RIFS Work Plan incorporates a phased investigation approach The phased approach is to investigate alluvial and hydraulically connected bedrock migration pathways first and then to subsequently investigate ground water contaminant sources This will allow planning design and implementation of a ground water IM/IRA if necessary before completion of the RFI/RI and Corrective Measures Study/Feasibility Study (CMS/FS) for OU2

In February and March 1990 representatives from DOE EPA and CDH met to discuss surface water IM/IRAs at the Rocky Flats Plant (RFP) site The result of these meetings was a series of agreements with the concurrence of all parties to implement an IM/IRA for the cleanup of contaminated surface water in OU2 On 26 September 1990 the DOE released for public comment a proposed Surface Water IM/IRA Plan and Decision Document for OU2 In this Plan specific point source locations in the South Walnut Creek and Woman Creek drainage basins were proposed for collection of surface water According to the Plan surface water

collected in each basin was to be transferred to a treatment facility discharging to the South Walnut Creek drainage. Effluent would ultimately flow to Pond B 5 where water is monitored, treated as necessary, and discharged in accordance with the RFP's National Pollutant Discharge Elimination System (NPDES). Comments on the IM/IRAP/EA received during the public comment period, however, revealed strong opposition to the transfer of contaminated seep water from the Woman Creek drainage to the South Walnut Creek drainage. Opposition was based on the absence of a proven performance record for the proposed IM/IRA treatment facility with respect to radionuclide removal and the potential for treatment process upsets. Opposition to the Plan was also based on the use of Indiana Street (located outside of the RFP boundary) to transport Woman Creek Basin seep water to the treatment facility by truck. In addition, the public voiced strong concern over potential worker and public health risks resulting from construction activities in the Woman Creek Basin (i.e., atmospheric resuspension of radionuclide contaminated dust). In light of these concerns, the DOE and regulatory agencies agreed to address collection and treatment of South Walnut Creek and Woman Creek Basin contaminated surface water in two separate IM/IRAP/EAs.

A final South Walnut Creek Basin Surface Water IM/IRAP was submitted in March 1991 (EG&G 1991f) and was approved by the regulatory agencies shortly thereafter. The Plan included removal of radionuclides and metals from surface water by chemical precipitation and microfiltration, followed by removal of VOCs by granular activated carbon (GAC) adsorption. Installation and startup of the GAC adsorption units occurred in May 1991. Installation of the chemical precipitation/microfiltration units was completed on 24 April 1992, and system startup occurred on 27 April 1992.

Prior to preparation of a Woman Creek Basin Surface Water IM/IRAP/EA, EPA mandated that bench scale treatability studies of various treatment technologies be conducted in the Spring of 1991 to provide performance data for radionuclide removal. However, seep flows were insufficient for collection of an adequate volume with sufficient levels of radionuclides for conduct of these studies, and it was agreed that the Woman Creek Basin IM/IRAP/EA would be prepared in the absence of such studies to avoid project delays.

A draft Woman Creek Basin Surface Water IM/IRAP/EA was submitted on 02 October 1991 (EG&G 1991g). This IM/IRAP/EA presents a detailed evaluation of the human health risks and environmental impacts associated with the contaminated Woman Creek Basin surface seeps. Results of the evaluation indicated that the contaminated seeps present no immediate threat to public health or the environment. The IM/IRAP/EA thus presented the No Action Alternative as the preferred alternative. Meetings between DOE, EPA, and CDH were held subsequent to submission of the IM/IRAP/EA to discuss alternative IM/IRAs that could be conducted at OU2 in lieu of the originally conceived Woman Creek Basin surface water action. The result of these discussions was an agreement that a better use of resources was to pursue an IM/IRA that addresses suspected residual free phase VOC contamination in the subsurface at one or more OU2 areas. It was further agreed that since subsurface VOC contamination at OU2 does not pose an immediate threat to public health and the environment, the IM/IRA should primarily be used to gain information that will aid in selection and design of final remedial actions at OU2.

1.2 OBSERVATIONAL/STREAMLINED APPROACH

OSWER Directive No. 9355.3-06 (EPA 1989b) provides guidance for streamlining RI/FS activities to reduce the cost and time required for planning and implementing site cleanups. Streamlining is based on the Observational Method, which has been used for decades in the geotechnical engineering field when dealing with uncertainties associated with subsurface work. The Observational/Streamlined Approach has been used to plan the Subsurface IM/IRA at OU2. The fundamentals of the Observational/Streamlined Approach are discussed in this section along with the benefits of applying this approach to the restoration of hazardous waste sites.

The Observational/Streamlined Approach is based on the fundamental tenet that it is not always possible to fully characterize the subsurface. In recent years, incomplete characterization of hazardous waste sites has delayed design and implementation of remedial actions, and has thus resulted in higher than expected costs. Observational methods aid in the streamlining of clean up activities by emphasizing data sufficiency rather than data completeness. Planners and designers should ask the question: "Is the site sufficiently characterized to develop a cost effective and technically defensible remedial action?" By using the four step process discussed below when developing a remedial action, this question is answered.

The first step is to explicitly state the expected or probable conditions at the site based on all available data. Expected conditions pertain to subsurface geology, nature of contamination, water table behavior, etc. The expected site conditions together with the remedial action objectives are used to formulate the proposed remedial action.

Steps 2 and 3 require identification of reasonable deviations or uncertainties in the expected conditions and development of mechanisms for their resolution, respectively. Uncertainties in subsurface hydraulic communication, for example, may be resolved by conducting a tracer study prior to placement of ground water recovery wells.

The final step in the Observational/Streamlined Approach planning involves development of contingency plans that address the potential deviations. Contingency planning may involve relocation of contaminant recovery systems, modification of treatment system configuration, use of alternative disposal methods for treatment system residuals, criteria to continue or cease system operation, etc. Modification of the proposed action based on Observational/Streamlined Approach contingency planning results in a technically superior and more cost effective remedial action than would otherwise be achieved.

Although the Subsurface IM/IRA is investigatory in nature, implementation of the pilot scale systems discussed herein is based on limited site characterization data and an Observational/Streamlined Approach to conduct this study is necessary. Utilizing this approach will maximize the quality and quantity of information that is gathered for subsequent remedial design of full scale systems for final remediation. This IM/IRA may also indicate that the technologies tested are either ineffective or not cost effective for final remediation. This information is equally valuable by allowing these technologies to be dropped from further consideration in the FS process and thus foregoing possible costly implementation of ineffective full scale systems.

1.3 IM/IRAP ORGANIZATION

Section 2 of this IM/IRAP/EA provides RFP site characterization information focusing on site characterization information for the 903 Pad Mound and East Trenches Areas at OU2. The

discussion also describes the potentially affected environment associated with the IM/IRA and the results of previous investigations at OU2. The information included in Section 2 has been derived from the draft RI report and final Phase II RFI/RIFS Work Plan.

Section 3 identifies the objectives of the Subsurface IM/IRA at OU2. Applicable or Relevant and Appropriate Requirements (ARAR) and applicable environmental regulations pertinent to remediation of subsurface VOC contamination are also presented in this section.

Section 4 presents the proposed remedial actions to be implemented at each of the OU2 Areas: 903 Pad Mound and East Trenches. The proposed actions address removal of expected residual free phase VOC contamination from the subsurface and are conceptually designed to provide information that will aid in the selection and design of final remedial actions at OU2. The proposed actions are critically evaluated based on CERCLA effectiveness and implementability and NEPA environmental impact criteria. Section 4 also presents an environmental assessment of the No Action Alternative.

Section 5 presents the plan for implementing the Subsurface IM/IRA at OU2. Implementation includes the preparation of a Pilot Test Plan for each of the proposed actions and a Pilot Test Report at the conclusion of pilot testing. The purpose and content of the Test Plans and Test Report is discussed. A preliminary schedule for the proposed Subsurface IM/IRA is also presented in this section.

Section 6 provides a list of sources referenced in this IM/IRAP/EA.

Volume II of this IM/IRAP/EA contains ground water, soils, and surface water quality data. Volume II also includes a tabulation of ARARs pertinent to the proposed Subsurface IM/IRA and includes details of the transportation analysis performed for this Plan.

SECTION 2 SITE CHARACTERIZATION

This section describes the RFP and surrounding environs and provides details on site hydrology geohydrology and contamination at OU2

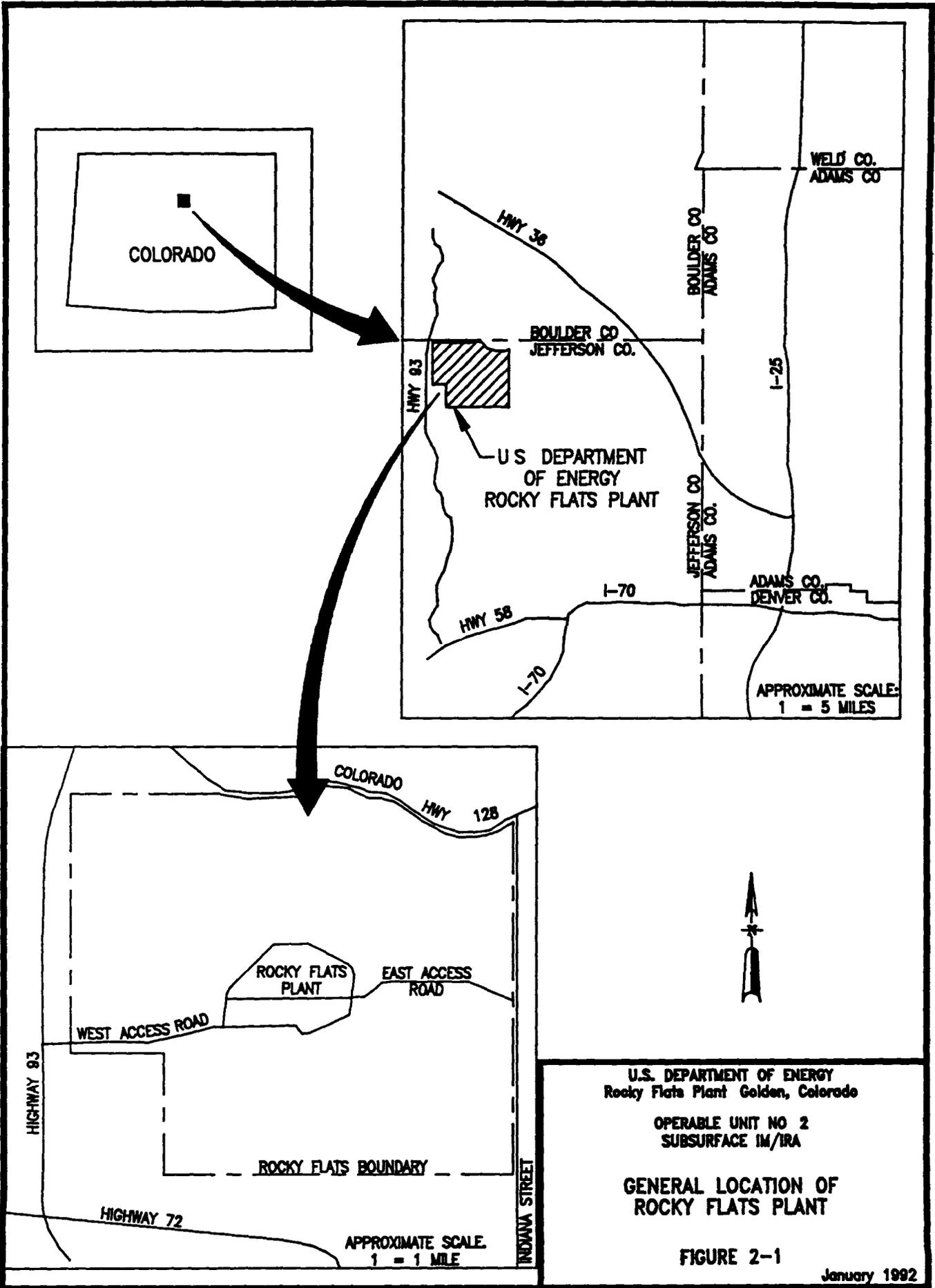
2.1 SITE DESCRIPTION AND BACKGROUND

2.1.1 Location and Facility Type

The RFP is located in northern Jefferson County Colorado approximately 16 miles northwest of downtown Denver (Figure 2.1). The plant site consists of approximately 6,550 acres of federally owned land in Sections 1 through 4 and 9 through 15 of Township 2 South Range 70 West 6th principal meridian. Plant buildings are located within an area of approximately 400 acres known as the RFP security area. The security area is surrounded by a buffer zone of approximately 6,150 acres.

The RFP is a government owned contractor operated facility. It is part of a nationwide nuclear weapons research, development, production, and plutonium reprocessing complex and is administered by the Rocky Flats Office of the DOE. The operating contractor for the RFP is EG&G Rocky Flats, Inc. The facility has been in operation since 1951 and manufactures components for nuclear weapons and conducts plutonium reprocessing. The RFP fabricates components from plutonium, uranium, beryllium, and stainless steel. Historically, production activities have included metal fabrication, machining, and assembly. Both radioactive and nonradioactive wastes are generated in the process. Current waste handling practices involve on-site and off-site recycling of hazardous materials and off-site disposal of solid radioactive and mixed wastes at another DOE facility.

The RFP is currently a RCRA hazardous waste treatment/storage facility. In the past, both storage and disposal of hazardous and radioactive wastes occurred at on-site locations. Preliminary assessments conducted under Phase I of the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination.



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

OPERABLE UNIT NO 2
 SUBSURFACE IM/IRA

**GENERAL LOCATION OF
 ROCKY FLATS PLANT**

FIGURE 2-1

January 1992

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2 1 2 Operable Unit No. 2 Description

OU2 is comprised of the 903 Pad Mound and East Trenches Areas which are located east-southeast of the RFP as shown in Figure 2 2 (Also see Figure 2-4) The Areas of OU2 lie within either the Woman Creek or South Walnut Creek drainage basins Because this IM/IRAP/EA exclusively addresses subsurface contamination within the Woman Creek and South Walnut Creek drainage basins it is useful to examine the historical uses of the OU2 Areas Twenty sites designated as IHSSs) lie within OU2 5 in the 903 Pad Area 4 in the Mound Area and 11 in the East Trenches Areas The historical activities at the OU2 IHSSs is discussed below

2 1 2 1 903 Pad Area

Five sites are located within the 903 Pad Area (Figure 2 2) These sites are

- 903 Drum Storage Site (IHSS No 112)
- 903 Lip Site (IHSS No 155)
- Trench T 2 Site (IHSS No 109)
- Reactive Metal Destruction Site (IHSS No 140)
- Gas Detoxification Site (IHSS No 183)

Brief descriptions of each of these sites are presented below

- 1 903 Drum Storage Site (IHSS No 112) — The site was used from 1958 to 1967 to store drums containing radioactively contaminated used machine cutting oil The drums some of which corroded and leaked contained oils and solvents contaminated with plutonium or uranium Most of the drums contained lathe coolant consisting of mineral oil (i.e. petroleum distillate oil) and carbon tetrachloride (CCl₄) in varying proportions However an unknown number of drums contained hydraulic oils vacuum pump oils trichloroethene (TCE) tetrachloroethene (PCE) silicone oils and acetone (Rockwell International 1987a) Ethanolamine was also added to new drums after 1959 to reduce the drum corrosion rate All drums were removed by 1968

After the drums were removed efforts were made to scrape and move the plutonium contaminated soil into a relatively small area cover it with fill material and top it with an asphalt containment cover This remedial action was completed in November 1969 An estimated 5 000 gallons of liquid leaked into the soil during use of the drum storage site The liquid was estimated to contain 86 grams of plutonium (Rockwell International 1987a)

- 2 903 Lip Site (IHSS No 155) — During drum removal and clean up activities associated with the 903 Drum Storage Site winds distributed plutonium to the south and east of what is now the 903 Pad Although most plutonium contaminated soils were removed radioactive contamination is still present at the 903 Lip Site in the surficial soils
- 3 Trench T 2 Site (IHSS No 109) — This trench was used prior to 1968 for the disposal of sanitary sewage sludge and flattened drums contaminated with uranium and plutonium
- 4 Reactive Metal Destruction Site (IHSS No 140) — This site was used during the 1950s and 1960s primarily for the destruction of lithium metal (DOE 1986) Small quantities of other reactive metals (sodium calcium and magnesium) and some solvents were also destroyed at this location (Illsley 1983)
- 5 Gas Detoxification Site (IHSS No 183) — Building 952 located south of the 903 Drum Storage Site was used to detoxify various bottled gases between June 1982 and August 1983 The gases consisted of nitrogen oxides chlorine hydrogen sulfide sulphur tetrafluoride methane hydrogen fluoride and ammonia Gas detoxification was accomplished by using various commercial neutralization processes available at the time The neutralized gases released to the environment during detoxification would no longer be detectable (Rockwell International 1987b)

A Phase I RI has been completed for these five sites Phase II was initiated in the fall of 1991

2 1 2 2 Mound Area

The Mound Area is composed of four sites (Figure 2 2) These are

- Mound Site (IHSS No 113)

- Trench T 1 Site (IHSS No 108)
- Oil Burn Pit No 2 Site (IHSS No 153)
- Pallet Burn Site (IHSS No 154)

These sites are individually described below

- 1 Mound Site (IHSS No 113) — The Mound Site contained approximately 1 405 drums containing primarily depleted uranium and plutonium contaminated lathe coolant (i e petroleum distillate oil) Some drums also contained Perclene (Smith 1975) perclene was a brand name of tetrachloroethene (Sax and Lewis 1987) Some of the drummed wastes placed in the Mound Site were in solid form (Rockwell International 1987b) Initial remediation of the Mound Site was accomplished in 1970 and the materials that were removed were packaged and shipped to an off site DOE facility as radioactive waste Subsequent surficial soils sampling in the vicinity of the excavated Mound Site indicated 0 8 to 112 5 disintegrations per minute per gram (d/m/g) alpha activity This radioactive contamination is thought to have come from the 903 Drum Storage Site via wind dispersion rather than from the Mound Site (Rockwell International 1987a)
- 2 Trench T 1 Site (IHSS No 108) — The trench was used from 1954 until 1962 and contains approximately 125 drums filled with depleted uranium chips (Dow Chemical 1971) and plutonium chips coated with lathe coolant The drums are still present in this trench
- 3 Oil Burn Pit No 2 Site (IHSS No 153) — Oil Burn Pit No 2 is actually two parallel trenches that were used in 1957 and from 1961 to 1965 to burn 1 082 drums of oil containing uranium (Rockwell International 1987a) The residues from the burning operations and some flattened drums were covered with backfill Initial remedial activities were performed in the 1970s (Rockwell International 1987a)
- 4 Pallet Burn Site (IHSS No 154) — An area southwest of Oil Burn Pit No 2 was reportedly used to destroy wooden pallets in 1965 The types of hazardous substances or radionuclides that may have been spilled on these pallets is unknown Initial remedial activities were performed in the 1970s (DOE 1986)

2 1 2 3 East Trenches Area

The East Trenches Area consists of nine burial trenches and two spray irrigation areas (Figure 2 2) The trench numbers and their respective IHSS designations are

- Trench T 3 — IHSS No 110
- Trench T-4 — IHSS No 111 1
- Trench T 5 — IHSS No 111 2
- Trench T 6 — IHSS No 111 3
- Trench T 7 — IHSS No 111 4
- Trench T 8 — IHSS No 111 5
- Trench T 9 — IHSS No 111 6
- Trench T 10 — IHSS No 111 7
- Trench T 11 — IHSS No 111 8

Trenches T 3 T 4 T 10 and T 11 are located north of the east access road and trenches T 5 through T 9 are located south of the east access road The trenches were used from 1954 to 1968 for disposal of depleted uranium flattened depleted uranium and plutonium contaminated drums and sanitary sewage sludge The wastes have not been disturbed since their burial

IHSS numbers 216 2 and 216 3 are part of the East Trenches Area and are designated as IHSSs because they were used for spray irrigation of sewage treatment plant effluent The historical discharge of Pond B 3 was to this spray irrigation area However this practice has been terminated and the current Pond B 3 discharge is sent to Pond B-4

2 1 3 Surrounding Land Use and Population Density

The RFP property is located in a rural area Approximately 50 percent of the area within 10 miles of the RFP is in Jefferson County The remainder is located in Boulder County (40 percent) and Adams County (10 percent) According to the 1973 Colorado Land Use Map 75 percent of this land was unused or was used for agriculture Since that time portions of this land have been converted to housing with several new housing subdivisions being started within

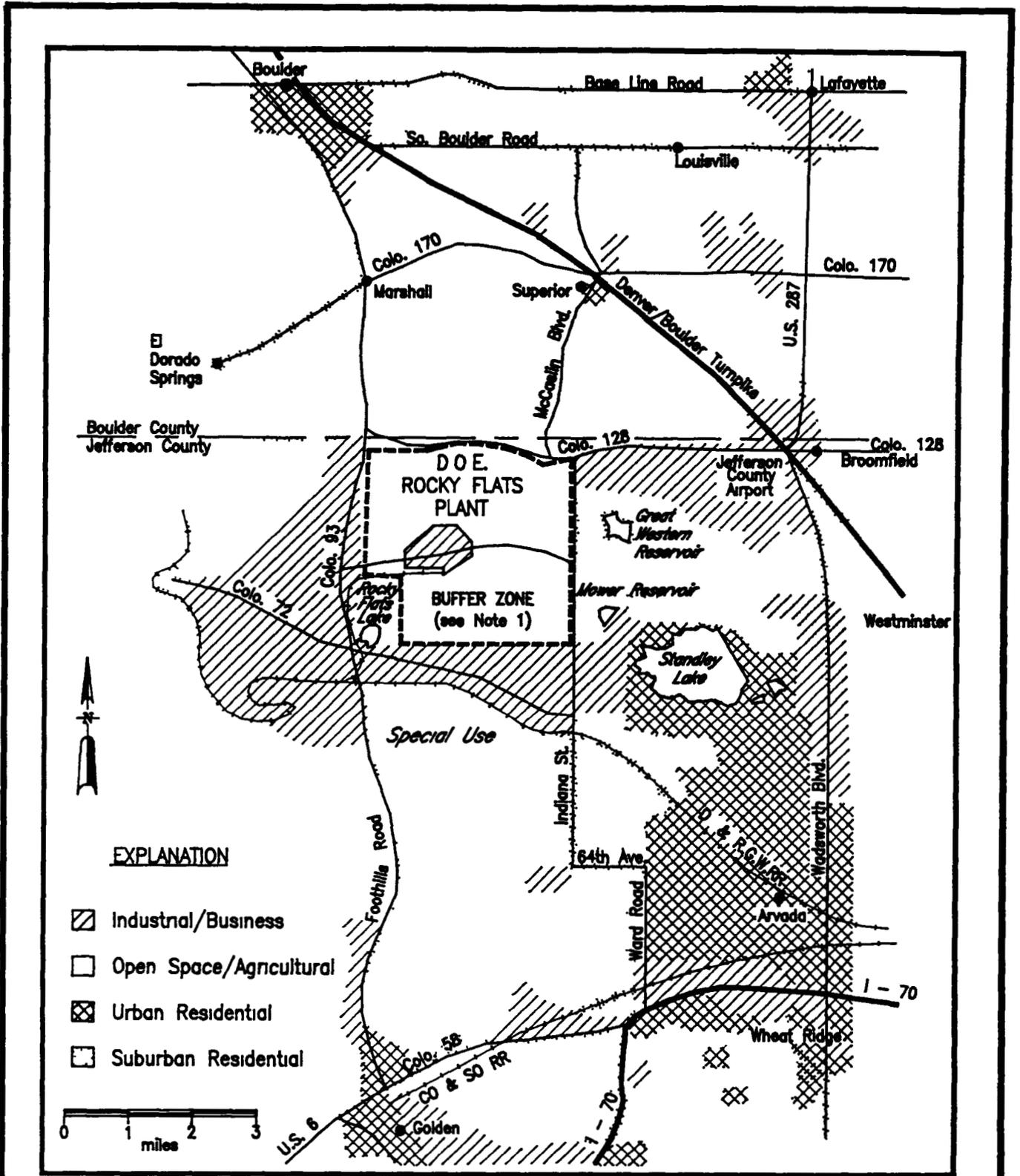
a few miles of the Buffer Zone southeast of the plant site. Land zoning is depicted in Figure 2.3.

A demographic study using 1990 census data shows that approximately 1.9 million people lived within the eight county Denver metropolitan region. This region covers approximately 5,076 square miles and includes the following counties: Adams, Arapahoe, Boulder, Clear Creek, Denver, Douglas, Gilpin, and Jefferson. The most populated sector is to the southeast toward the center of Denver. This sector had a 1989 population of approximately 600,000 people living between 10 and 50 miles from Rocky Flats. Recent population estimates registered by the Denver Regional Council of Governments (DRCOG) for the eight county Denver metro region have shown distinct patterns of growth between the first and second halves of the decade.

Between 1980 and 1985 the population of the 8 county region increased by 197,890, a 2.4 percent annual growth rate (DRCOG 1989). Between 1985 and 1990 a population gain of 80,875 was recorded, representing a 0.9 percent annual increase. The 1990 population showed an increase of 9,300 (or 0.5 percent) from the same date in 1989 (DRCOG 1990).

The RFP property is approximately 3 miles (north-south) by 4 miles (east-west). Figure 2.3 illustrates that this property consists of plant facilities surrounded by an area of undeveloped land known as the Buffer Zone (approximately 4,600 acres). The current and intended future use of the Buffer Zone is as an undeveloped open area (i.e. greenbelt) (AEC 1972). Use of the Buffer Zone as a greenbelt serves to preserve the natural ecological state of the land and prevents development immediately adjacent to the plant area.

There are eight public schools within 6 miles of the RFP. The nearest educational facility is Witt Elementary School, which is approximately 2.7 miles east of the Plant Buffer Zone. The closest hospital is Centennial Peaks Hospital, located approximately 7 miles northeast. The closest park and recreational area is the Standley Lake area, approximately 5 miles southeast of the Plant. Boating, picnicking, and limited overnight camping are permitted in the Standley Lake Recreational Area. Several other small parks are located in communities within 10 miles of the RFP. The closest major park is Golden Gate Canyon State Park, located approximately 15 miles to the southwest, providing 8,400 acres of general camping and outdoor recreation.



(after Jefferson County Planning and Zoning Department, April, 1990)

NOTE 1 Current and intended future use of the Buffer Zone is as an undeveloped open area (i.e., greenbelt*) (A.E.C., 1972)

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Rocky Flats Plant
Golden, Colorado

LAND ZONING IN THE VICINITY
OF ROCKY FLATS PLANT

FIGURE
2-3

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Other national and state parks are located in the mountains west of the RFP but all are more than 15 miles away

Some of the land adjacent to the RFP is zoned for industrial development. Industrial facilities within 5 miles include the former TOSCO (The Oil Shale Company) laboratory (40-acre site located 2 miles south and now occupied by Analytica Inc.) the Great Western Inorganics Plant (2 miles south) the Frontier Forest Products yard (2 miles south) the Idealite Lightweight Aggregate Plant (2.4 miles northwest) and the Jefferson County Airport and Industrial Park (990 acre site located 4.8 miles northeast)

Several ranches are located within 10 miles of the RFP primarily in Jefferson and Boulder Counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1987 Colorado Agricultural Statistics, 20,758 acres of crops were planted in Jefferson County (total land area of approximately 475,000 acres) and 68,760 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of 5,314 head of cattle, 113 hogs, and 346 sheep in Jefferson County, and 19,578 head of cattle, 2,216 hogs, and 12,133 sheep in Boulder County (Post, 1989).

2.2 AFFECTED ENVIRONMENT

2.2.1 Physical Environment

The natural environment of the RFP and vicinity is primarily influenced by its proximity to the Front Range of the Rocky Mountains. The RFP is located directly east of the north-south trending Rocky Mountains at an elevation of approximately 6,000 feet above mean sea level. The RFP is located on a broad, eastward sloping plain of overlapping alluvial fans. These fans extend approximately 5 miles east of the Front Range and terminate where gentle slopes break to low rolling hills. The Continental Divide is approximately 16 miles west of the RFP. The operational area at the RFP is located near the eastern edge of the fans on a terrace between the stream cut valleys of North Walnut Creek and Woman Creek. The Rocky Flats Alluvium (the

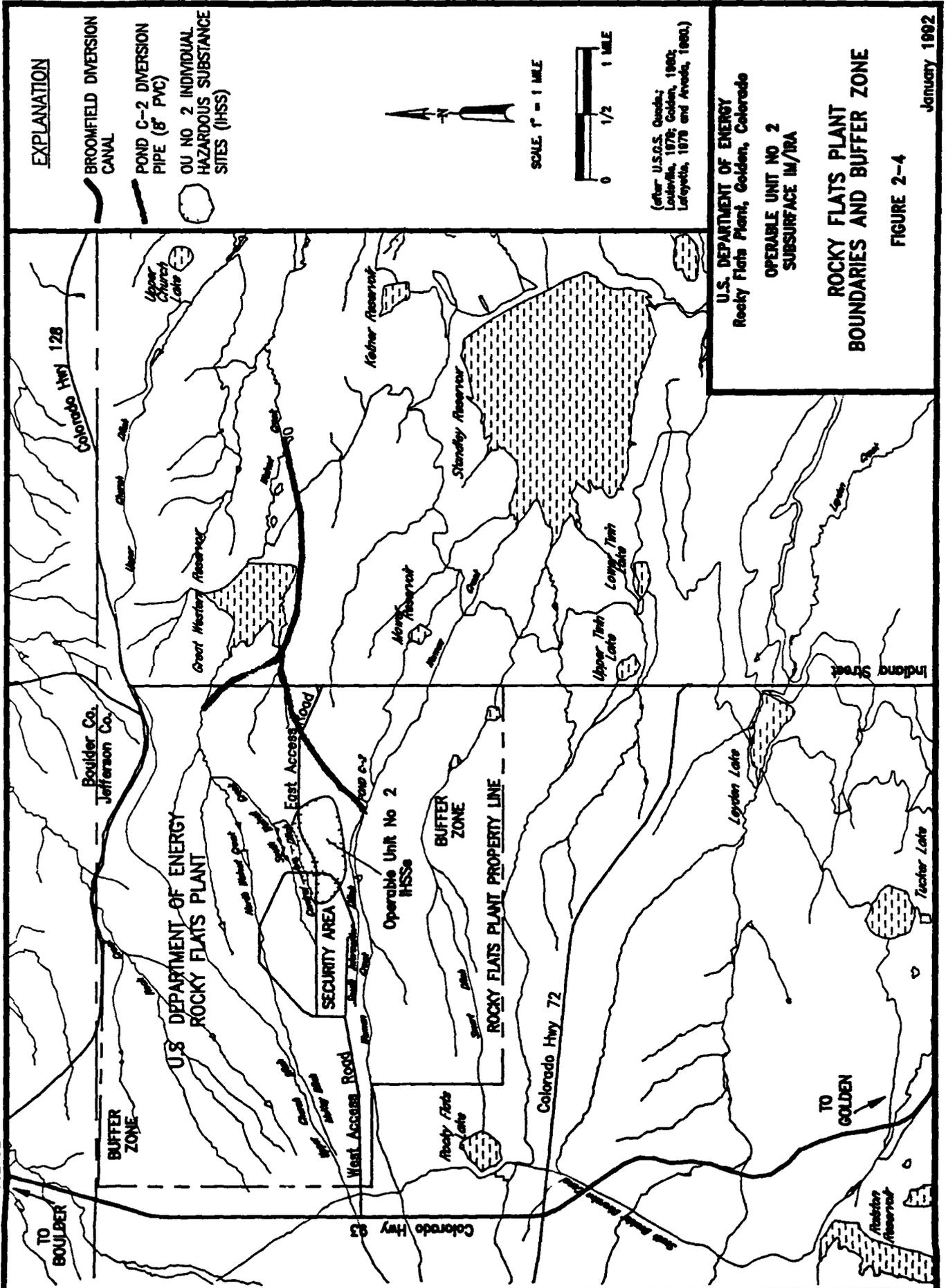
deposit of coalescing alluvial fans) is exposed at the surface and consists of a topsoil layer underlain by as much as 100 feet of silt clay sand and gravel

Mineral resources found in the vicinity of the RFP include sand gravel crushed rock clay coal and uranium There are no known clay coal or uranium deposits within the RFP Buffer Zone however these commodities are mined within 20 miles of the plant The Schwartzwalder Uranium Mine is located approximately 4 miles southwest of the RFP This mine has been the largest producer of vein type uranium ore in Colorado and ranks among the six largest of this type in the United States (DOE 1980) Active sand and gravel mines lie within the Buffer Zone boundaries In addition there is an aggregate processing facility adjacent to the northwest corner of the Buffer Zone that reopened in 1989 Oil and natural gas production is also active in nearby northwest Adams County and east central Boulder County

Oil and natural gas activities near the RFP site includes oil field developments pipeline and production operations The closest major oil and gas fields are in northwest Adams County (Jackpot and Spindle Fields) and in east central Boulder County (Boulder Field) A natural gas pipeline which originates in Wyoming and proceeds across eastern Colorado into Oklahoma is located approximately 10 miles north of the RFP in southern Boulder County Local natural gas pipelines cross the south side of the RFP The nearest refinery operation is the Conoco Refinery located in Commerce City about 20 miles east of the RFP A north-south oriented oil pipeline feeds into the refinery from fields in northeastern Colorado and southeastern Wyoming (Donaldson and MacMillan 1980)

There are four main drainages within the RFP property as shown in Figure 2.4 North Walnut South Walnut Rock and Woman Creeks all have intermittent streams These drainages enter downstream reservoirs that provide drinking and irrigation water There are a number of ditches crossing the area that convey water collected off site to other areas of the RFP Walnut Creek or Woman Creek Until late 1974 Plant wastewater had been discharged into Walnut Creek and until 1975 filter backwash from the raw water treatment plant went into Woman Creek All process wastewater is now either recycled or disposed through evaporation Evaporation residues are solidified by the addition of Portland cement characterized and subsequently

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managed according to RFP waste management operating procedures. Sanitary wastewater is discharged in accordance with the RFP's NPDES permit effluent requirements.

2.2.2 Regional and Local Hydrogeology

The stratigraphic section that pertains to the RFP includes, in descending order, unconsolidated surficial units (Rocky Flats Alluvium, various terrace alluviums, valley fill alluvium, and colluvium) (Figure 2.5), Arapahoe Formation, Laramie Formation, and Fox Hills Sandstone (Figure 2.6). Ground water occurs under unconfined conditions in both the surficial and shallow bedrock units. In addition, confined ground water flow occurs in deeper bedrock sandstones.

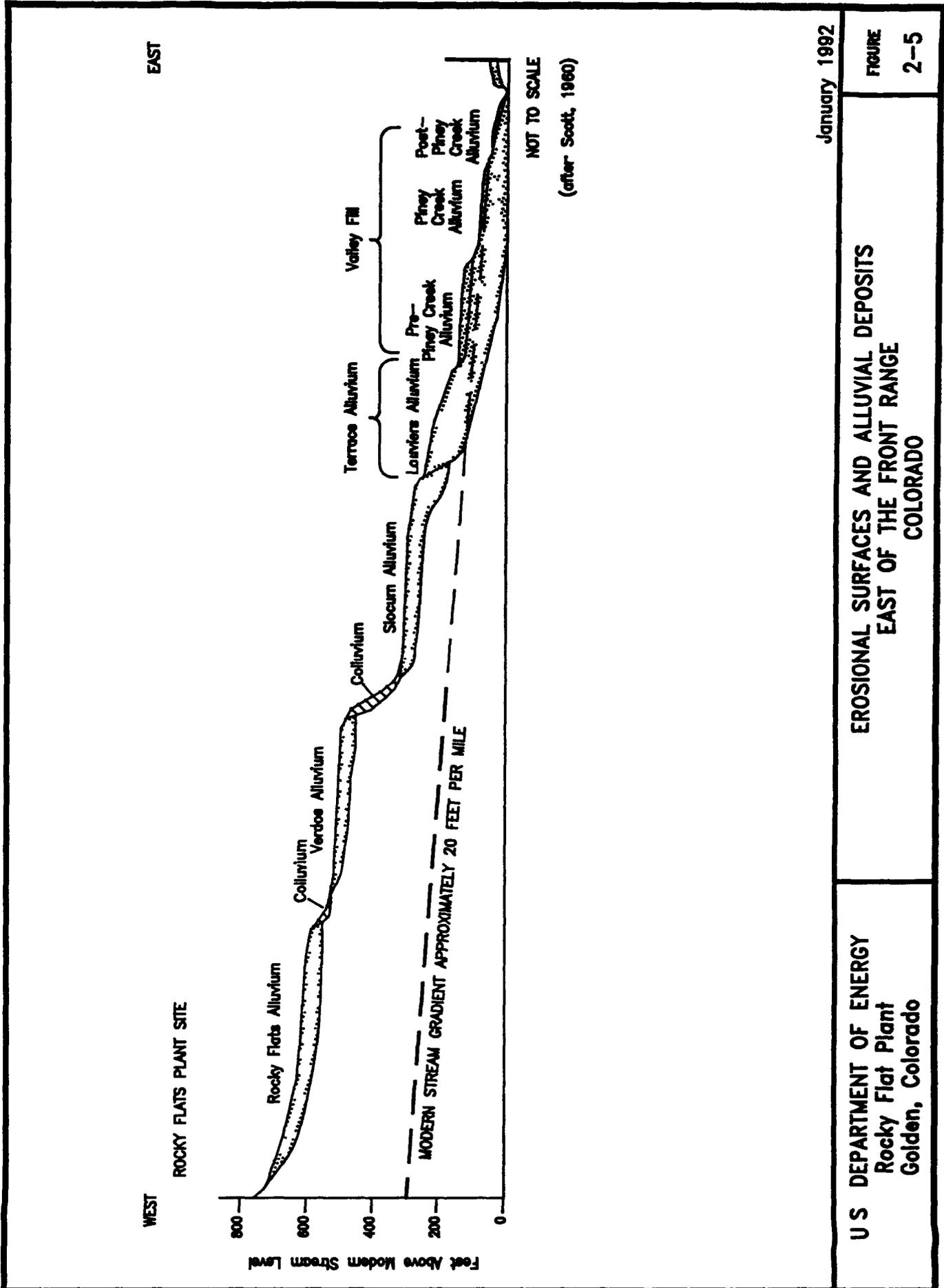
2.2.2.1 Alluvial Materials

The Rocky Flats Alluvium underlies a large portion of the RFP. The alluvium is a broad planar deposit consisting of a topsoil layer underlain by up to 100 feet of poorly stratified silt, clay, sand, gravel, and cobbles.

Unconfined ground water flow occurs in the Rocky Flats Alluvium, which is relatively permeable. Recharge to the alluvium occurs from precipitation, snowmelt, and water losses from ditches, streams, and ponds that are cut into the alluvium. General water movement in the Rocky Flats Alluvium is from west to east and toward the drainages. (Ground water flow is also controlled by paleochannels in the top of the bedrock.) The water table in the Rocky Flats Alluvium rises in response to recharge during the spring and declines during the remainder of the year. Discharge from the alluvium occurs at minor seeps in the colluvium that covers the contact between the alluvium and bedrock along the edges of the valleys. OU2 is situated on a terrace of Rocky Flats Alluvium that thins to the east of the RFP and does not directly supply water to wells located downgradient of the RFP.

Various other alluvial deposits occur topographically below the Rocky Flats Alluvium in the Plant drainages. Colluvium (slope wash) mantles the valley side slopes between the Rocky Flats Alluvium and the valley bottoms. In addition, remnants of younger terrace deposits, including

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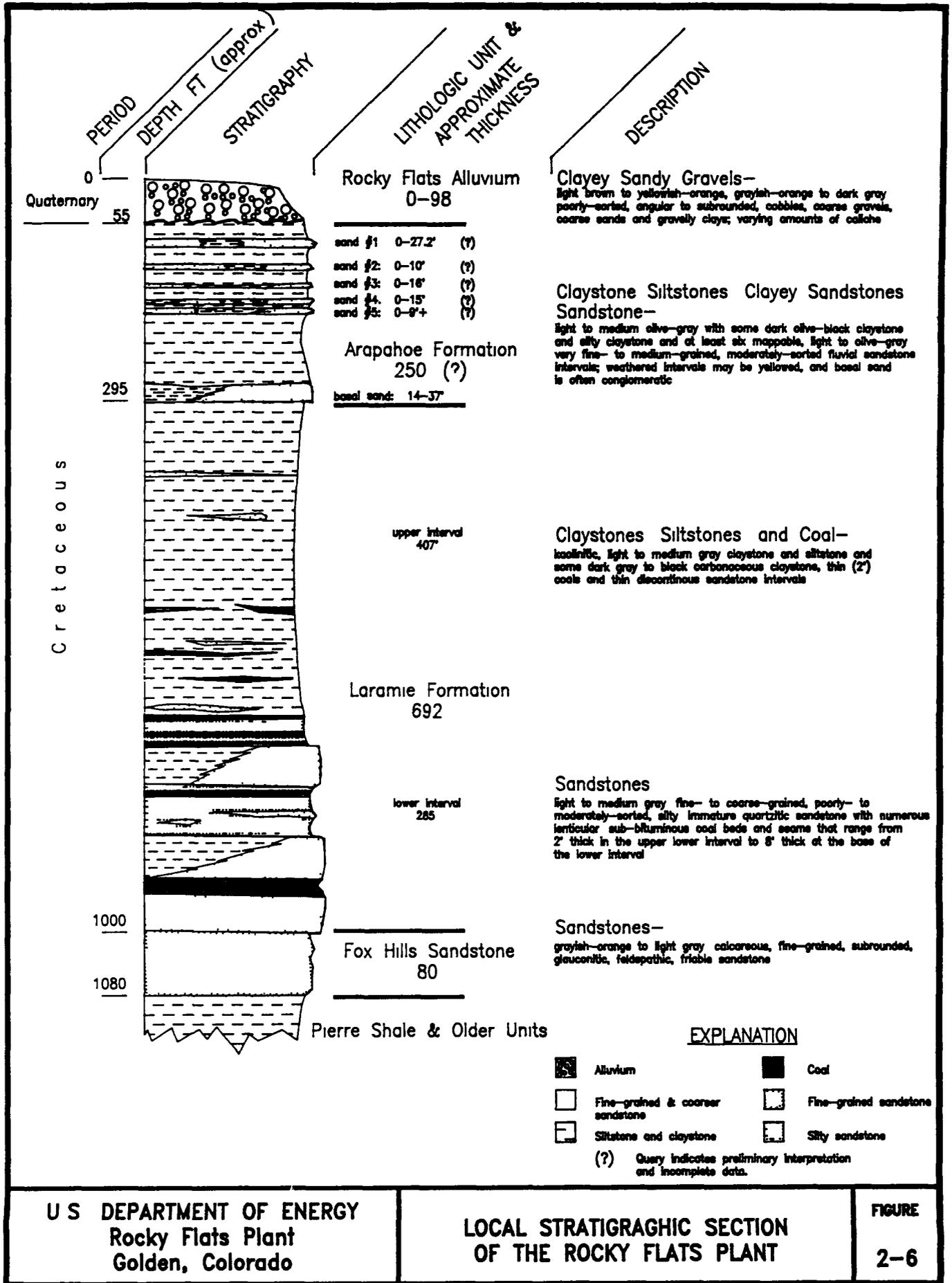


January 1992

EROSIONAL SURFACES AND ALLUVIAL DEPOSITS
EAST OF THE FRONT RANGE
COLORADO

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FIGURE
2-5



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Rocky Flats Plant
Golden, Colorado

LOCAL STRATIGRAPHIC SECTION
OF THE ROCKY FLATS PLANT

FIGURE
2-6

the Verdos Slocum and Louviers Alluvia occasionally occur along the valley side slopes
Recent valley fill alluvium occurs in the active stream channels

Unconfined ground water flow occurs in these surficial units Recharge is from precipitation percolation from streams and ditches during periods of surface water runoff and by seeps discharging from the Rocky Flats Alluvium Discharge is by seepage into other geologic formations and streams and by evaporation where the water table approaches the ground surface The direction of ground water 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

2 2 2 2 Bedrock Materials

The Cretaceous Arapahoe Formation underlies surficial materials beneath the Plant This formation is a fluvial deposit composed of overbank and channel deposits It primarily consists of claystone with some sandstone and is nearly flat lying beneath the Plant (less than a 2 degree dip) based on the draft seismic profiling report (Rockwell International 1989a) The sand bodies within the claystone are composed of fine grained sands and silts and their hydraulic conductivity is relatively low compared to the overlying Rocky Flats Alluvium Total formation thickness varies up to 270 feet (Robson Romero and Zawistowski 1981)

The Arapahoe Formation is recharged by ground water movements from overlying surficial deposits and by leakage from streams The main recharge areas are under the Rocky Flats Alluvium although some recharge from the colluvium and valley fill alluvium is likely to occur along the stream valleys Recharge is greatest during the spring and early summer when rainfall and stream flow are at a maximum and water levels in the Rocky Flats Alluvium are high Ground water movement in the Arapahoe Formation is generally toward the east although flow within individual sandstones is not fully characterized at this time Regionally ground water flow in the Arapahoe Formation is toward the South Platte River in the center of the Denver Basin (Robson Romero and Zawistowski 1981)

The Laramie Formation underlies the Arapahoe Formation and is composed of two units a thick upper claystone and a lower sandstone. The claystone is greater than 700 feet thick and is of very low hydraulic conductivity therefore the U S Geologic Survey (Hurr 1976) concludes that RFP operations will not impact any units below the upper claystone unit of the Laramie Formation.

The lower sandstone unit 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. Aquifer thickness ranges from 200 to 300 feet near the center of the basin. These units subcrop west of the Plant and can be seen in clay pits excavated through the Rocky Flats Alluvium. The steeply dipping beds of these units west of the Plant (approximately a 50 degree dip) quickly flatten to the east (less than 2-degree dip) based on preliminary results of the high resolution seismic reflection study (Rockwell International 1989a). Recharge to the aquifer occurs along the rather limited outcrop area exposed to surface water flow and leakage along the Front Range (Robson Wacinski Zawistowski and Romero 1981). In the vicinity of the RFP this would occur west of the Plant where the units subcrop.

Sixteen wells were completed in various zones within bedrock during the 1987 drilling program at OU2. Although claystone was the most frequently encountered lithology immediately below the alluvium/bedrock contact interbedded sandy silty and lignitic units with both gradational and sharp contacts were present as well. All of the bedrock encountered directly beneath surficial materials was weathered and some saturated sandstones were encountered.

2.2.3 Site Hydrology

The following discussion of the site hydrology of OU2 includes ground water that occurs in surficial and bedrock materials and surface water drainage patterns of the Woman Creek and South Walnut Creek drainages.

2 2 3 1 Ground Water

Ground water occurs in surficial materials (Rocky Flats Alluvium colluvium and valley fill alluvium) and in Arapahoe sandstones and claystones at OU2. These two flow systems which are hydraulically connected at shallower portions of the Arapahoe Formation are discussed separately below.

Ground Water in Surficial Materials

Ground water is present in the Rocky Flats Alluvium colluvium and valley fill alluvium under unconfined conditions. Recharge to the water table occurs as infiltration of incident precipitation and seepage from ditches and creeks. In addition, detention ponds along Woman Creek and South Walnut Creek recharge the valley fill alluvium. Figure 2.7 shows the potentiometric surface of the uppermost ground water measured between April 4 and April 8, 1988, and the locations of alluvial and bedrock wells in the vicinity of OU2. The potentiometric surface during April 1988 is typical of the spring time water table at OU2.

The shallow ground water flow system is quite dynamic with large water level changes occurring in response to precipitation events that influence stream and ditch flow. For example, between mid April and September 1986, water levels in wells 1.86 and 4.86 (completed in valley fill alluvium) dropped more than 4 and 8 feet, respectively. Alluvial water levels are highest during the months of May and June, then decline during late summer and fall, with some wells going completely dry. Ground water flow in the Rocky Flats Alluvium is generally from west to east following the surface of the claystone bedrock.

Alluvial ground water discharges to seeps, springs, surface water drainages, and subcropping Arapahoe Sandstone at OU2. Seeps and springs occur along the edge of the Rocky Flats Alluvium terrace (at the alluvium/bedrock contact) and on the side slopes of the terrace. Seeps and springs on the terrace side slopes may be due to thinning of colluvial materials. Ground water in colluvial materials south of the 903 Pad and East Trenches Areas discharges to the South Interceptor Ditch (SID), and ground water in valley fill materials discharges to Woman or South Walnut Creeks.

Hydraulic conductivity values for surficial materials were estimated from drawdown recovery tests performed on 1986 wells during the initial site characterization and from slug tests performed on selected 1986 and 1987 wells during the Phase I RI (Rockwell International, 1987a). Mean hydraulic conductivities are 4×10^{-4} , 7×10^{-4} and 9.5×10^{-5} centimeters per second (cm/s) for Rocky Flats, Woman Creek Valley Fill and South Walnut Creek Valley Fill Alluvium respectively.

Bedrock Ground Water

Due to their relatively high permeability, the meandering lenticular sandstones contained within the claystones (i.e., the basal formation) provide the greatest potential for ground water flow in the Arapahoe Formation. Flow within individual sandstones is assumed to be from west to east, but the geometry of the bedrock ground water flow path is not fully understood at this time due to its dependence upon the continuity of the sandstones and their hydraulic interconnection (Robson, Romero, and Zawistowski, 1981). Evaluation of the lateral extent and degree of interconnection of the sandstone units is a primary goal of the Phase II Bedrock RI for OU2. Ground water recharged to sandstones occurs as infiltration from alluvial ground water where sandstones subcrop beneath the alluvium and by leakage from claystones overlying the sandstones. Ground water from the basal formation of the Arapahoe aquifer is used for irrigation, livestock watering, and domestic purposes. Wells are located east of the RFP within the Denver Basin.

There is a strong downward gradient between ground water in surficial materials and bedrock. Vertical gradients range from 0.31 feet per foot (ft/ft) between wells 35-86 and 34-86 to 1.05 ft/ft between wells 41-86 and 40-86. These gradients imply a relatively high hydraulic conductivity contrast between the surficial materials and bedrock, which is supported by hydraulic conductivity test results.

2.2.3.2 Surface Water

Surface water drainage patterns at the RFP are shown on Figures 2-2 and 2-4. A discussion of the major OU2 surface water features, including the Woman Creek and South Walnut Creek

drainages is presented below. Collection and treatment of the South Walnut Creek Basin surface water and seepage is being addressed in the IM/IRA (EG&G 1991f) discussed in Section 1.

Woman Creek

Woman Creek is located south of the Plant with headwaters in largely undisturbed Rocky Flats Alluvium. Runoff from the southern part of the Plant is collected in the SID located north of the creek and delivered downstream to Pond C 2 (see Figure 2.2). Pond C 1 (upstream of C 2) receives stream flow from Woman Creek. Flow in Woman Creek is also influenced by diversion of water from Rocky Flats Lake into the creek by local landowners. The discharge from Pond C 1 is diverted around Pond C 2 into the Woman Creek channel downstream. Water in Pond C 2 is treated and monitored prior to discharge. Discharge from Pond C 2 is in accordance with the Plant's NPDES permit (discharge point 007). Historically, discharge from Pond C 2 has been to Woman Creek; however, since October of 1989, treated water is being pumped to the South Walnut Creek drainage and flows off site via the Broomfield Diversion Canal.

Flow in Woman Creek and the SID is intermittent. This has been observed by field investigation crews since 1986.

South Walnut Creek

The headwaters area of South Walnut Creek has been filled during construction of RFP facilities. As a result, flow originates from a buried culvert located in the east-central portion of OU2 west of Building 991. Flow in the upper reach of South Walnut Creek is directed to the south of Building 991 and under the Protected Area (PA) fence by a buried corrugated metal culvert. The culvert outlet is located in the South Walnut Creek drainage approximately 500 feet downgradient of the PA fence near the discharge of the sewage treatment plant. A concrete culvert and a second corrugated metal culvert also discharge into the South Walnut Creek drainage just downgradient of the PA fence and north of the Mound Area. The flow from the concrete culvert originates as seepage from the hillside south of Building 991 and flows into a

ditch along the slope. The corrugated metal culvert drains Plant runoff that collects in a drainage south of the PA. The combined flow then enters the South Walnut Creek detention pond system. Below the detention ponds, South Walnut Creek, North Walnut Creek, and an unnamed tributary join within the Buffer Zone to form Walnut Creek. Flow is routed around Great Western Reservoir by the Broomfield Diversion Canal. Great Western Reservoir is located approximately 1 mile east of this confluence and is a primary drinking water source for the residents of Broomfield.

The South Walnut Creek detention pond system consists of five ponds (B 1, B 2, B 3, B 4, and B 5) that retain surface water runoff and RFP discharges for flood control, monitoring, and treatment prior to downstream release. All flow in the pond system is eventually detained in Pond B 5, where it is treated and monitored prior to discharge. Water is discharged from Pond B 5 in accordance with the Plant NPDES permit (discharge point 006). Ponds B 1 and B 2 are reserved for spill control, surface water runoff, or treated sanitary waste of questionable quality. Pond B 3 is used as a holding pond for sanitary sewage treatment plant effluent. The historical discharge of Pond B 3 was a spray irrigation system located in the vicinity of the East Trenches; however, this practice has been terminated and current Pond B 3 discharge is routed to Pond B-4. In addition to Pond B 3 discharge, Ponds B-4 and B 5 receive surface water runoff from the central portion of the RFP. The surface water runoff received by Pond B 4 is collected by the Central Avenue Ditch and the South Walnut Creek Drainage.

2.2.4 Meteorology and Climatology

The area surrounding the RFP has a semiarid climate characteristic of much of the central Rocky Mountain region. Approximately 40 percent of the 15 inch annual precipitation falls during the spring season, much of it as snow. Thunderstorms (June to August) account for an additional 30 percent of the annual precipitation. Autumn and winter are drier seasons, accounting for 19 and 11 percent of the annual precipitation, respectively. Snowfall averages 85 inches per year, falling from October through May (DOE 1980). Temperatures are moderate; extremely warm and cold weather is usually of short duration. On the average, daily summer temperatures range from 55 F to 85 F, and winter temperatures range from 20 F to 45 F. The low average relative humidity (46 percent) is due to the blocking effect of the Rocky Mountains.

Wind temperature and precipitation data are collected on Plant site and summarized annually. Table 2.1 presents the 1990 annual summary of the percent frequency of wind directions (16 compass points) divided into 6 speed categories. These frequency values are represented graphically in Figure 2.8. Winds at the RFP are predominantly northwesterly. Winds greater than 4.18 meters per second (m/s) (9.2 miles per hour [mph]) with easterly components occur with a low frequency. The Pasquill Stability Class D represents the prevailing meteorological conditions for the RFP (EG&G 1991a) and average downwind directional frequencies.

Special attention has been focused on dispersion meteorology surrounding the Plant due to the remote possibility that significant atmospheric releases might affect the Denver metropolitan area which is located in the predominant downwind (southeast) direction. Studies of air flow and dispersion characteristics (e.g. Hodgkin 1983 and 1984) indicate that drainage flows (winds coming down from the mountains to the west) turn and move toward the north and northeast along the South Platte River valley and pass to the west and north of Brighton, Colorado (DOE 1980) which is just north of Denver.

2.2.5 Ecology

The RFP site includes species of flora representative of tall grass prairie, short grass plains, lower montane, and foothills ravine regions. It is evident that the vegetative cover along the Front Range of the Rocky Mountains has been altered by human activities such as burning, timber cutting, road building, and overgrazing for many years. Since the acquisition of the RFP property, vegetative recovery has occurred as evidenced by the presence of grasses such as big bluestem and sideoats grama (two disturbance sensitive species). No vegetative stresses attributable to hazardous waste contamination have been identified (DOE 1980).

The animal life inhabiting the RFP and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer with an estimated population between 100 to 125 permanent residents. There are a number of small carnivores such as the coyote, red fox, striped skunk, and long tailed weasel. A profusion of small herbivore species can be found throughout the RFP and Buffer Zone such as the pocket gopher, white tailed jackrabbit, and the meadow vole (DOE 1980).

Table 2 1

**Rocky Flats Meteorological Monitoring Station
60 Meter Tower
January 1, 1990 to December 31, 1990
Wind Frequency Distribution by Percent - Stability Class D
10 Meter Level**

Wind Speed Classes (Knots)

| Wind Direction | <30 | 30 <60 | 60 <100 | 100 <160 | 160 <210 | ≥210 | Class ^a | Total ^b |
|----------------|------|--------|---------|----------|----------|------|--------------------|--------------------|
| N | 08 | 29 | 34 | 16 | 02 | 0.2 | 9.29 | 9.25 |
| NNE | 11 | 35 | 29 | 10 | 00 | 0.0 | 8.52 | 8.49 |
| NE | 11 | 3.3 | 16 | 0.3 | 00 | 0.0 | 6.31 | 6.29 |
| ENE | 10 | 2.3 | 8 | 0.1 | 00 | 0.0 | 4.20 | 4.19 |
| E | 14 | 30 | 7 | 0.0 | 00 | 0.0 | 5.06 | 5.04 |
| ESE | 09 | 27 | 19 | 0.1 | 00 | 0.0 | 5.60 | 5.58 |
| SE | 09 | 3.5 | 36 | 0.6 | 00 | 0.0 | 8.57 | 8.54 |
| SSE | 08 | 2.5 | 26 | 0.6 | 0.1 | 0.0 | 6.66 | 6.64 |
| S | 07 | 20 | 1.5 | 0.5 | 0.1 | 0.0 | 4.79 | 4.78 |
| SSW | 05 | 12 | 10 | 0.3 | 0.1 | 0.0 | 3.09 | 3.08 |
| SW | 03 | 12 | 12 | 0.4 | 0.1 | 0.0 | 3.29 | 3.28 |
| WSW | 04 | 11 | 12 | 10 | 0.4 | 0.3 | 4.25 | 4.24 |
| W | 05 | 11 | 11 | 16 | 1.1 | 1.5 | 6.89 | 6.87 |
| WNW | 05 | 13 | 15 | 30 | 1.8 | 1.6 | 9.59 | 9.56 |
| NW | 07 | 16 | 21 | 23 | 0.7 | 0.2 | 7.54 | 7.51 |
| NNW | 06 | 19 | 26 | 11 | 0.1 | 0.0 | 6.34 | 6.32 |
| All | 12.1 | 35.0 | 29.7 | 14.6 | 4.7 | 3.9 | 100.00 | 99.64 |

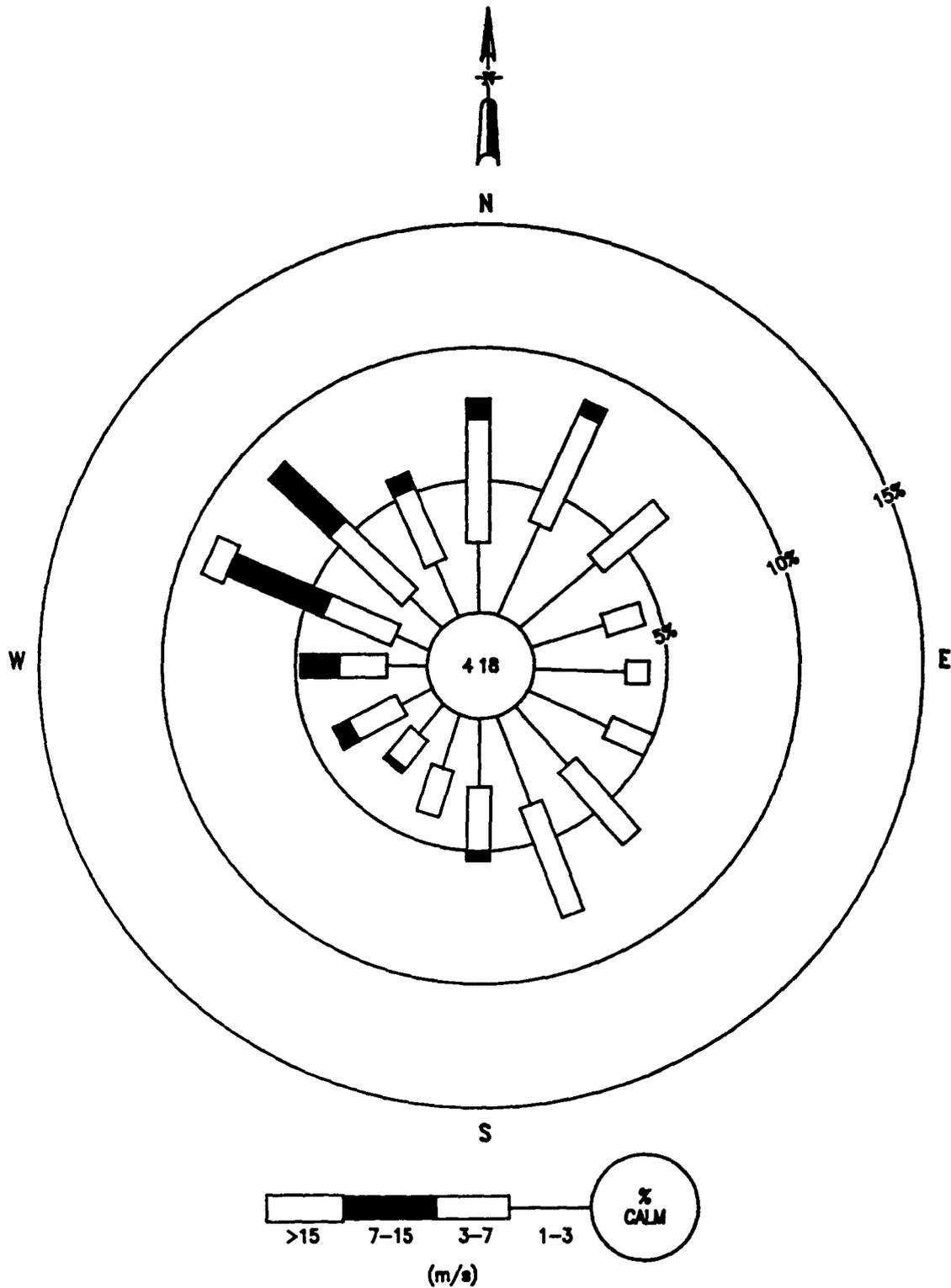
^a Total Percent for this stability class

^b Total percent relative to all stability classes (A through F)

Total Number of invalid observations in this stability class - 18

Total Number of valid observations in this stability class - 18,240

Joint Data Recovery Rate - 99.9%



R37066 MBpj-012792

January 1992

U S DEPARTMENT OF ENERGY
 Rocky Flats Plant
 Golden, Colorado

1990 ANNUAL WIND ROSE
 FOR THE ROCKY FLATS PLANT

FIGURE
 2-8

Woman Creek supports an aquatic biota typical of high prairie streams. Due to the low nutrient content in Woman Creek, the stream supports only small algal populations. Cattails and bullrush are also present. The rocky bottom of Woman Creek supports a relatively diverse biota composed of may flies, caddis flies, and other forms typical of clean water streams. Redside dace minnows are abundant in the streams and ponds, a few bluegill are also present (DOE 1990a).

Bull snakes and rattlesnakes are the most frequently observed reptiles. Eastern yellow bellied racers have also been seen. The eastern short horned lizard has been reported on Plant site, but these and other lizards are not commonly observed. The western painted turtle and the western plains garter snake are found in and around many of the ponds (DOE 1980).

Commonly observed birds include western meadowlarks, horned larks, morning doves, and vesper sparrow. A variety of ducks, killdeer, and red winged blackbirds are seen in areas adjacent to ponds. Mallards and other ducks frequently nest and raise young on several of the ponds. Common birds of prey in the area include marsh hawks, red tailed hawks, common birds of prey, rough legged hawks, Swanson's Hawks, Great Horned Owls, and Burrowing Owls (DOE 1980).

2.2.6 Threatened and Endangered Species

Relevant laws and regulations that protect threatened and endangered species include NEPA of 1969, the Endangered Species Act (ESA) of 1973 (Public Law 93-0205), the Clean Water Act (CWA) as amended (33 U.S.C. 1251), and the Migratory Bird Treaty Act (16 U.S.C. 1701-1711). Federal agencies must ensure that actions authorized, funded, or carried out by them will not jeopardize the continued existence of any endangered or threatened species (EG&G 1991g).

Studies were conducted at the RFP to identify potential habitat for threatened and endangered species and other species of special concern (EG&G 1991e). A literature search was conducted to obtain information on sensitive species that may be present at the RFP and data on habitats present on the site. Information on endangered species was obtained from the U.S. Fish and

Wildlife Service (USFWS) The U S Army Corps of Engineers (COE) was contacted for information on wetland plant species The Colorado Natural Areas Program and Colorado Division of Wildlife were contacted for information on state plant and animal species of special concern (EG&G 1991e)

Habitat potentially suitable for four sensitive plant species the Colorado butterfly plant (*Gaura neomexicana* var *coloradensis*) the diluvium lady s tresses orchid (*Spiranthes diluvialis*) the forktip threeawn (*Aristida basiramea*) and the toothcup (*Rotala ramosior*) is also present on the RFP site However no individuals of these species were observed during the reconnaissance surveys

The bald eagle (*Haliaeetus leucocephalus*) was identified to occasionally use habitat between 0.3 and 1.1 miles from the RFP site during the winter months Habitat use by bald eagles on the site is expected to be casual if it occurs at all No bald eagle nests occur on the RFP site (DOE 1990a)

Results of RFP studies also indicate that habitats potentially suitable for the endangered peregrine falcon (*Falco peregrinus*) and the ferruginous hawk (*Buteo regalis*) are present at the RFP site (EG&G 1991g) Although the peregrine falcon was not observed during the reconnaissance level surveys two historic eyries are present within 10 miles of the RFP site The Peregrine Falcon Recovery Plan (USFWS 1984) discourages land use practices that would adversely alter the character of their hunting habitat or prey base within a 10 mile radius of a nesting cliff (including historical sites)

Potentially suitable habitat is also present for six sensitive wildlife species including white faced ibis (*Plegadis chuchi*) ferruginous hawk (*Buteo regalis*) mountain plover (*Charadrius montanus*) long billed curlew (*Numenius americanus*) Preble s meadow jumping mouse (*Zapus hudsonius preblei*) and swift fox (*Vulpes velox*) Insufficient information is available to determine if habitat for the sensitive species Texas horned lizard (*Phrynosoma cornutum*) is present on the RFP site Prior to undertaking actions that may affect potentially suitable habitat focused surveys will be conducted to determine if sensitive wildlife species are present

The results of the aforementioned studies that pertain to fauna indicate that habitat potentially suitable for the endangered black footed ferret (*Mustela nigripes*) is present on the RFP site. Black footed ferrets require prairie dog colonies or complexes of smaller prairie dog colonies as habitat. In the northeast area of the plant site approximately 15 acres were identified as a prairie dog colony location. These 15 acres are part of a larger colony comprised of an estimated 47 acres that is dissected by Highway 128. This acreage is part of a 753 acre complex that primarily occurs east of Indiana Street. Although the 47 acre colony by itself is insufficient to support black footed ferrets the larger complex is potentially suitable habitat for ferrets. This 753 acre complex is fragmented by several major roads and highways. No confirmed sightings have been reported for this area but several unconfirmed sightings have been reported for the Denver area. Surveys of the 753 acre complex may be required to determine if the 15 acres present on the RFP site is habitat for the black footed ferret. Surveys will be required only if potential development directly impacts this colony. Based upon the information gathered for this survey the USFWS is not considering the area of the RFP site as a re introduction site for black footed ferrets.

2.2.7 Sensitive Environments – Wetlands and Floodplains

The relevant laws and acts which protect wetlands and floodplains include NEPA Executive Order (E O) 11990—Protection of Wetlands all pertinent sections of the CWA the Fish and Wildlife Act plus associated coordination acts and regulations promulgated under 10 CFR Part 1022 - DOE Compliance with Floodplain Wetlands Environmental Review Requirements. The rules promulgated under NEPA 42 U S C 4321 et seq in 40 CFR parts 1500 through 1508 state that all federal agencies are required to consider the environmental effects to wetlands and floodplains for any proposed action (EG&G 1990d).

Aerial photography for the 903 Pad Mound and East Trenches Areas was examined for wetlands identification followed by limited site inspection (EG&G 1990a). Wetlands have also been identified along both the Woman Creek and SID drainage areas (EG&G 1990a). The SID receives surface water runoff from the southern part of the RFP facility with additional contributions from OU2. However drainage contribution to the SID from OU2 is minimal. Evenly spaced drop structures along the SID have lowered flow velocities increased sediment

accumulation and created fairly dense linear stands of wetlands. From a point due south of the 903 Pad and extending to Pond C 2, approximately 0.15 acres of wetlands are contained within this portion of the SID. Two isolated stands of wetlands have also been identified southeast of IHSS 140 where ground water emerges as seeps or springs. These two areas are each less than 500 square feet in size. Wetland species observed were primarily common cattails (*Typha latifolia*) (greater than 95 percent predominance), spike rush (*Eleocharis macrostachya*) and bullrush (*Scirpus americanus*). The wetlands primarily function as flow attenuation features with additional minor contributions to wildlife habitat and water quality enhancement. Drainage contribution to the SID from OU2 is minimal.

A detailed floodplain analysis has delineated a narrow 100 year floodplain along the linear channel configuration of Woman Creek estimated to be 100-feet wide (DOE 1991a). Woman Creek is an intermittent stream flowing primarily in response to precipitation events and interaction between surface water and shallow ground water. Initial site characterization studies completed in 1986 record measurable flow occurrences only at 4 of the 11 gauging stations along the drainage. Flow data for each of the four gauging stations was less than 10 gallons per minute (DOE 1990a).

Each of the proposed actions for the Subsurface IM/IRA along with their anticipated impacts to floodplains and wetlands are described in Section 4. However, since the proposed actions are not located in the above described floodplains or wetlands, it should be noted that the provisions of 10 CFR 1022, DOE Compliance with Floodplain/Wetlands Environmental Review Requirements, do not apply.

2.2.8 Cultural Resources

NEPA (1969), the National Historic Preservation Act of 1966 (Public Law 89-665) and subsequent law amendments (Public Laws 91-243, 93-54, 94-422, 94-458) provide that all federal agencies implement programs for the protection of cultural resources.

A Cultural Resources Survey of the RFP was conducted between 31 May and 23 June 1991 that identified 45 cultural resources, none of which were recommended as eligible for listing on the

National Register of Historic Places (EG&G 1991a) In addition to the 45 sites located during the 1991 survey there are six previously identified historic sites that were previously determined not to be eligible for listing on the National Register for Historic Places However these sites were not re evaluated during this site wide archeological survey The State Office of Archeology and Historic Preservation has determined that any action in the vicinity of OU2 will not impact cultural resources (Burney 1989)

2.3 CONTAMINANTS — DESCRIPTION AND SOURCES

The following discussion of contaminant types and distribution are based on data and interpretations presented in the Phase II RI/FS Work Plan (EG&G 1990c) Draft Remedial Investigation Report (Rockwell 1987a) and Draft Remedial Investigation Plan (Rockwell 1988c) Soil ground water and surface water were sampled and analyzed for radionuclides and for the Hazardous Substance List (HSL) organics and inorganics In general soils in the vicinity of the IHSSs were found to contain low concentrations of VOCs and occasionally elevated concentrations of plutonium (Pu) and americium (Am) Most soil samples contained phthalates but this may be a result of field or laboratory contamination of the samples Carbon tetrachloride (CCl₄) tetrachloroethene (PCE) and trichloroethene (TCE) are the primary VOCs found in the upper hydrostratigraphic unit (this includes the alluvium and hydraulically interconnected bedrock sandstone [uppermost sandstone]) ground water flow system at OU2 Trace elements occurring above natural background levels in ground water include strontium barium copper and nickel and to a lesser extent chromium manganese selenium lead zinc and molybdenum Also major cations and anions and total dissolved solids are somewhat elevated above background throughout and downgradient of the 903 Pad Mound and East Trenches Areas Uranium 238 is the predominant radionuclide occurring above background in the upper hydrostratigraphic unit ground water flow system An evaporative concentration conceptual model has been advanced that may explain concentrations of high total dissolved solids metals and uranium in ground water at OU2

Organic contamination is observed in seeps downgradient of the 903 Pad and in the upper reaches of South Walnut Creek at the Mound Area Also there are somewhat elevated concentrations of total dissolved solids major ions strontium zinc and uranium at many of the

surface water stations Seeps downgradient of the 903 Pad have also been found to contain Pu and Am This is postulated to be due to the presence of contaminated suspended solids (i.e. soil) in the seep water and is based on the chemistry of Pu and Am in natural water systems and studies performed by EG&G The literature indicates that Pu is practically insoluble under oxidizing and near neutral conditions (Cleveland 1979) and Am strongly complexes with colloidal material and should exist in the particulate fraction (Orlandini et al 1990) That Pu and Am in surface seep water is particulate in nature is also supported by preliminary studies performed by EG&G (EG&G 1991) The studies involved successive filtration of OU2 seep water with filter media possessing various pore sizes (i.e. 0.45 micrometers (μm), 0.2 μm and 0.1 μm) The filtrates were then analyzed for Pu and Am The analyses indicate that Pu and Am in surface water at OU2 are associated with the particulate phase A more comprehensive successive filtration study to examine the distribution of Pu and Am (i.e. dissolved versus particulate) in OU2 surface water is being planned by EG&G at this time

Pu and Am occur above background in surface soils Other radionuclides and trace metals occur at low concentrations and are infrequently above background but may also be soil contaminants at the 903 Pad Mound and East Trenches Areas Data suggest Pu and Am were released to soils in the area via wind dispersion during initial remedial efforts at the 903 Drum Storage Site These radionuclides occur in surface soils throughout the 903 Pad Mound and East Trenches Areas and other downwind areas to the southeast

The following discussion provides additional details of contamination in OU2 ground water soils sediments and surface water Comprehensive ground water monitoring at the RFP has occurred since 1986 Wells have been installed throughout the property and are sampled quarterly Appendix B 1 presents a summary of VOCs radionuclides metals and inorganic contaminant concentrations above detection limits in the unconfined ground water system at OU2 The extent of soil contamination at the 903 Pad Mound and East Trenches Areas was determined from soil samples collected in 1987 during the Phase I RI (Appendix A) Samples were collected from boreholes drilled in and adjacent to known IHSS locations (Figure 2.9) Two foot intervals were composited for VOCs and 2 to 10 foot intervals were composited for all other analytes Boreholes were not drilled into sites still containing wastes (the Trenches and 903 Pad) due to potential health hazards to field workers and potential for release of waste

constituents to the environment. Data for surface water and sediments has not been tabulated in this IM/IRAP because these media are not directly relevant to the IM/IRA. Nevertheless a discussion of existing contamination in these media is provided in order to present a comprehensive description of the nature and extent of contamination at OU2.

2.3.1 Background Characterization

In order to facilitate the interpretation of chemical results in non background areas a background characterization program has been implemented to define the spatial and temporal variability of naturally occurring constituents. Field work was conducted in 1989 and a draft Background Geochemical Characterization Report was prepared and submitted to the regulatory agencies on 15 December 1989 (Rockwell International 1989a). The draft report was updated in December 1990 to include additional rounds of ground water and surface water samples. The document summarizes the background data for ground water, surface water, sediments, and geologic materials and identifies preliminary statistical boundaries (tolerance intervals) of background variability. Spatial variations in the chemistry of geologic materials and water were addressed by placing sample locations throughout background areas at the Plant. Evaluation of temporal variations in water chemistry is ongoing.

2.3.2 Soil Contamination

The following discussions include a summary of VOCs, radionuclides, and metals concentrations that are above detection limits in soils at OU2. This discussion is considered preliminary because soil samples have not been collected in the actual waste burial areas (IHSS). This type of sampling will be conducted during the Phase II RI.

2.3.2.1 Volatile Organic Contamination

VOCs (including PCE, TCE, toluene, 2-butanone, CCl_4 , acetone, and methylene chloride) were reported in samples from the 903 Pad and East Trenches Areas. Occurrences of total xylenes, ethylbenzene, and toluene were also reported for the 903 Pad Area, whereas 1,2-dichloroethane (1,2-DCA), 1,1,1-TCA, and 1,1,2-Trichloroethane (1,1,2-TCA) were reported

in an East Trenches borehole. The Mound Area soils like other portions of OU2 contained acetone (hundreds of micrograms per kilogram) and methylene chloride (typically tens of micrograms per kilogram) at concentrations too low to unambiguously demonstrate contamination with these compounds. Other organic constituents in the Mound Area (PCE, CHCl₃, 1,2-DCA) were less numerous and at lower levels than at other areas within OU2.

2.3.2.2 Inorganic Contamination

Radionuclide Contamination

Based on the Phase I RI borehole data, Pu and Am are the principal radionuclide contaminants exhibiting elevated concentrations in soils. High concentrations occurred in samples that included the surface soils in the area and were typically on the order of 100 pCi/g. Because many of the surface soil samples were mixed into large composites, the Phase I RI data do not eliminate the presence of radionuclides other than Pu and Am. Cesium-137, tritium, and uranium were detected, albeit at near background concentrations and in fewer than 10 samples. Surface contamination of soils with Pu and Am was further demonstrated by recent aerial and *in situ* radiological surveys (EG&G 1990a, EG&G 1991b) (Figures 2.10 and 2.11). The radioactivity detected in that survey was associated with known radioactive material storage and handling areas (i.e., the 903 Pad) and was attributed to Pu, Am, and a uranium decay product. Soil sampling indicated elevated concentrations of americium in soils east of the 903 Pad Lip Site as high as 97 pCi/g, and by inference from their expected activity ratio, plutonium as high as 500 pCi/g. Subsequent analysis of samples from the area with high americium concentrations indicated plutonium concentrations as high as 457 pCi/g. The cesium-137 activity at RFP is at a level consistent with global fallout.

Metals Contamination

Several metals occurred above background in soil samples (aluminum, arsenic, barium, cadmium, calcium, iron, mercury, manganese, lead, antimony, vanadium, and zinc), although most exceeded background by less than a factor of two and/or in only one or two samples. Appendix A presents maximum metal concentrations in soils.

2 3 3 Ground Water Contamination

2 3 3 1 Volatile Organic Contamination

The primary VOCs in ground water (CCl_4 , PCE and TCE) are portrayed by isopleths for alluvial ground water in Figures 2 12 through 2 14 and bedrock ground water in Figures 2 15 through 2 17 This data provides a representative snapshot of ground water contamination at OU2 i e previous and subsequent water quality data show similar patterns of ground water VOC contamination The ground water data in Appendix B 2 confirm the relative dominance of CCl_4 , PCE and TCE in alluvial and shallow bedrock ground water at OU2 compared to other VOCs and documents occurrences of 1 1 dichloroethane (1 1 DCA) 1 1 dichloroethene (1 1 DCE) 1 2 dichloroethene (1 2 DCE) and vinyl chloride (all are possible degradation products of the principal contaminants) and 1 1 1 trichloroethane (1 1 1 TCA) total 1 2 DCE 2 hexanone chloroform (CHCl_3) methylene chloride acetone and carbon disulfide The latter four analytes were reported at levels below detection limit and therefore represent only estimated values

A review of Figures 2 12 through 2 17 suggest that the 903 Pad is the main source of CCl_4 with possible contributions from the northern East Trenches Also the Mound Area appears to be the main source of PCE and TCE occurs throughout OU2 implying multiple sources

2 3 3 2 Inorganic Contamination

Radionuclides

Appendix B 2 shows that dissolved concentrations of the uranium isotopes (U 234 U 235 and U 238) have been above background at OU2 The maximum concentration for uranium 238 was 28 ± 2 picoCuries per liter (pCi/ℓ) in well 12 87 in the 903 Pad Area Numerous occurrences of uranium at lower concentrations and in wells completed in diverse lithologies demonstrate that the distribution of uranium is not thoroughly delineated at OU2 Review of unvalidated Pu data (total and dissolved) for ground water wells east-southeast of the 903 Pad indicates Pu in ground water is generally at non detectable levels (error term is greater than the reported value) The

highest concentrations of Pu reported were in well 2 71 (total plutonium = 1.9 ± 1 pCi/l on 3/11/87 and 32 ± 3 pCi/l in 1988) However there are three other sampling events showing total Pu was non detectable and the reported value for 1988 is suspect because an exact date for the sample cannot be determined from the documentation Furthermore there are seven other analyses for dissolved plutonium for this well where the radionuclide was non detectable Because Pu and Am are infrequently detected in ground water at this well and elsewhere it is uncertain whether these radionuclides are actual ground water contaminants

Metals

Metals that exceeded background in one or more wells in the second quarter of 1989 include aluminum antimony arsenic barium cadmium chromium copper iron lead lithium manganese mercury molybdenum nickel potassium selenium silver strontium vanadium and zinc A summary of multiple sampling events (Appendix B 1) shows that only a subset of these analytes repeatedly exceed background and/or exceed background by a wide margin The sporadic exceedances of background and the absence of apparent gradients in metal concentrations with respect to IHSSs hinders drawing definite conclusions as to whether these constituents are derived from IHSSs

Major Ions

Major ions and total dissolved solids (TDS) are somewhat elevated above background throughout and downgradient of the 903 Pad Mound and East Trenches Areas (Appendix B 2) Total dissolved solids typically ranged between 400 and 1 000 milligrams per liter (mg/l) chloride was generally 30 to 100 mg/l nitrate was 2 to 10 mg/l and most sulfate concentrations were between 10 and 100 mg/l in the second quarter of 1989 In general major cations were accordingly elevated The highest concentrations of major ions are in well 29 87 southeast of the 903 Pad although TDS in ground water at the northernmost wells (34 87 and 35 87) was also quite high in ($\sim 1\ 000$ mg/l)

2 3 4 Surface Water Contamination

Surface water and surface seep stations in the vicinity of the 903 Pad Mound and East Trenches Areas were sampled during field activities from 1986 through 1991. The following discussion is based on all available data because many seeps or stream stations were dry during some samplings. Surface water monitoring locations are shown in Figure 2.18. The surface water seeps are immediately downslope and southeast of the 903 Pad Area and downslope and north of the Mound Area and East Trenches Areas.

Because surface water at seeps and in streams represents ground water discharge (intermittent discharge with respect to streams) the surface water compositions are similar to those of local ground water. The data for both media show that PCE, TCE, CCl_4 , and their degradation products are the principal VOCs and show very similar major ion contents as well. However, there is enough variability within stations so that it is not possible to demonstrate surface/ground water connections on a well by well seep by seep basis.

Seeps in the vicinity of the 903 Pad Lip Site have had significant concentrations of Pu and/or Am. However, the samples contained suspended solids and surface soils in the vicinity of the seeps are contaminated with radionuclides. Furthermore, total radiochemistry data do indicate notably higher Pu and Am concentrations than in filtered samples (0.45 μm nominal pore size) demonstrating that most of the radionuclides are in a particulate form. Therefore, the local soils represent the most direct potential source for seep contamination. There is no immediate threat to public health and the environment posed by surface water contamination because the affected surface water is contained within the Plant boundary by existing detection ponds and is treated and monitored prior to discharge for removal of volatile organic contaminants and suspended particulates to which radionuclides, if present, are likely to adsorb.

2 3 5 Air Contamination

The 903 Pad Area is recognized as the principal source of airborne Pu contamination at the RFP. An extensive air monitoring network known as the Radioactive Ambient Air Monitoring Program (RAAMP) is maintained at the Plant in order to monitor particulate emissions from the 903 Pad.

Area and other Plant facilities Historically the particulate samplers located immediately east southeast and northeast of the 903 Pad Mound and East Trenches Areas have shown the highest Pu concentrations This finding is corroborated by the results of soil surveys that indicate elevated Pu concentrations to the east particularly southeast of the area However RAAMP has found ambient air samples for Pu to be well within the DOE guidelines of 20.0×10^{-6} pCi/l established for the protection of human health (Rockwell International 1987b)

2.3.6 Summary of Contamination

The Phase I RI investigations of environmental media lead to the general conclusions that volatile organic and inorganic contamination in soils ground water and surface water and radionuclide contamination in soils exist around several OU2 IHSS The RI also determined that the distribution and magnitude of the contamination can be better delineated via sampling and analysis planned for the Phase II investigation

TCE PCE and CCl_4 are the principal organic contaminants in soils surface and ground waters with lesser amounts of their degradation products and other compounds at numerous sampling sites throughout OU2 Apparent Pu and Am in surface water samples are other apparent indicators of RFP derived contamination

Several metals and other inorganic constituents (including uranium) are also above background in the environmental media but the data do not permit unambiguous conclusions with regard to contamination The uncertainty results in part from the absence of clear concentration gradients and from the limited knowledge of the inorganic composition of waste sources in OU2 Natural processes (e.g. evaporative concentration) may govern the source and distribution of such inorganic constituents This will be further investigated in the context of long term remediation at OU2

2.4 ANALYTICAL DATA

Appendix A of Volume II presents a compilation of volatile organic inorganic and radiochemistry data for all ground water monitoring stations at OU2 that are available at this

time Some of the data have been validated they are identified in the appendices by a qualifier adjacent to each datum The qualifiers V (valid) A (acceptable with qualifications) and R (rejected) are assigned in accordance with the ER Program Quality Assurance/Quality Control (QA/QC) Plan (Rockwell International 1989c) Rejected data either did not conform to the QA/QC procedures or insufficient documentation exists to demonstrate conformance with these procedures These data at best can only be considered qualitative measures of the analyte concentrations The schedule for the IM/IRA does not permit waiting for all data to be validated However the validated data and their similarity to invalidated data are considered sufficient for this IM/IRAP/EA

2.5 SITE CONDITIONS THAT JUSTIFY AN IM/IRA

The IM/IRA will provide information for selection design and implementation of the final remedial action that addresses subsurface VOC contamination

As discussed in Section 1 there is no immediate threat to public health and the environment posed by subsurface VOC contamination at OU2 Cleanup of subsurface VOC contamination at OU2 will therefore be addressed in designing and implementing final remedial actions However uncertainties with respect to the OU2 subsurface geology and its effect on site specific remedial technology performance presents many challenges for selection and design of final actions Thus the IM/IRA is an investigative tool to resolve such uncertainties and streamline the RI/FS/remedial action (RA) process which is the primary justification for the proposed Subsurface IM/IRA at OU2

SECTION 3
IDENTIFICATION OF SUBSURFACE IM/IRA OBJECTIVES

3.1 OBJECTIVES OF INTERIM MEASURES/INTERIM REMEDIAL ACTION

The primary objective of the Subsurface IM/IRA is to provide information that will aid in the selection and design of final remedial actions at OU2 that will address removal of suspected residual free phase VOC contamination. In general, the information to be collected includes subsurface characterization and site specific technology performance data, which can be used in the FS remedial alternatives evaluation and final remedial system design. The IM/IRA will be comprehensive in that subsurface geological data will be collected for a minimum of three different OU2 locations. Based on the meetings between DOE, EPA, and CDH during the Fall of 1991 (Section 1), DOE is proposing this Subsurface IM/IRAP/EA that specifies treatability testing at the 903 Pad Mound, and East Trenches Areas for the implementation and evaluation of VOC source removal technologies.

3.2 COMPLIANCE WITH ARARS AND PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The NCP [40 CFR 300.430 (e)] requires that in development of remediation goals the following be considered:

- ARARs
- For systemic contaminants, concentration levels that will not cause adverse effects to the human population and sensitive subgroups over a lifetime of exposure.
- For carcinogens, exposure levels represent an upper bound lifetime cancer risk between 10^{-4} and 10^{-6} . The 10^{-6} risk level is to be used as a point of departure when ARARs are not available or are not sufficiently protective because of multiple contaminants or multiple exposure pathways.
- Factors related to detection limits.
- For current or potential sources of drinking water, attainment of Maximum Contaminant Level Goals (MCLGs) or Maximum Contaminant Levels (MCLs) if MCLGs are zero.

- Attainment of CWA ambient water quality criteria (AWQC) where relevant and appropriate

The IAG in paragraph 150 states Interim Remedial Actions/Interim Measures shall to the greatest extent practicable attain ARARs Also for interim actions the NCP [40 CFR 300.430(f)] specifically notes that an ARAR can be waived if the action is to become part of the final remedy that will attain ARARs

This section identifies and analyzes ARARs relevant to the proposed Operable Unit No 2 Subsurface IM/IRA. Because a remedial action would be considered an on site IM/IRA to be administered under CERCLA, only substantive and not administrative requirements of regulations (such as RCRA) apply Permits for example are not required (per paragraph 121 of the IAG)

3.2.1 Applicable or Relevant and Appropriate Requirements

Applicable requirements as defined in 40 CFR 300.5 mean 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 specifically address a hazardous substance pollutant contaminant, remedial action, location, or other circumstance 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 mean 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 According to CERCLA §121(d)(2) in order to be considered an ARAR, a state requirement must have

been promulgated As defined in 40 CFR 300.400(g)(4) of the NCP the term promulgated means that the requirement is of general applicability and is legally enforceable

3.2.2 Items to be Considered

In addition to ARARs advisories criteria, or guidance may be identified as to be considered (TBC) 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 Unlike ARARs use of TBCs is discretionary

3.2.3 ARAR Categories

In general there are three categories of ARARs These categories are

- Ambient or chemical specific requirements
- Location specific requirements
- Performance design, or other action specific requirements

Each category is discussed in more detail below

3.3 AMBIENT OR CHEMICAL-SPECIFIC REQUIREMENTS

Ambient or chemical specific requirements set health or risk based concentration limits in various environmental media for specific hazardous substances or pollutants These requirements set protective clean up levels for the chemicals of concern in the designated media or may act as action related requirements in indicating a safe level of air emission or wastewater discharge The chemical specific ARARs identified herein are used in defining the remediation goals for discharge of treated ground water to surface water

ARARs are derived primarily from federal and state health and environmental statutes and regulations Where background concentrations for constituents are above the ARAR for that constituent a waiver from the ARAR may be appropriate (e.g. technical impracticability)

A summary of ARARs for the contaminants found to exceed background in OU2 ground water are presented in Appendix C Table C 1 and includes ARARs for volatile organics metals conventional pollutants and radionuclides TBCs are also identified in Table C 1 where ARARs do not exist, and are used as goals for ground water treatment, where necessary to be protective

The two sets of ARARs identified in Table C 1 are those previously established for the OU1 ground water treatment facility and for the OU2 South Walnut Creek surface water treatment facility These ARARs were established by the regulatory approval of the respective IRAPs that define the IM/IRAs for OU1 and OU2 Both of these treatment facilities are candidates for the treatment of ground water extracted during the Subsurface IM/IRA. A third candidate facility is the Building 231/374 treatment systems The Building 231/374 facility is a zero discharge treatment system, therefore water quality chemical specific ARARs are not applicable

There are a number of potential OU2 ground water contaminants for which ARARs were not identified in the respective OU1 and OU2 IRAPs i.e. these contaminants were not expected to be present in the influent based on the quality of the water the systems were designed to treat These contaminants are identified in Table C 1 For this IM/IRA, ARARs or TBCs (in the absence of an ARAR) have been identified for these contaminants by applying the ARAR rationale in the respective IRAPs and selecting the rationale (and ARAR) that was most stringent This technique is used for the Subsurface IM/IRA to provide conservative effluent standards for all potential OU2 ground water contaminants It is not, however considered a basis for establishing ARARs for future remedial efforts at the RFP DOE is preparing a consolidated approach to establishing ARARs for future remedial activities that it plans to offer to EPA and CDH in the near future This consolidated approach will provide the premise for discussions with EPA and CDH on the ARAR selection methodology to be used for remediation at all operable units at the RFP

Of the elements/compounds detected in ground water at OU2 ARARs or TBCs cannot be identified from environmental regulations and guidance for 4 methyl 2 pentanone 2 hexanone calcium, magnesium, potassium, sodium, strontium, bicarbonate and cesium¹³⁷

(Note As discussed in Section 2.3.3 cesium¹³⁷ is not an RFP contaminant) For these constituents background concentrations (EG&G 1990b) are used as goals for the IM/IRA. For organic contaminants background is considered the Contract Laboratory Program (CLP) Contract Required Quantitation Limits (CRQL)

Regardless of ARARs the system ultimately used for treatment of ground water in this IM/IRA will be selected based on the ability of the treatment system to remove the contaminants actually measured in the extracted water e.g. the OU1 facility will not be used if the ground water contains above background plutonium or americium concentrations because this facility was not designed for their removal (Note The unit processes in the OU1 facility potentially can remove plutonium/americium, but treatment performance for removal of these radionuclides would have to be demonstrated before OU2 ground water is transferred there for treatment) Likewise the Building 231 facility utilizes activated carbon for organic contaminant removal and the presence of methylene chloride vinyl chloride chloroform or ketones in extracted ground water would render this facility inappropriate for use The South Walnut Creek Basin Treatment System has been designed to treat water containing all of the potential OU2 contaminants Based on current data, this treatment system is the preferred system for the Subsurface IM/IRA. Treatment performance considerations for selection of the Subsurface IM/IRA ground water treatment system is discussed further in Section 4

3.4 LOCATION SPECIFIC REQUIREMENTS

Location specific ARARs are limits placed on the concentration of hazardous substances or the conduct of activities solely because they occur in certain locations These may restrict or preclude certain remedial actions or may apply only to certain portions of a site Examples of location specific ARARs that pertain to the IM/IRA are federal and state siting laws for hazardous waste facilities (40 CFR 264.18 fault zone and floodplain restrictions) and federal regulations requiring that actions minimize or avoid adverse effects to wetlands (40 CFR Part 6 Appendix A and 40 CFR Parts 230-231)

More specifically in addition to the requirements described above pertinent location specific ARARs include Colorado requirements for siting of hazardous waste facilities and wastewater treatment facilities (Colorado Revised Statute 25 15 101 203 208 302 and 25 8 292 702 respectively) National Historic Preservation Act requirements for preservation of significant articles and historic properties (36 CFR Parts 65 and 800 respectively) federal critical habitat protection requirements (50 CFR Parts 200 402 and 33 CFR Parts 320 330) and federal requirements for the protection of fish and wildlife resources (40 CFR 6 302)

A summary of location specific ARARs which this IM/IRA will attain to the greatest extent practicable is presented in Table C-4

3 5 PERFORMANCE, DESIGN, OR OTHER ACTION SPECIFIC REQUIREMENTS

Performance design, or other action specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants These requirements are not triggered by the specific chemicals present at a site but rather by the particular IM/IRA actions that are part of this plan Action specific ARARs are technology based performance standards such as the Best Available Technology (BAT) standard of the Federal Water Pollution Control Act Other examples include RCRA treatment storage and disposal standards and CWA pretreatment standards for discharges to publicly owned treatment works (POTW)

RCRA land disposal restrictions (LDR) for certain contaminants (40 CFR Part 268 40) are also action specific ARARs for the disposal of secondary wastes generated during water treatment Any wastes hazardous or not are subject to CERCLA section 121(d)(3) also known as the off site policy The off site policy requires that CERCLA wastes be shipped off site only to facilities in compliance with applicable federal and state laws Action specific ARARs that will be attained by the IM/IRA to the greatest extent practicable are included in Table C 3 Table C 2 presents RCRA LDRs that are potentially ARAR for placement or land disposal involving non effluent wastes (e g treatment sludges excavated soils used treatment materials) if they may be determined to contain hazardous wastes LDR requirements may be relevant and appropriate for wastes that are not hazardous wastes as

defined in 40 CFR Part 261 but do contain hazardous substances. Any wastes generated by the IM/IRA will be evaluated to determine if they are identifiable as hazardous wastes. At present, no determination has been made whether the anticipated contaminants of wastes from the IM/IRA are listed hazardous wastes. However, IM/IRA wastes such as spent carbon may be found to be characteristically hazardous (40 CFR part 261 Subpart C).

Action specific ARARs also exist for air emissions from this IM/IRA. The Colorado Air Quality Control Commission (AQCC) has established emission control regulations for the protection of state air quality. Relative to this IM/IRA, AQCC regulations provide pertinent requirements that must be considered. Action specific ARARs which the IM/IRA will attain to the greatest extent practicable are included in Table C 3.

AQCC Regulation 7 (5 CCR 1001 7) provides requirements for sources of VOCs that are associated with the formation of ozone. Regulated sources of VOCs must implement Reasonably Achievable Control Technology (RACT) and describe any control measures in an emission permit application to the Air Quality Control Division (AQCD). According to AQCC Regulation 3 Section III D, the threshold for the permit requirement is emission of 1 ton or more of VOCs per year. As defined in Section G of the AQCC Common Provisions Regulations, RACT means a technology that will achieve the maximum degree of emission control that a particular source is capable of meeting and which is reasonably available considering technological and economic feasibility. The IM/IRA will not emit VOCs in excess of 1 ton/year because a vapor treatment system will be used to remove in excess of 99 percent of the VOCs. However, the treatment system would constitute a RACT.

AQCC Regulation 8 (5 CCR 1001 8) includes requirements for the control of hazardous air pollutants. Of the potential contaminants in this IM/IRA, beryllium, benzene, mercury, lead, and vinyl chloride are considered hazardous air pollutants according to this regulation. With the exception of lead, the requirements of Regulation 8 are neither applicable nor relevant and appropriate to this IM/IRA. In general, the controls of Regulation 8 apply to emission sources that use or manufacture material containing the hazardous air pollutant. Since this IM/IRA will neither use nor manufacture any of the hazardous air pollutants, the emission limit provisions of Regulation 8 are not ARAR, however, they do provide useful guidance to

be considered With respect to lead the emission limit of 1.5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) applies to any stationary source Therefore the standard may be applicable to the IM/IRA, and accordingly has been applied as ARAR

Under EPA regulations at 40 CFR Part 61 Subpart H, hazardous air pollutant restrictions also exist for radionuclide emissions at DOE facilities These regulations require monitoring to ensure that any radionuclides emitted do not result in any member of the public receiving an effective dose equivalent or more than 10 milliradiation equivalent man per year (mrem/yr) Because this standard applies to RFP as a whole plant emissions are regularly assessed The plant emissions have been found to fall orders of magnitude below the standard Emissions from the IM/IRA will be monitored and the results incorporated with the plant data

A table summarizing restrictions on IM/IRA air emissions is presented in Table C 5

DOE requirements for worker protection in hazardous waste operations and emergency response (DOE Order 5480) are applicable to workers involved in hazardous substance related activities Even though these requirements are not environmental in nature and therefore are not considered ARARs they must be satisfied

SECTION 4 PROPOSED ACTIONS

This IM/IRA involves application of *in situ* vacuum-enhanced vapor extraction at three different subsurface environments at OU2 for removal of suspected residual free phase VOCs from the vadose and saturated zones. The three subsurface sites selected for implementation of the IM/IRA differ in their expected geology and nature of contamination. Each of the three selected sites are located within one of the three primary OU2 areas: 903 Pad, Mound, and East Trenches. As discussed in this section, each of the sites offer unique challenges for *in situ* remediation of the subsurface.

Implementation of the proposed *in situ* vacuum enhanced vapor extraction actions may be complicated by uncertainties resulting from incomplete site characterization of OU2. A phased implementation of the proposed actions is therefore proposed to ensure project success. The planned phases of implementation include:

- Location of test sites
- Pilot testing
- Post pilot operation (if deemed beneficial)

The first phase is the location of suitable test sites at the 903 Pad, Mound, and East Trenches Areas. Data from the Phase II RI will be used to pinpoint locations for the vapor extraction and injection wells. In the event that these data do not provide enough information to select well locations, a soil vapor survey will be conducted.

The second phase involves *in situ* pilot testing of the proposed vapor extraction systems at each of the test sites. Information collected during the pilot studies will aid in the selection, design, and implementation of final subsurface VOC removal actions at OU2. Information from the pilot study phase will also be used to assess the benefit of pursuing the final phase of the IM/IRA: post pilot study operation of the systems with system modifications as appropriate.

The final phase of IM/IRA implementation is post pilot operation (if deemed beneficial) of the vapor extraction systems at the three OU2 test sites. EPA OSWER Observational/Streamlined Approach methodology has been used to formulate the proposed actions to minimize difficulties in the execution of this IM/IRA. The Observation/Streamlined Approach involves development of a remedial action based on probable site conditions that are identified using existing information and that are modified as necessary as additional information is gained during implementation.

Prior to presentation of the proposed actions, it is useful to consider the rationale behind selection of *in situ* vacuum-enhanced vapor extraction for this IM/IRA. This background information is presented in Section 4.1. Section 4.2 describes the process that is used to critically evaluate the effectiveness, implementability, and environmental impact of the proposed actions. Sections 4.3 through 4.5 present and evaluate each of the proposed actions at the 903 Pad Mound and East Trenches Areas, respectively. Section 4.6 presents a detailed description of existing or planned RFP water treatment facilities that could potentially be used to treat contaminated ground water generated during Subsurface IM/IRA dewatering operations. Section 4.7 presents an environmental assessment of the No Action Alternative with respect to OU2 subsurface VOC contamination, and Section 4.8 provides a summary comparison of environmental impacts from the proposed remedial actions and the No Action Alternative.

4.1 RATIONALE FOR IM/IRA TECHNOLOGY SELECTION

NCP guidance states that few alternatives, and in some cases perhaps only one, should be developed for interim actions. Based on a review of technologies available for *in situ* removal/destruction of VOCs, only one remedial alternative, *in situ* vacuum-enhanced vapor extraction, was selected for immediate implementation in the Subsurface IM/IRA. A second technology, *in situ* steam stripping, is also being considered for investigation as part of this IM/IRA because it has the potential to recover both VOCs and radionuclides, and the technology is currently being tested by DOE.

The technology review process involved identification of potentially feasible VOC removal/destruction technologies followed by evaluation with respect to the following criteria:

- Achieve IM/IRA objective
- Address the source of the dissolved phase ground water plume
- Minimize the risk of spreading contamination

As discussed in Section 3 the primary objective of the IM/IRA is to collect information that will aid in selection and design of final OU2 remedial actions that address subsurface residual free phase VOC contamination

Source removal played an important role in the technology review process. The organic contaminants at OU2 are primarily chlorinated solvents (PCE, TCE, and carbon tetrachloride). All of the chlorinated solvent contaminants at OU2 have specific gravities greater than 1.0 (i.e., heavier than water). Liquids with this property are referred to as Dense Non Aqueous Phase Liquids or DNAPLs. These substances have very low solubilities in water, on the order of 100 to 1,100 mg/l (parts per million). For this reason, classical remedial actions like ground water extraction and aboveground treatment will not remediate the site in a timely manner. Pump and treat technologies require that the source material first dissolve into the ground water. For example, removal of a 55 gallon solvent spill in this manner would require pumping approximately 45,000,000 gallons of ground water with an average concentration of 2 mg/l. Furthermore, the water bearing formations at OU2 are not expected to yield large volumes of water due to their low permeabilities. Therefore, technologies that have the potential to directly remove the source material were considered desirable.

Finally, the review process involved examining technologies with respect to their risk of spreading VOC and radionuclide contamination. This is particularly important at OU2 due to the potential mobilization of radionuclides that may be present at the test sites, specifically uranium, plutonium, and americium. Radionuclide mobility in the aquifer is sensitive to fluctuations in temperature and pH. Candidate remedial technologies were eliminated from further consideration if they posed any unknown risk of uncontrolled mobilization of radionuclides or VOCs.

Candidate *in situ* remedial technologies considered for the Subsurface IM/IRA included

- Dehalogenation
- Chemical oxidation
- Steam stripping
- Bioremediation
- Vacuum enhanced vapor extraction

In situ dehalogenation involves introducing an aqueous dehalogenating solution such as sodium borohydrite solution or zinc and acetic acid into the affected portion of the aquifer. Dehalogenating solutions are reductants that liberate nascent (atomic) hydrogen which replaces chlorine atoms on the solvent molecules significantly reducing their toxicity. However there are process uncertainties with respect to uncontrolled mobilization of radionuclides that may be present in the subsurface. The dehalogenation solutions may for example lower the pH of the ground water or degrade subsurface humic materials potentially increasing radionuclide mobility. Bench scale treatability studies will be performed to resolve this uncertainty prior to consideration of the technology for field implementation.

In situ chemical oxidation involves introducing an aqueous oxidizing solution such as a combination of metallic iron and hydrogen peroxide (i.e. Fenton's reagent) into the affected portion of the aquifer. The oxidizing agent (hydroxyl radical in the case of Fenton's reagent) reacts with the VOCs to mineralize them to carbon dioxide and water. Preliminary results of bench scale testing of chemical oxidation for the 881 Hillside ultra violet (UV) peroxide/oxidation treatment system have indicated successful destruction of VOCs containing carbon carbon double bonds (i.e. TCE, PCE, etc.) The results have suggested poor destruction efficiencies for VOCs not containing the reactive carbon carbon double bonds (i.e. carbon tetrachloride, 1,1,1-TCA, etc.) Also as discussed above for *in situ* dehalogenation there are uncertainties associated with chemical oxidation with respect to uncontrolled mobilization of radionuclides. Therefore treatability studies examining chemical oxidation will be conducted in the laboratory prior to consideration of the technology for field implementation.

In situ bioremediation utilizes naturally occurring or cultured microorganisms to degrade VOCs. Nutrients and co-metabolites are injected into the subsurface to augment and sustain the microbe populations. Bioremediation has successfully treated many non halogenated hydrocarbons but has been less successful with halogenated compounds. Nonetheless, recent progress in bioremediation research indicates that this technology holds promise for the degradation of halogenated organic compounds. At this time, however, inclusion of bioremediation investigations in the Subsurface IM/IRA at OU2 is premature. If future research progress indicates that bioremediation is a practical alternative for degradation of free phase chlorinated solvents, this technology will be tested to examine its applicability for OU2.

In situ steam stripping includes injection of pressurized steam to displace ground water and vaporize free phase VOCs trapped in the aquifer and vadose zone soils. Subsurface temperature increases associated with the injected steam, along with a reduction in subsurface pH, may be effective in solubilizing radionuclides adsorbed to the subsurface matrix. Recovery wells are used to collect dissolved free phase and/or vapor phase VOCs and dissolved radionuclides. Condensation of steam and VOCs occurs at the steam front, which expands vertically and laterally over time. The orientation of the steam front is critical to prevent the downward migration of condensed free phase VOCs. However, uncertainties associated with maintaining the steam front at the proper angle and the effectiveness of radionuclide desorption and solubilization require that *in situ* steam stripping be first examined on a bench scale prior to field testing. Treatability studies examining this technology are currently being conducted by Lawrence Livermore National Laboratory (LLNL) in Livermore, California. Because *in situ* steam stripping has the potential to recover both VOCs and radionuclides, and this technology is currently being investigated by DOE, it is being considered for further investigation as part of this Subsurface IM/IRA. An additional project phase may therefore be added to the Subsurface IM/IRA to conduct an *in situ* steam stripping pilot test after the results of LLNL study are assessed.

In situ vacuum enhanced vapor extraction involves the installation of one or more vapor extraction wells within or adjacent to an area containing residual free phase hydrocarbons. The wells are manifolded into a vacuum pump and the vacuum induced in the subsurface creates a sweep of air through the formation. The induced air flow volatilizes and removes the residual

free phase solvents. Separate wells may also be used to inject ambient or heated air into the formation to increase airflow through the contaminated area. In order to address residual contamination held in the aquifer material, the water table must be lowered by pumping to expose the residual DNAPL to the air flow induced in the formation.

In situ vacuum-enhanced vapor extraction coupled with water table depression satisfies the three criteria listed above and has been selected for the Subsurface IM/IRA at OU2. It will provide data that will be useful in the selection and design of a final action as it is potentially applicable at all OU2 solvent spill or burial sites. It addresses the source of the dissolved phase ground water plume and reduces the likelihood of additional contaminants migrating from the vadose to the saturated zone. This technology does not involve subsurface injection of liquid reagents so there is little probability of spreading the VOC contamination. In addition, mobilization of radionuclides that may be present is not expected because no change in ground water pH is expected.

Actions involving *in situ* vacuum-enhanced vapor extraction are proposed at three locations within OU2: IHSS No. 112, a former drum storage site at the 903 Pad Area; IHSS No. 113, a former drum storage site at the Mound Area; and IHSS No. 111.1, a burial trench at the East Trenches Area. The locations of these IHSSs are shown on Figure 2.2. Vapor extraction technology can be universally applied at all proposed test locations given adequate formation permeability to air and a known residual DNAPL location. However, application of this technology will be customized to the site-specific hydrogeologic and contaminant distribution conditions. Water table depression efforts will be applied only at those sites where a significant saturated thickness exists (>3 feet). Additional differences in vapor extraction technology application at the three test sites will include site-specific extraction and air injection well placement and design. Site-specific considerations are discussed in Sections 4.3 through 4.5.

4.2 EVALUATION OF PROPOSED ACTIONS

This section discusses the elements of an integrated CERCLA/NEPA evaluation process that will be used to critically examine the proposed actions at the 903 Pad, Mound, and East Trenches Areas. This integrated process is based on both CERCLA and NEPA evaluation criteria as set

forth in the March 1990 NCP and the draft DOE NEPA Compliance Guidance Manual (DOE 1988a as revised) respectively

An integrated CERCLA/NEPA evaluation process is used in DOE remedial action planning to critically evaluate alternative remedies so that a preferred alternative may be selected. In this case however only one action alternative *in situ* vacuum-enhanced vapor extraction has been proposed for implementation at this time (see Section 4.1). Nonetheless analysis of the proposed *in situ* vapor extraction actions with respect to CERCLA and NEPA evaluation criteria provides a more thorough understanding of the actions. CERCLA evaluation criteria considered in the analysis include effectiveness and implementability. Analysis of relative cost is used in the CERCLA evaluation process to choose between one or more similarly effective and implementable remedial alternatives. Cost analysis therefore need not be included in the evaluation process for the Subsurface IM/IRA. NEPA evaluation criteria considered in the analysis include impacts of the proposed remedial actions to human health and the environment. In order to integrate the requirements of NEPA into the evaluation process two elements are included:

- CERCLA and NEPA criteria are given equal weighing in the evaluation process
- Assessment of the environmental impacts of the No Action Alternative is included in the evaluation process

4.2.1 Effectiveness

The criteria for effectiveness evaluation of the proposed subsurface IRAs include the use of alternatives to land disposal thus promoting treatment or recycling, risk of potential exposure to residuals remaining on site, continued reliability over the life of the IM/IRA, and compliance with ARARs criteria, advisories, and guidance. In addition the proposed actions will be evaluated with respect to reduction of toxicity, mobility, and volume of wastes per the March 1990 NCP.

Effectiveness evaluation of the proposed subsurface IRAs does not include several of the CERCLA effectiveness criteria due to the nature of the IM/IRA. These criteria include threat

reduction and length of time until protection is achieved. These criteria are not applicable to the Subsurface IM/IRA since subsurface VOC contamination at OU2 does not pose a threat to public health or the environment nor is the proposed action in its current form expected to substantially alter the existing dissolved phase ground water plume during the duration of the test. The Subsurface IM/IRA is designed to remove contaminants from small areas at three of the suspected source areas at OU2 and to evaluate a remedial technology that may ultimately be applied on a large scale as part of the final action. Therefore, statements regarding mitigation of identified threats or length of time until protection is achieved are not applicable.

CERCLA effectiveness and NEPA environmental impact criteria both address worker and community protection. In order to avoid repetition in this document, worker and community protection issues associated with the proposed actions will be presented only once in the environmental impact analysis sections.

4.2.2 Implementability

The criteria for implementability evaluation of proposed actions include technical feasibility, availability, and administrative feasibility. Technical feasibility includes the ability to construct the technology, maintain its operation, meet process efficiencies or performance goals, demonstrate performance, and comply with the Superfund Amendments and Reauthorization Act (SARA) requirement that IM/IRAs should contribute to the efficient performance of a long-term remedial action to the extent practicable. Availability includes the availability of necessary equipment, materials, and personnel; availability of adequate off-site treatment, storage, and disposal capacity, if appropriate; and description of post-remedial site controls that will be required at the completion of the action. Administrative feasibility includes the likelihood of public acceptance of the proposed action, including site and local concern, coordination of activities with other agencies, and ability to obtain any necessary approvals or permits.

4.2.3 Environmental Impacts

The criteria for environmental evaluation of the IM/IRA actions include DOE NEPA compliance guidelines for terrestrial and aquatic impacts, threatened and endangered species, historical and

archeological sites wetlands and floodplains and cumulative impacts and air quality water quality short and long term land productivity personnel exposures commitment of resources and transportation impacts

The procedural guidance for compliance with NEPA and various related environmental statutes for the proposed action in this Subsurface IM/IRAP/EA is found in the Draft DOE NEPA Compliance Guide (DOE 1988a as revised) Coordination of NEPA compliance procedures with review requirements of other environmental statutes that bear on the NEPA process enhances the probability of complete compliance and achievement of timely implementation of programs and projects

The Compliance Guide is intended to assist DOE and contractors by providing the following information on the NEPA process the processes of related environmental statutes that bear on the NEPA process the timing relationships between EPA review and review requirements of other environmental statutes and the NEPA process compliance and development for programs and projects Regulatory guidance procedures for environmental restoration projects as they relate to air quality water quality terrestrial and aquatic impacts threatened and endangered species and historic and archaeological sites are discussed in Sections 4 2 3 1 through 4 2 3 5 Short and long term land productivity personnel exposures commitment of resources transportation impacts wetland and floodplain impact assessment and cumulative impacts are discussed in Sections 4 2 3 6 through 4 2 3 11

4 2 3 1 Air Quality

Air quality impacts are addressed by estimating changes in ambient air quality due to the No Action Alternative and the Subsurface IM/IRAs Changes in air quality could result from possible emissions of VOCs (Subsurface IM/IRAs) and generation of fugitive dust (Subsurface IM/IRAs) VOC air emissions from the No Action Alternative are not expected to be significant relative to other VOC air emissions from the RFP that are regulated by CDH since under the No Action Alternative VOCs will primarily remain in the subsurface and continue to leach into ground water

Air quality impacts from VOCs released during vapor extraction system installation activities (e.g. drilling well installation and vapor extraction system component setup) would be minimal when compared to the normal operational activity at the RFP even though VOC concentrations in soils in the vicinity of 903 Pad Mound and East Trenches are significant. This is because the limited amount of drilling planned for each of the three IM/IRA sites is expected to minimize the generation of VOC-containing drill cuttings. Thus, there will be an insignificant release of VOCs to the air from drill cuttings that amount to less than 2 cubic yards per site. However, in the event that releases are greater than expected, they will be controlled by adherence to the procedures set forth in the Project Specific Health and Safety Plan (PSHSP) and the Plan for Prevention of Contaminant Dispersion. (See Personal Exposures section below.)

The PSHSP will require employees to wear personal protection equipment (PPE) including respirators, gloves, and protective clothing during work tasks where contaminant releases are likely. This will prevent employee exposure in the event of an unplanned release. Employees who are unprotected at the time of an unexpected release will be alerted to take immediate evasive/protective action by warning alarms on direct reading analytical equipment.

If routine air monitoring of dust emissions from planned activities reveals higher than expected dust concentrations, the implementation of dust control techniques described in the PPCD will be initiated. These techniques may include such measures as soil wetting with water or a water surfactant mixture, windscreen deployment, a change in drilling techniques, application of surfactants to unpaved roads, restrictions on vehicular traffic, temporary stoppage of project operations due to high winds, etc. The PPCD describes a staged approach to preventive measures assessment.

The vapor extraction system includes an offgas treatment unit for removal of contaminants from the vapor stream prior to discharge to the atmosphere. The system includes GAC adsorption units to remove VOCs and in-line high efficiency air particulate (HEPA) filters to capture any radionuclides that may be released from the subsurface. HEPA filters will be followed by a radiation sensor that will shut the system down before the release of major amounts of radionuclides to the GAC units can occur. Although vapor phase GAC adsorption is not intended for removal of particulates, filtration of 20 to 50 microns and larger in size is provided.

by the granular packed bed Thus in the unlikely event that the upstream HEPA filters are not properly functioning the GAC units would provide some filtration capacity

Dermal exposure inhalation and inadvertent ingestion of airborne radioactivity and VOCs on fugitive dusts are analyzed in later sections of this report entitled Personnel Exposure Routine Operation Pollution from engine emissions fugitive dust generation by vehicles and particulates from tire wear will be analyzed separately in Transportation Impacts

With respect to dewatering activities any subsurface water collected would be processed through existing RFP treatment systems If free phase VOCs are recovered during dewatering a closed phase separator system (described in Section 4 3 2) will be added to the vapor extraction system Therefore no change in the levels of VOCs in the ambient air off site is expected The mixing of chemicals for water treatment and use of strong acids or bases in cleaning operations may contribute to odors within the confines of existing water treatment facilities and will be controlled by adequate ventilation These odors would not be noticeable from outside the treatment facilities nor would they be a hazard to workers in the facility under normal circumstances Spills of chemicals that might be involved in accident conditions will be administratively controlled by actions specified in the Operational Safety Analysis (OSA) Considering the above factors air quality impacts are not further discussed except under personnel exposures and transportation impacts

4 2 3 2 Water Quality

As discussed in Section 2 3 5 the water quality data for the 26 surface water and surface seep stations in OU2 suggest that VOC contamination at these stations is a result at least in part from soil and subsurface contamination at the 903 Pad Mound and East Trenches The proposed vapor extraction system will remove VOCs from the subsurface and may over an extended period of time eliminate enough source material to reduce VOC contaminants in the OU2 seeps ponds and creeks

With respect to the Subsurface IM/IRA potential impacts to water quality may also arise from surface water runoff from disturbed ground surfaces resulting in sediment transport to the

surface waters in both South Walnut Creek and Woman Creek drainage basins. However, erosion control measures as defined in the construction specifications would prevent any contaminated runoff from entering surface waters. Techniques may include but not be limited to fiber compost nets, grouted riprock, hydromulching and seeding, erosion bales to prevent runoff, and benches, berms, and silt fences to control runoff. The area impacted by the construction would be restored immediately upon completion of the project.

Soils within OU2 are contaminated with plutonium, uranium, and americium (Rockwell International 1989a). During drilling and vapor extraction system installation, surveys would be performed to detect any radioactive contamination. Significant radioactive contamination would be handled in accordance with the PSHSP procedures.

With respect to water treatment, spills of subsurface water, chemicals, or treatment media associated with operation and maintenance of the vapor extraction system will be mitigated by use of secondary containment, which would likely capture all of the spilled material. Spills of liquids resulting from accidents will be controlled by actions specified in the OSA. Transport of secondary wastes will be in accordance with standard Plant and project specific operating procedures and presents a negligible hazard to on-site or off-site water quality. Considering the above factors, water quality impacts are not further discussed.

4.2.3.3 Terrestrial and Aquatic Impacts

Regulations which require federal agencies to assess project impacts on terrestrial and aquatic biota include NEPA of 1969, the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666c), the ESA of 1973 (Public Law 93-0205), the CWA as amended, and the Migratory Bird Treaty Act (16 U.S.C. 1701-1711) and DOE Order 5400.5. Related guidance includes DOE 1988 Environmental Guidance Program Reference Book, ESA, and the FWCA. U.S. DOE, Washington, D.C.

Terrestrial populations that may be negatively impacted by drilling and excavation within OU2 for subsurface remediation include vegetation, ground-dwelling rodents, reptiles, and invertebrates. However, none of these terrestrial populations are threatened or endangered, and

they can be expected to quickly re establish their populations in the disturbed area Furthermore areas of impact will be minimal (less than 50 feet by 50 feet) and any loss of vegetation could be offset somewhat by reseeding disturbed areas with native grass and shrub species Therefore impacts to terrestrial ecosystems from subsurface remediation will not be further discussed in subsequent sections

The nearest point of aquatic life that may be affected by the collection treatment and discharge of subsurface contaminated ground water is South Walnut Creek The quality of effluent discharges and the effects on aquatic biota are evaluated and discussed in the Surface Water IM/IRAP for South Walnut Creek (EG&G 1991e)

4 2 3 4 Threatened and Endangered Species

Representative laws and regulations which protect threatened and endangered species include the NEPA of 1969 the ESA of 1973 the CWA as amended and the Migratory Bird Treaty Act Federal agencies must ensure that actions authorized funded or carried out by them will not jeopardize the continued existence of any endangered or threatened species (EG&G 1991g) Section 7(a)(2) of the ESA requires federal agencies in consultation with and with the assistance of the Secretaries of the Interior and Commerce to ensure that their actions are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species The statutory authority is listed as follows Section 7 of the ESA of 1973 (16 U S C 1536) P L 93 205 December 28 1973 as amended by P L 95 632 P L 96 159 and P L 97 304 Authority to conduct consultations has been delegated by the Secretary of the Interior to the Director of the USFWS who has authority over endangered or threatened species and their critical habitats as listed in 50 CFR 17

Related guidance implementation includes the following

- 50 CFR Part 17 — Endangered and Threatened Wildlife and Plants (includes critical habitats)

- 50 CFR Part 225 — Federal/State Cooperation in the Conservation of Endangered and Threatened Species
- 50 CFR Part 402 — Interagency Cooperation
- Environmental Guidance Program Reference Book U S Department of Energy 1988
- Endangered Species Act and the Fish and Wildlife Coordination Act U S DOE Washington D C

The drilling and excavation for subsurface IRA in OU2 will not affect potential habitat suited for threatened and endangered species. Although there are three endangered species of interest in the RFP area, there is no critical habitat present for these species in the OU2 area. The three endangered species of interest in the RFP area are the black footed ferret (*Mustela nigripes*) (USFWS 1988), the peregrine falcon (*Falco peregrinus*) and the bald eagle (*Haliaeetus leucociphalus*) (EG&G 1991g).

Prairie dog colonies in the northeast area of the plant site provide the potential food source and habitat for the black footed ferrets. However, no prairie dog towns exist in or near the OU2 area, so black footed ferrets are likely not to exist in this area (DOE 1990a).

Peregrine falcons were not observed during the reconnaissance level surveys for the threatened and endangered species evaluation (EG&G 1991g), although two historic nest sites are located within 10 miles of the RFP site. The Peregrine Falcon Recovery Plan (USFWS 1984) discourages land use practices that would adversely alter the character of their hunting habitat or prey base within a 10 mile radius of a nest cliff (including historical sites). Because peregrine falcons prey exclusively on waterfowl and other birds, drilling extraction and or injection wells in OU2 and installation of wells in OU2 will not affect the hunting habitat or the prey base for the peregrine falcon.

Although bald eagles (*Haliaeetus leucocephalus*) are identified as occasionally using habitat between 0.3 and 1.1 miles from the RFP site during the winter months, sightings are rare and little suitable habitat occurs. No bald eagle nests occur on plant site (DOE 1990a).

Based on the above discussion further consideration of impacts to threatened and endangered species for OU2 IM/IRA is not warranted and is not included in subsequent sections

4 2 3 5 Cultural Resource

NEPA (1969) and the National Historic Preservation Act of 1966 (Public Law 89 665) together with subsequent law amendments (Public Laws 91 243 93 54 94-422 94-458) provide that all federal agencies implement programs for the protection of historical and archeological resources. Section 106 of the National Historic Preservation Act requires federal agencies to consider the effects of the proposed actions on properties eligible for or listed on the National Register of Historic Places. Section 110(f) of the National Historic Preservation Act requires specifications in federal agency's actions to minimize harm and adverse effects to National Historic Landmarks. Regulatory guidance procedures include the following:

- 36 CFR 800 — Protection of Historic and Cultural Properties (51 FR 31118 31125 September 2 1986)
- Environmental Guidance Program Reference Book Historic Preservation Requirements U S Department of Energy 1987 U S DOE Washington D C
- Guidelines for Federal Agency Responsibilities under Section 110 of the National Historic Preservation Act (53 FR 4727-4746 February 17 1988) National Park Service
- National Register of Historic Places (published by the National Park Service at various times in the Federal Register) (reference to these listings is in DOE 1987)
- Advisory Council on Historic Preservation 1986 Section 1206 Step-by step
- National Register Bulletins issues periodically by the National Park Service

Compliance with Section 106 requires federal agencies to identify and evaluate historic properties. The RSO (DOE Order 5440 1c) and the State Historic Preservation Officer locate and evaluate the eligibility of possible historic properties for the National Register of Historic Places. A cultural resource study of the RFP was conducted between 31 May and 28 June 1991.

that identified 45 cultural resources none of which were recommended as eligible for listing on the National Register of Historic Places (EG&G 1991a) In addition to the 45 sites located during the 1991 survey six previously identified historic sites were also previously determined to not be eligible for listing on the National Register for Historic Places They were not re-evaluated during this site wide archeological survey The State Office of Archeology and Historic Preservation has determined that any action in the vicinity of OU2 will not impact cultural resources (Burney 1989) Therefore further discussion of historic and archeological sites is not included in subsequent sections

4 2 3 6 Short and Long Term Land Productivity

Land within OU2 is currently undeveloped and will remain so for the foreseeable future as part of the Rocky Flats Plant OU2 lies within the Rocky Flats security boundaries and is not accessible to the general public Short and long term land productivity will not be altered by the project and therefore is not discussed

4 2 3 7 Personnel Exposures

DOE NEPA documentation includes analysis of potentially significant occupational impacts to workers and the public This analysis includes radiological and nonradiological impacts under routine and accident conditions Analysis of accidents includes potential impacts to workers as a result of an accident and potential impacts associated with clean up activities

When analyzing occupational impacts credit was taken for worker protection provided by the Environmental Restoration Health and Safety Program Plan (ERHSPP) The ERHSPP addresses the minimum health and safety requirements for outside contractors as dictated by the EM Department and the Health and Safety (HS) Department The ERHSPP outlines the requirements for a PSHSP that identifies construction tasks potential hazards and the steps to control hazards The PSHSP would be prepared in accordance with guidelines set forth in the ERHSPP and the Plan for Prevention of Contaminant Dispersion (PPCD) (EG&G 1991d) and would be completed after the IM/IRA design is finalized The PSHSP must be approved by the EM and HS Departments and will be reviewed by EPA and CDH Worker protection is also

addressed by the OSA which is completed during preparation of the PSHSP. The OSA addresses health and safety concerns originating from routine site operations.

Drilling Activities

Potential personnel exposures during drilling/vapor extraction system installation activities would result from several pathways:

- Dermal and airborne exposure to VOCs or radioactive materials from subsurface water and drilling fluids
- Airborne exposure to radionuclides and VOCs while drilling the wells

There would be limited potential for dermal contact with contaminated soil and fluids considering the small amount of soil cuttings generated (~2 yd³). Also, the PSHSP would specify the appropriate levels of personnel protection (e.g., respirators, gloves, goggles, protective clothing) to protect against inhalation and direct contact with contaminants. Considering the personnel protection and limited potential for dermal exposure, and that dermal contact is a minor exposure route for the identified contaminants, potential impact to workers would be negligible. Airborne exposure of workers and the public to radionuclides and VOCs will be prevented through the PPCD and the PSHSP. Access controls to the plant site and drilling areas would preclude dermal contact as a credible exposure route for other site personnel and the public.

Routine Operations

Potential exposure routes for remediation workers, other on-site personnel, and members of the general public during routine operations include:

- Airborne exposure to VOC vapors from the subsurface water collection system, sumps, the tank truck, the process influent tank, and from the water treatment process equipment.

- Dermal contact with contaminants while performing operations and maintenance activities
- Fugitive dust generated in the wake of vehicles traveling to the water collection stations for maintenance and surveillance activities

Subsurface IM/TRA operations and maintenance activities would be performed in accordance with OSA procedures which specify appropriate levels of monitoring and personnel worker exposure protection. Considering the unconfined nature of the work areas and administrative controls, potential worker exposures to airborne VOCs would be very low. Airborne VOC concentrations and resulting exposures to other on site personnel and the general public would be significantly less because of their greater distance from the source. The potential for chronic exposure of workers to VOCs resulting from operational tasks associated with the GAC adsorption system would be small, considering replacement of GAC units does not involve contact with spent carbon, and OSA procedures will be in place to protect workers from potential hazards.

Personnel protective measures may be necessary during some routine operational activities where there is a potential for worker contact with contaminated water. Appropriate measures would be followed as specified in the OSA for those activities. Access controls would preclude dermal exposure as a credible pathway for other on site personnel and the general public.

Occasional travel to the subsurface water collection stations will be required for maintenance and surveillance purposes. While some fugitive dust may be generated in the wake of vehicles, it is not expected to be a significant exposure pathway for the vehicle operator, other on site personnel, or the general public because of the short travel distance on unpaved roads and the anticipated low frequency of travel to the collection stations.

Any accidents that may occur during the installation phase of the proposed action would be typical of drilling activities. The PSHSP will identify appropriate precautions and responsibilities for each job. The PSHSP will also specify appropriate air monitoring and response procedures in the event of an unusual VOC or radionuclide release. Workers will be familiar with the PSHSP and a copy of it will be available at the work site.

During operations accidents that could impact either workers or members of the public would include fires or major spills of contaminated material Potential releases of untreated water along the truck route or proposed pipeline or within the existing treatment facilities would create the potential for short duration airborne VOCs Intake of contaminants by workers involved in the cleanup would be controlled by following safety precautions specified in the OSA

This section on personnel exposures applies to all three proposed actions Therefore further discussion of personnel exposure is not included in subsequent sections

4 2 3 8 Commitment of Resources

Commitment of Resources is evaluated by examining the economic and ecological value of materials (and labor) required for the IM/IRA preferred actions The resources (including both material and labor) required for construction and operation of this Subsurface IM/IRA are relatively minor No significant commitment of economically or ecologically valuable resources is involved With the exception of the land area all the materials for construction and operation of the surface water treatment system will be irrevocably and irretrievably committed to the implementation of remedial action The facilities proposed for treatment of the Subsurface IM/IRA generated water utilize pre existing process equipment and do not require additional purchase and installation of treatment facilities for the IM/IRA

4 2 3 9 Transportation Impacts

Human health impacts due to transportation include latent effects associated with vehicle pollution in addition to traumatic injuries and fatalities resulting from accidents Normal transportation is associated with incremental pollution from engine emissions fugitive dust generation in the vehicle s wake and particulates from tire wear The table below presents estimates of risks (Rao et al 1982) resulting from truck and rail transportation Uncertainties are associated with pollution emission rates and atmospheric dispersion behavior To compensate for these uncertainties the analysis utilized conservative estimates for determining pollution health effects The tabulated accident impacts are average values over population zones

(urban suburban rural) and are derived from Department of Transportation (DOT) nationwide statistics

| Estimates of Risks Resulting from Truck and Rail Transportation | | | | |
|---|---------------------|------------------------------|----------|------------|
| Source | Transportation Mode | Health Effects per Kilometer | | |
| | | LCFs* | Injuries | Fatalities |
| Pollutants | Truck | 1 0 E 7 (urban only) | | |
| | Rail | 1 3 E 7 (urban only) | | |
| Accidents | Truck | | 5 1 E 7 | 3 0 E 8 |
| | Rail | | 4 6 E-7 | 3 4 E-8 |

LCFs represent latent cancer fatalities resulting from incremental vehicle pollution and would occur after a latency period following initial exposure

Drilling fluids and cuttings are to be treated as hazardous material and transported in accordance with appropriate DOT regulations and DOE orders. Transport and handling of other hazardous materials will also be in accordance with appropriate regulations and orders and the On Site Transportation Manual (DOE 1991c). Emergency response procedures for accidental spills or container failures are described in Section 17 of the On Site Transportation Manual. Estimation of transportation impacts for the 903 Pad Mound and East Trenches Subsurface IM/TRAs is detailed in Appendix E.

4.2.3.10 Wetlands and Floodplains Impact Assessment

The relevant laws and acts that protect wetlands and floodplains include NEPA of 1969, Section 401 and 402 of the CWA, the Fish and Wildlife Act of 1956 plus associated coordination

acts and regulations promulgated under 10 CFR Part 1022 — DOE Compliance with Floodplain Wetlands Environmental Review Requirements The rules promulgated under NEPA 42 U S C 4321 et seq in 40 CFR parts 1500 through 1508 state that all federal agencies are required to consider the environmental affects of any proposed action (EG&G 1990d) Since the proposed actions are at least 400 feet away from any wetlands and are not within a floodplain 10 CFR Part 1022 does not apply

Executive Orders (E O) that require federal agencies to consider the effects of proposed action on wetlands and floodplains are as follows

- E O 11990 Protection of Wetlands (May 24 1977)
- E O 11988 Floodplain Management (May 24 1977)

These orders require federal agencies to avoid to the extent possible destruction and modifications of wetlands and adverse impacts associated with the occupancy and modification of floodplains Federal agencies are required to determine if wetlands and floodplains that may be affected by the action are present assess the impacts on these environments and consider alternatives to the action DOE regulations establishing policy and procedures for the RFP site in compliance with E O 11990 and 11988 are found in 44 FR 12594 (7 May 1979)

Documentation of a wetlands and/or floodplain review involves (1) public notification of intent to perform a wetlands/floodplain review (2) wetlands/floodplain assessment and (3) a statement of findings for actions involving floodplains

When an action in a wetlands and/or floodplain requires an EA the wetlands and/or floodplain assessment will be prepared concurrent with and is included in the EA Wetlands and/or floodplain assessments that are part of the EA are subject to approval by the Assistant Secretary for the Environment Safety and Health Actions in wetlands may but do not necessarily require an EA (DOE 1988)

4 2 3 11 Cumulative Impacts

A cumulative impact is defined in 40 CFR 1508.7 as the impact on the environment which results from the incremental impact of the action when added to other past present and reasonably foreseeable future actions regardless of what agency (federal or non federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative impacts will incorporate similar previous IM/IRA actions in the same geographic location and consider impacts on aquatic and terrestrial biota and impacts from construction and operations of the proposed action to on site personnel and the general public (DOE 1988d). It is noted that air quality and water quality impacts are not cumulative because emissions discharges or releases are not expected to occur during routine operations. Impacts resulting from installation activities or operational accidents would be short lived and are thus also not cumulative.

4 3 VACUUM ENHANCED VAPOR EXTRACTION AT 903 PAD (IHSS NO 112)

This section presents a detailed description of the proposed action at the 903 Pad. This discussion focuses on the rationale and criteria for selecting the test site at the 903 Pad, expected test site conditions, proposed treatment systems, and Observational/Streamlined Approach considerations with respect to deviations in expected test site conditions. The criteria presented below for 903 Pad test site selection were also used to select sites at the Mound and East Trenches Areas (Sections 4.4 and 4.5 respectively).

4 3 1 Test Site Description

4 3 1 1 Test Site Selection Rationale

The criteria listed below were used to guide test site selection. The test area should possess

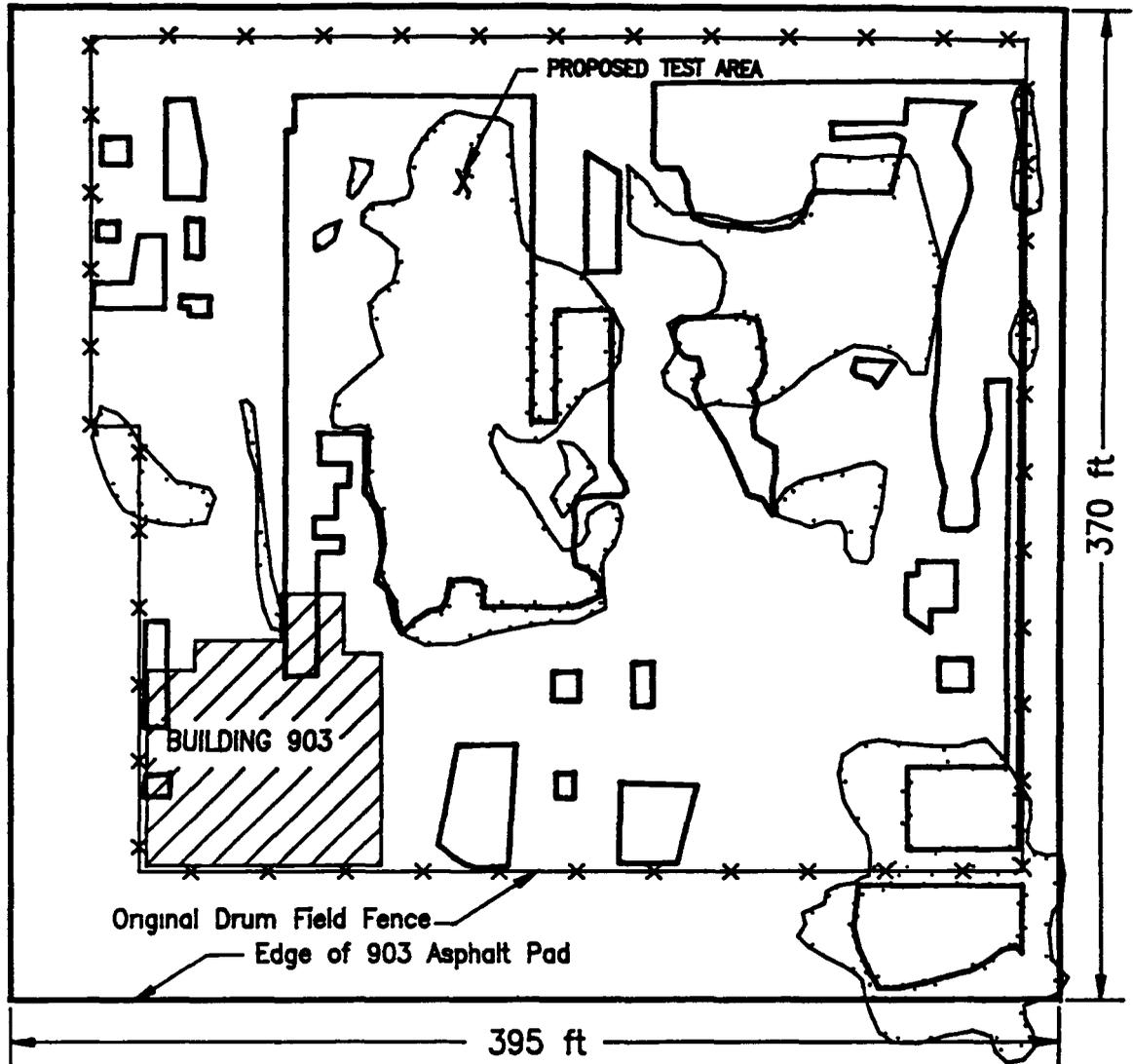
- A relatively high probability of containing residual free phase DNAPL in the vadose and/or saturated zone
- A low probability of containing buried drums

- A low probability of containing metallic Pu or U

The first criterion is related to the proposed remedial technology *in situ* vacuum enhanced vapor extraction. As discussed in Section 4.1 *in situ* vacuum-enhanced vapor extraction is a VOC source removal technology requiring the presence of residual free phase chlorinated solvents in order to demonstrate successful performance. In addition, the test site should not contain buried containers because the proposed actions involve drilling boreholes. Penetration of a buried drum containing waste will likely result in a release of contamination to the subsurface. Lastly, the test site should not contain buried metallic Pu or U as these materials are potentially autopyrophoric and should not be disturbed during drilling or vapor extraction activities.

IHSS No. 112 (see Figure 2.2) a former drum storage location at the 903 Pad satisfies all three test site selection criteria. With respect to the first criterion, drums stored at IHSS No. 112 between 1958 and 1967 reportedly leaked an estimated 5,000 gallons of fluid onto the ground (Freiberg, 1970). Calkins (1970) reports that fluids stored at the 903 Pad included lathe coolant consisting of hydrocarbon oils and carbon tetrachloride in varying proportions, hydraulic oils, vacuum pump oils, TCE, and PCE. Carbon tetrachloride was detected at a 6,400 µg/l in a water sample collected in September 1990 from alluvial monitoring well 1587 which is located downgradient of the 903 Pad (see Figure 2.11). This well is located approximately 300 feet from the suspected spill location, suggesting much higher concentrations at the spill site. IHSS 112 satisfies the second criterion based on reports indicating that drums were not buried at this location. All drums were stored on the ground and subsequently removed. Reportedly, the only metallic nuclear material released at the 903 Pad is an estimated 86 grams of finely divided plutonium (Freiberg, 1970) of which a significant portion was removed during subsequent remedial efforts. A study conducted by Clark (1991) concluded that plutonium in the 903 Pad soil is inert with respect to pyrophoricity (Clark, 1991).

The specific location of the fluids released at 903 Pad was determined by review of aerial photographs which reveal the former location of storage drums and areas of stained soils (Figure 4.1). The proposed action will be conducted in an area of stained soils in the north central portion of IHSS No. 112.



EXPLANATION

-  AREA OF SOIL STAINING BASED ON AERIAL PHOTOGRAPHS FROM:
4/29/67 4/10/68, 5/24/69
-  BARREL STORAGE LOCATIONS BASED ON AERIAL PHOTOGRAPHS FROM:
5/5/63, 4/29/65, 4/29/67 9/10/68.

NOTE. BUILDING 903 LOCATION BASED ON AERIAL PHOTOGRAPHS FROM 4/10/68.

January 1992

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

APPROXIMATE LOCATIONS OF
DRUM STORAGE
903 PAD DRUM STORAGE SITE

FIGURE
4-1

r37060 mbPJ-012792

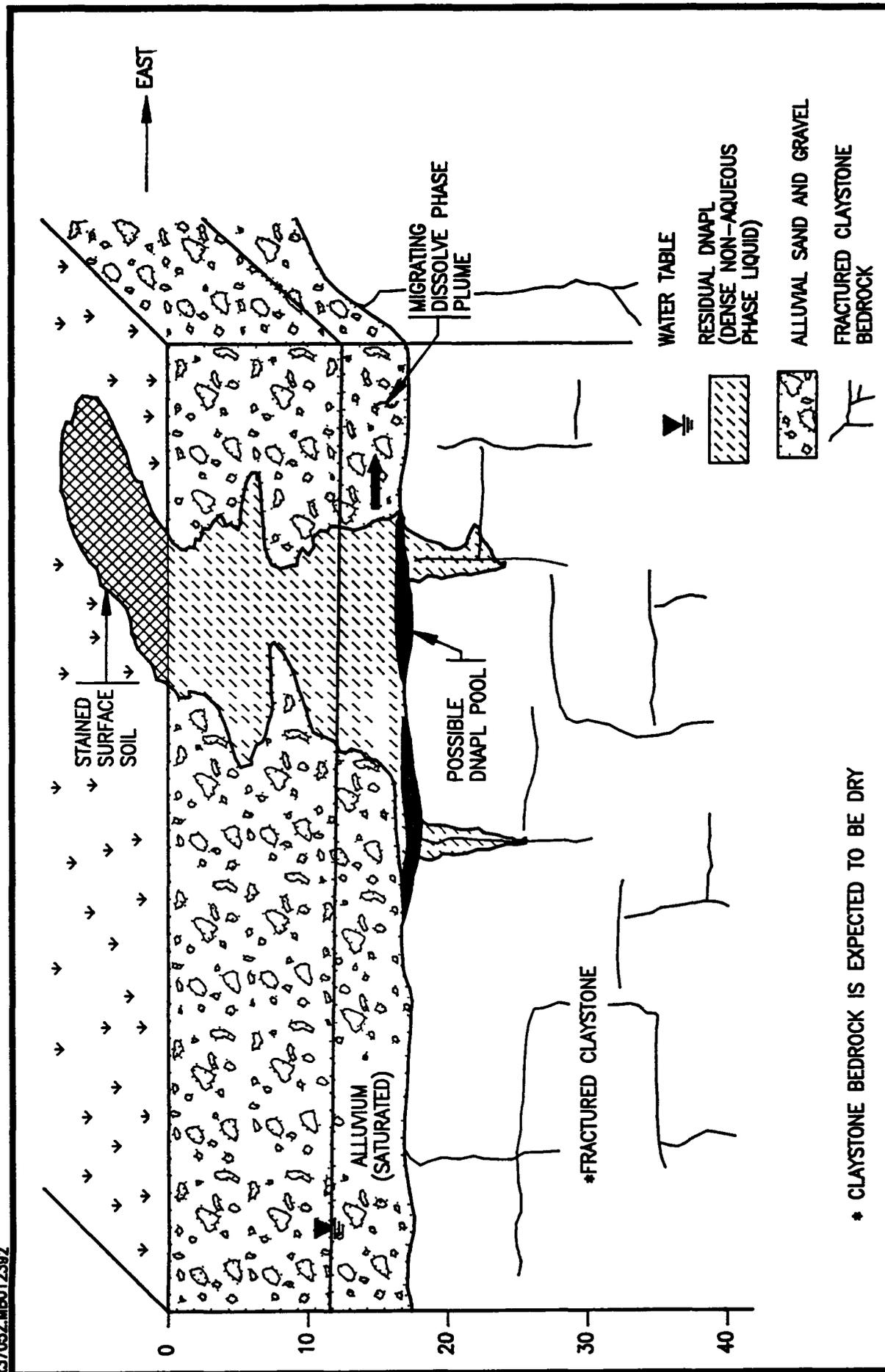
4 3 1 2 Expected Conditions

Site specific geologic hydrologic and contaminant type and distribution information local to the proposed 903 Pad test site is not currently available. Therefore, an idealized conceptual hydrogeologic and contaminant distribution model has been developed based on information derived from geologic logs, water level data, and ground water chemistry from investigative activities conducted near the proposed test site. The site specific conceptual model was further refined using the geologic log of the borehole drilled for monitoring well 1687 located approximately 300 feet east of the 903 Pad. This log is representative of the 903 Pad Area and is presented in Appendix D. The idealized conceptual model of the 903 Pad pilot test site is illustrated in Figure 4.2. The diagram illustrates the hydrogeology and contaminant distribution expected to exist within 50 feet of the ground surface.

Sand and gravel alluvium extends to approximately 18 feet below ground surface. It is expected that the alluvium contains unconfined ground water perched on bedrock with a saturated thickness of approximately 4 feet. Furthermore, the saturated thickness will likely vary seasonally. The alluvium overlies claystone bedrock which may contain isolated or interconnected fractures. The claystone bedrock is not expected to contain recoverable ground water.

It is expected that carbon tetrachloride comprises the majority of the released hazardous contaminants with lesser amounts of TCE and PCE. As discussed in Section 4.1, these contaminants have limited solubility in water and have a specific gravity greater than 1.0 (i.e., DNAPL). The conceptual model thus indicates the vertical migration of these DNAPLs through the vadose zone and the saturated alluvium coming to rest in structural depressions on the claystone bedrock surface. Infiltration of DNAPL along bedrock fractures is also shown. A review of existing monitoring well design and ground water chemistry (Rockwell, 1987a) with respect to the presence of dissolved versus residual free phase chlorinated solvents in the claystone bedrock near the 903 Pad was inconclusive. It is important to note that the presence of pools of DNAPL perched on the bedrock is also uncertain and may never be conclusively determined. However, the presence of a dissolved carbon tetrachloride plume coupled with the presence of stained surface soils and an estimated release of 5,000 gallons of fluids suggests the

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* CLAYSTONE BEDROCK IS EXPECTED TO BE DRY

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IDEALIZED CROSS-SECTION
903 PAD AREA (IHSS 112)

presence of residual free phase chlorinated solvents in the vadose and saturated zones which would constitute a continuing source for the dissolved phase contaminant plume

4 3 2 Remedial Approach

4 3 2 1 Proposed Action Based on Expected Conditions

This section provides a detailed description of the interim remedial action proposed for implementation at the 903 Pad test site. The proposed action is based on the idealized conceptual hydrogeologic and contaminant distribution model described in Section 4 3 1 2 and involves

- *In situ* vacuum enhanced vapor extraction coupled with ground water depression for the alluvial material
- *In situ* vacuum-enhanced vapor extraction for the upper portion of the claystone bedrock

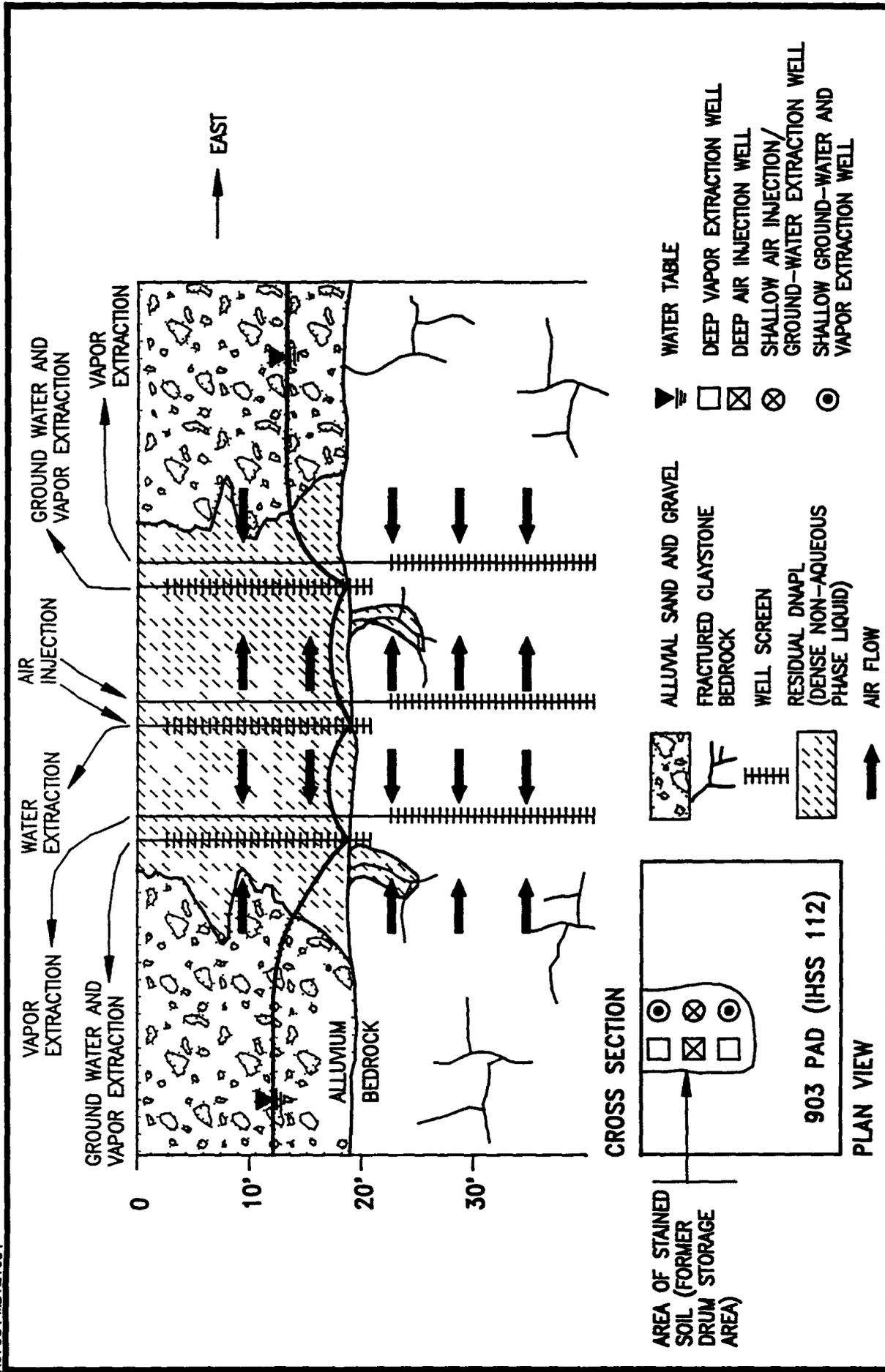
A second site may also be selected at the 903 Pad to conduct tests of *in situ* steam stripping for removal of both VOC and radionuclide contamination. Further consideration of this technology is deferred pending completion of treatability studies being conducted by LLNL. The reader is referred to Section 4 1 for additional explanation of *in situ* steam stripping.

This section first discusses the elements of the vapor and ground water extraction system followed by a description of the proposed vapor and ground water treatment systems.

Vapor and Ground Water Extraction

Figure 4 3 illustrates the location and configuration of the vapor and ground water recovery wells to be installed at the 903 Pad. Two alluvial vapor extraction wells will be installed in an area of stained soils in the north central portion of IHSS No 112 (Figure 4 1). The existing asphalt cap on 903 Pad is expected to prevent short circuiting of air flow from the atmosphere to the extraction wells. Ground water will be extracted from the alluvium using pumps installed

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SCHEMATIC
GROUND-WATER AND VAPOR RECOVERY SYSTEM
903 PAD DRUM STORAGE SITE (IHSS 112)

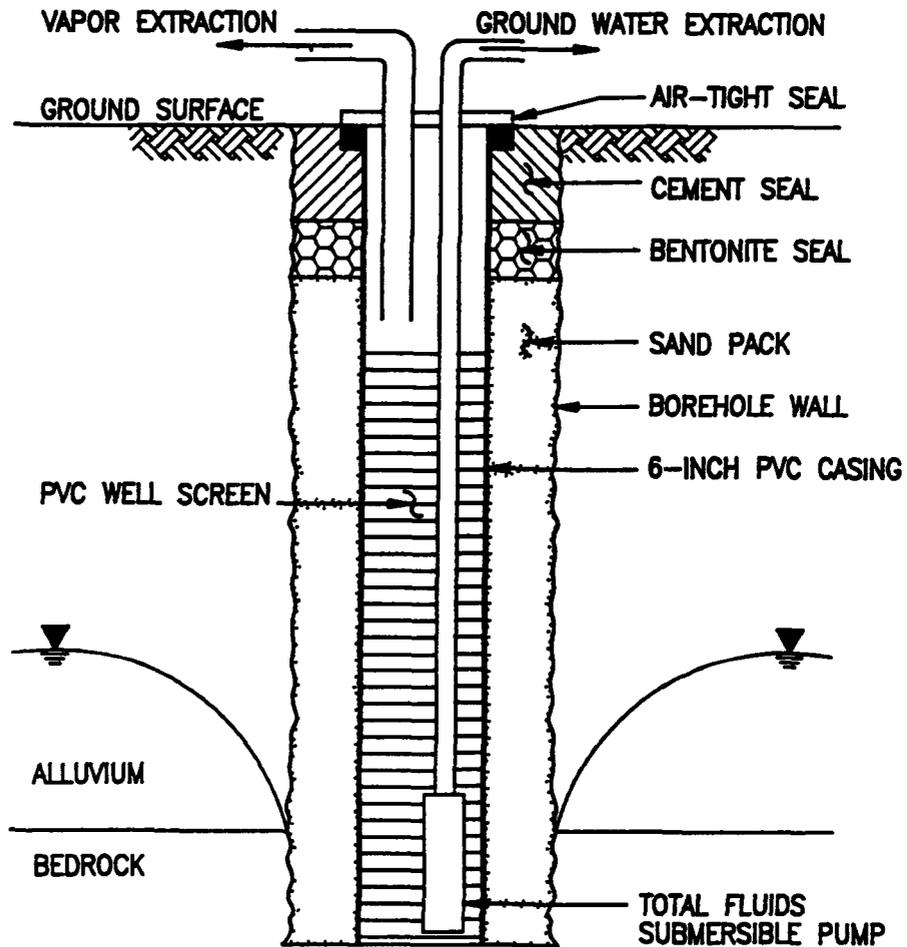
FIGURE
4-3

in the vapor extraction wells. An air tight seal will be installed at the top of the well casing to allow the extraction of both vapor and ground water. A schematic diagram showing pump placement and casing cap is presented in Figure 4-4. Between these two wells one air injection well will be installed in the alluvium. This well will be used to depress the water table and increase the volume of soils contacted by injecting ambient air. This will be accomplished by connecting an air injection manifold to the well and also installing a submersible pump. The pump riser pipe and air injection manifold will exit the well casing via an airtight seal. Ambient and heated air will also be injected during the test to determine if the additional air flow and heat increases the rate of volatilization of residual DNAPL. Ambient and heated air will be injected at a rate equal to one half of the combined extraction rate. This is to ensure that injected air does not further disperse vapor phase contaminants in the vadose zone. Under ideal conditions of isotropy and homogeneity of the alluvial soils or bedrock air flow lines can be expected to form a closed loop between the injection and extraction wells given reasonably close well spacing (<25 feet). Radial pressure distribution equations (Johnson et al 1989) will be used during Test Plan development to insure that negative pressures are maintained at the boundary of the test area.

Remedial efforts in the alluvium and bedrock will be isolated from each other in order to prevent cross contamination. Preventative measures include installing separate wells in the alluvium and bedrock. Bedrock wells will be isolated from the alluvium by the installation of a steel surface casing. Well construction schematics are presented in Figure 4-5. Note that alluvial ground water extraction wells will have screened sections that penetrate several feet into the bedrock. This is to allow for the collection and recovery of free phase or flowing DNAPL should it be encountered at the alluvial/bedrock interface.

The results of the *in situ* pilot tests will be evaluated to assess the benefit of post pilot operation of the vapor extraction system at each of the IM/IRA test sites. The objective of post pilot system operation is to recover significant amounts of VOCs from the test areas. Pilot test data will be evaluated with respect to the following criteria:

- Mass of VOCs recovered per unit cost
- Mass of VOCs recovered per unit time



VAPOR AND GROUND-WATER
EXTRACTION WELL

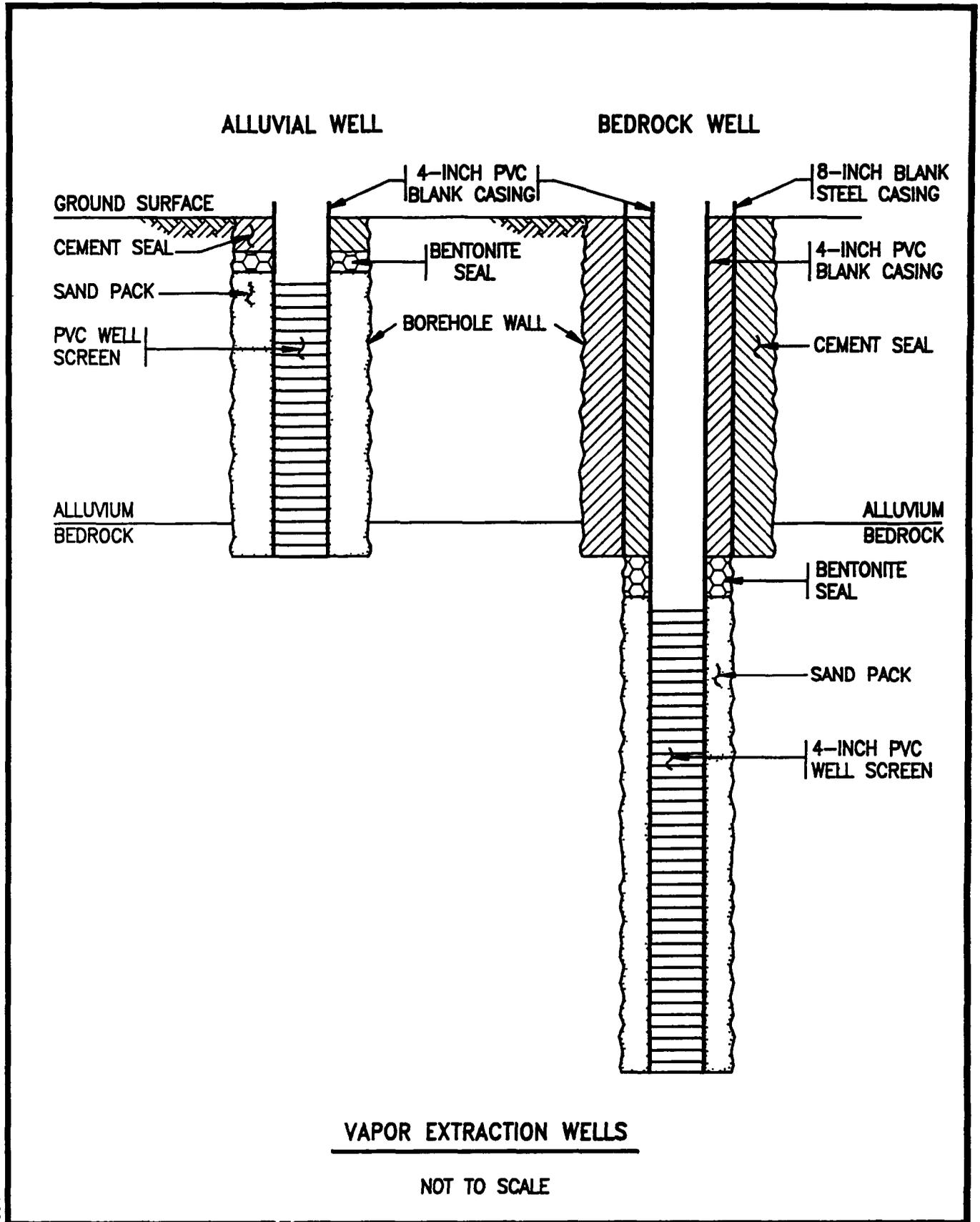
NOT TO SCALE

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GROUND-WATER AND
VAPOR EXTRACTION WELL
SCHEMATIC

FIGURE
4-4



VAPOR EXTRACTION WELLS

NOT TO SCALE

R37048 MB121691

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VAPOR EXTRACTION WELLS
 SCHEMATIC

FIGURE
 4-5

- Areal influence of vapor extraction system
- Ability to successfully control the mobility of contaminants
- Ability to successfully dewater aquifer material (if present)

These criteria will be used to evaluate the pilot test data within the context of the limitations imposed by test site geology and contaminant distribution logistical considerations and costs relative to alternative residual free phase VOC removal technologies (e.g. excavation). As discussed in Section 5 the pilot test data data analysis and recommendations for continued system operation at the three test sites will be presented in a Pilot Test Report.

The conceptual hydrogeologic model illustrated in Figure 4.2 shows some limited penetration of DNAPLs into bedrock fractures. To evaluate the potential to recover residual DNAPL (if any) two vapor extraction wells will be installed in the upper portion of the claystone bedrock. One air injection well will be installed between the two extraction wells. All bedrock extraction/injection wells will be installed to a minimum depth of 30 feet into the bedrock. No recoverable ground water is expected in the upper portion of the bedrock.

Dynamic system performance will be evaluated by monitoring vapor recovery rates, contaminant concentrations in recovered vapor and by measuring vacuum induced in the subsurface. Vapor recovery rates will be measured using a dedicated pitot tube installed in the vapor collection manifold. Contaminant concentrations will be measured by sampling recovered vapor with subsequent chemical analyses. Formation pressures will be measured in recovery wells and the injection well prior to injecting air. Dedicated valves between the vapor collection manifold and each vapor extraction well will allow one well to be operated independently while formation pressures are measured in the adjacent well. In addition, two or more temporary vacuum monitoring probes will be placed within the test area to determine the area of influence of the vapor extraction system.

System effectiveness will be evaluated by establishing initial conditions through collection of soil samples during the advancement of boreholes for well installation and subjecting them to laboratory analyses. Upon completion of the IRA, additional soil samples will be collected in

the proximity of the original samples. Comparison of contaminant concentrations before and after the test will provide a quantitative evaluation of system effectiveness.

The proposed test site selection was based on qualitative data from the proposed test site and conditions extrapolated from quantitative data collected near the proposed test site. Should the proposed test site prove inadequate, an alternative test site will be selected. The most likely reason for poor site conditions is the absence of residual free phase DNAPL. A preliminary threshold for determining success will be concentrations of hydrocarbon compounds in the recovered soil vapor equal to 1 part per million (ppm) as measured with a portable photoionization detector calibrated for the major contaminant expected at each test site (1 e CCl₄ at 903 Pad). This value was selected because it is the lowest concentration which can be reliably detected with basic field instrumentation. The hydrocarbon concentrations will be confirmed by subsequent laboratory analyses. The test will be conducted for a minimum of 7 days before abandonment and new site selection. If the recovered vapor contains hydrocarbon concentrations equal or greater than 1 ppm, the test duration will be determined while the test is in progress. In any case, the test duration should not exceed 3 months.

Therefore, implementation of this technology may be appropriate under the criteria outlined in the introductory paragraphs of this section, once treatability studies have been successfully completed.

A preliminary review of potential test sites revealed 903 Pad as the most suitable test site. Releases of VOCs are suspected to have occurred at the 903 Pad and finely disseminated radionuclide contamination is known to be present in the soil. However, further evaluation of this technology is deferred pending completion of the treatability studies.

Vapor and Ground Water Treatment

Vapors extracted from the subsurface at the 903 Pad will be treated for removal of particulates and VOCs prior to discharge to the atmosphere as illustrated in Figure 4-6. The vapor treatment system conceptually illustrated in Figure 4-6 will be newly constructed specifically for the Subsurface IM/IRA. Extracted vapors are first passed through a mist eliminator to remove

entrained condensate that may be present. The mist eliminator is packed with stainless steel mesh that provides a large surface area that allows small entrained liquid droplets to coalesce into larger droplets that separate by gravity from the vapor stream. Accumulated liquids are gravity drained from the mist eliminator while the vacuum pump is off. Condensate generated by the treatment system will be placed in the ground water holding tank for subsequent treatment (discussed below).

The vapor leaving the mist eliminator passes through a vacuum pump provides the driving force for subsurface vapor extraction. The vacuum pump will be specified to provide a range of operational service to accommodate the different subsurface conditions at each of the OU2 pilot test sites. Lower permeability clay soils at the Mound, for example, will likely require higher vacuum pressure to be applied to the subsurface to induce adequate vapor flow than would be required for the higher permeability soils at the East Trenches Area. Detailed specification of the vacuum pump as well as all other treatment system components will be provided in the Pilot Test Plan which will be prepared after regulatory agency approval of the Subsurface IM/IRAP/EA (Section 5.1).

The vapor exiting the vacuum pump is filtered by a HEPA filtration unit. HEPA filters contain fabric filtration media that is capable of removing particulates as small as 0.3 microns with 99.7 percent efficiency (Federal Standard 209b). In this vapor treatment application, HEPA filtration prevents fouling of downstream process equipment (i.e., vacuum pump and GAC units) and ensures operation within particulate emissions standards (Section 3.2.3). The latter is particularly important if the extracted vapors contain particulates contaminated with radionuclides. Figure 4.6 shows that the vapor treatment process includes two HEPA filters configured in parallel. One of the units is operated in a standby mode and thus provides redundancy in the event that the on-line filter plugs or otherwise fails. Filter plugging is monitored with the pressure indicators installed on the inlet and outlet of the HEPA filters.

The vacuum pump mentioned above imparts heat to the vapor stream as a result of the work performed on the fluid. The magnitude of increase in vapor temperature depends on many factors including vapor flow rate and pump duty. The vapor stream may have to be cooled to ensure efficient adsorption of VOCs by the GAC units. Optimal adsorption efficiencies are

achieved at temperatures less than 80 F. If required, a heat exchanger will be included in the pilot system design to cool the vapor stream. Figure 4.6 illustrates a water cooled heat exchanger where warm water exiting the exchanger is sprayed cooled (i.e. evaporative cooling) in a recirculation tank.

The cooled vapor stream is then processed through two GAC adsorption units for removal of VOCs prior to discharge to the atmosphere. Adsorption of VOCs is a result of a physico-chemical attraction between the VOC molecules and the GAC which provides a very large surface area for adsorption to occur. The concept design includes two GAC units configured in series (i.e. lead and polishing positions). Once the GAC unit in the lead position is fully loaded with VOCs (i.e. spent) it is taken out of service. The polishing GAC unit is moved to the lead position and a new GAC unit is placed in the polishing position. Physical movement of the polishing GAC unit is not necessary to place it in the lead position. This is accomplished by changing the open/closed configuration of the process valves. Spent GAC generated during the pilot study phase of the IM/IRA will be analyzed for the presence of radionuclides to determine whether it may be regenerated or must be managed as a mixed waste. Due to the nature of this remedial action along with the presence of HEPA filtration upstream of the GAC units, it is expected that the GAC will not be contaminated with radionuclides and will be able to be regenerated. Regeneration is typically performed by the manufacturer and involves the passage of hot air through the bed to desorb the VOCs. The desorbed VOCs are then destroyed by high temperature incineration.

The instrumentation and analytical sampling locations shown on Figure 4.6 conceptually illustrates the process information necessary to properly operate and evaluate the proposed vacuum enhanced vapor extraction and treatment system. Detailed specification and placement of process instrumentation will be provided in the Pilot Test Plan. However, the following discussion of process measurements that are common to a variety of vapor extraction system configurations will aid in the understanding of process operation.

Level measurement on the mist eliminator indicates the amount of condensate that has accumulated and notifies the operator of the need to drain the unit. As mentioned above, pressure measurement before and after the HEPA filters provides an indication of filter plugging.

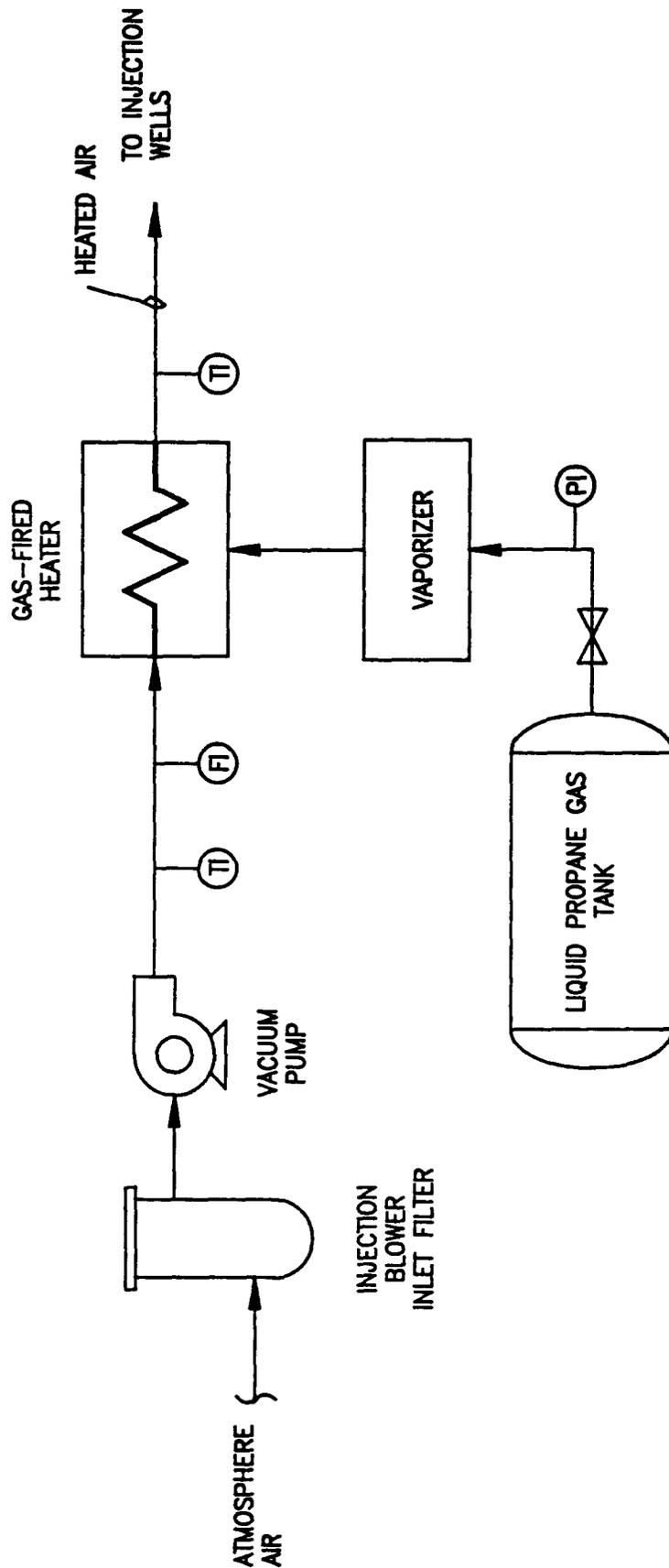
Based on this differential pressure measurement the standby filter containing virgin filter media is brought on line. The spent filter is taken off line and its filter media replaced. Similarly differential pressure measurement across the GAC units provides an indication of unit loading and/or plugging.

Real time monitoring is often employed for critical parameter measurement, alarm, and control. For the proposed vapor treatment system, on line radiation monitoring immediately downstream of the HEPA filters detects failure of the filters to remove radionuclide-contaminated particulates if present in the extracted vapors. Likewise, real time VOC leak detection is used to monitor the integrity of system piping and connections to ensure emission free operation. Leaks in process piping located downstream of the vacuum pump (i.e. positive pressure side) and upstream of the GAC units may result in VOC emissions. Leaks on the negative pressure side of the process do not result in undesired emissions. Rather, atmospheric air is pulled into the system. RCRA leak detection is often implemented by monitoring the secondary containment cavity of the process piping. Specifically, a hydrocarbon sensor is placed into the secondary containment cavities of the process piping and connected to an alarm. In addition to these alarms, the signals from the real time radiation and VOC sensors may be used to provide automatic shutdown of the system. Details of control signal wiring will be presented in the Pilot Test Plans.

Vapor flow measurement and analysis of vapor samples will allow calculation of contaminant mass recovery rates and thus evaluation of system performance. Comparison of upstream and downstream vapor flow measurements provides additional information for assessment of system vapor leaks. Measurement of the temperature of the vapor leaving the heat exchanger is crucial in maintaining the operating efficiency of the GAC units.

As mentioned above, pilot testing of the *in situ* vacuum enhanced vapor extraction system involves injection of ambient and heated air into the test area formation to study the effect on VOC mass recovery. Figure 4.7 illustrates the equipment that will be used for air injection: a blower and liquid propane gas fired heater. This equipment will be sized during the detailed design phase of the IM/IRA (i.e. Test Plan) to provide a range of operational service that accommodates the different subsurface conditions at each of the OU2 test areas. Process

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LEGEND

- (FI) FLOW INDICATOR
- (PI) PRESSURE INDICATOR
- (TI) TEMPERATURE INDICATOR
- ∇ VALVE

NOTE.
VAPOR INJECTION EQUIPMENT
IS MOUNTED ON A FLATBED
TRAILER FOR EASE OF TRANSPORT
TO EACH PILOT TEST SITE.

January 1992

**PILOT TEST UNIT
VAPOR INJECTION SYSTEM**

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Golden, Colorado**

**FIGURE
4-7**

instruments and controls will be used on the air injection system to ensure proper control of air flows and temperatures

As noted on Figures 4 6 and 4 7 the vapor injection extraction and treatment system components are mounted on a flat bed trailer This allows the equipment to be easily moved to different vapor extraction test sites Electric power necessary to operate these systems at the 903 Pad test site will be obtained from existing power lines in the vicinity of 903 Pad Electric power driven equipment includes vapor and ground water extraction pumps air injection blower instrumentation and controls cooling water circulation pump and heat tracing

The South Walnut Creek Basin Surface Water Treatment Facility (Section 4 6 1) is proposed for use in treating contaminated ground water and condensate generated by Subsurface IM/IRA pilot test activities at the 903 Pad This facility has been selected because of the uncertainty associated with the chemistry of the ground water that may be recovered directly beneath the 903 Pad The South Walnut Creek Basin Surface Water Treatment Facility is the only existing or planned RFP treatment system that has been designed to address all of the potential contaminants of concern At OU2 these contaminants include VOCs radionuclides (i e Pu Am and U) and metals The 881 Hillside Ground Water Treatment System for example has been designed to remove VOCs metals and U but not Pu or Am Proposed use of the South Walnut Creek Basin facility to treat contaminated Woman Creek Basin Surface seeps and discharge the treated water to the South Walnut Creek drainage (EG&G 1990e) encountered strong public opposition with respect to interbasin transfer of this seep water It should be noted however that ground water at the 903 Pad test site flows in two directions northeast toward the South Walnut Creek Basin and southeast toward the Woman Creek Basin This bidirectional flow is a result of the 903 Pad Area being located on a potentiometric crest Therefore use of the South Walnut Creek Basin facility to treat any ground water that may be recovered at the 903 Pad IM/IRA test site does not raise the issue of interbasin transfer of contaminated water The South Walnut Creek Basin Treatment System is centrally located with respect to all of the proposed pilot test locations and has spare processing capacity It is also proposed that ground water and condensate generated from pilot testing at the 903 Pad be transported to the South Walnut Creek Basin Treatment System by tank truck Truck transport has been selected over pipeline transport because of the relatively short duration of the pilot study and the uncertainties associated with

production of ground water if any. Ground water production and chemistry data collected during the pilot study phase of the IM/IRA will allow consideration of the use of other RFP treatment systems for post pilot study operation. These data will also be used to determine the means of contaminated water transport (tank truck versus pipeline) to the designated treatment facility during post pilot study operation. Candidate RFP water treatment systems that may potentially support the Subsurface IM/IRA are discussed in Section 4.6.

It is estimated that approximately 1 gallon per minute (gpm) of ground water will be produced in dewatering the 903 Pad test area alluvium. The volume of condensate produced will be minimal. Ground water and condensate recovered during pilot testing will be allowed to accumulate in an insulated and heated holding tank located at the test site. The contents of the tank will be transported by tank truck to the South Walnut Creek Basin Treatment Facility for removal of contaminants. Assuming the use of a 5,000-gallon holding tank and a 5,000-gallon tank truck, one trip will be required every 3 days to accommodate a 1 gpm recovery rate. The one way transportation distance from the 903 Pad test site to the South Walnut Creek Basin treatment facility is less than one half mile via Central Avenue and the treatment facility access road.

As discussed above, several incidental wastes would be generated during installation and operation of the proposed subsurface action at the 903 Pad. These wastes include personnel protective equipment, drill cuttings (i.e., contaminated soil from well installation), vapor extraction treatment residuals including spent HEPA filtration media and GAC, ground water treatment residuals including sludge and GAC, and recovered free phase solvents (Section 4.3.3.2). All incidental wastes from installation and operation are expected to be similar to those already generated at RFP and will constitute a small fraction of the wastes already processed for storage or disposal by the site. These solid wastes will be characterized and handled according to RFP waste management operating procedures (EG&G 1991h).

4.3.2.2 Observational/Streamlined Approach Considerations

In accordance with EPA Observational/Streamlined Approach guidance, this section identifies potential deviations from the expected conditions at the 903 Pad test site, mechanisms to identify

the deviations and contingency plans that respond to the deviations. Deviations from expected conditions are a result of incorrect assumptions with respect to site specific hydrogeology and nature of contamination based on limited site characterization data. As mentioned in Section 4.3.1.2, the expected conditions at the 903 Pad are based on qualitative data regarding the site history and quantitative data derived from investigative activities performed near the proposed test site but not actually within the test area. In light of the uncertainties associated with extrapolation of site conditions from these data, the development of contingencies to respond to unexpected conditions within the test site is a critical component of the IM/IRA.

Table 4.1 presents reasonable deviations that might be encountered during implementation of the proposed vapor extraction system at the 903 Pad test site. The table also indicates the mechanisms that will be used to identify the potential deviations and presents contingency plans that will be implemented in the event that a deviation actually occurs. The remainder of this Section provides a detailed explanation of Table 4.1.

Free phase solvent contamination at 903 Pad is not expected to have penetrated more than 30 feet into the claystone bedrock. This expected condition is based on a review of existing RI data. The potential deviation would be the presence of free phase contamination at depths greater than 30 feet into bedrock. The method for detecting the deviation is visual inspection of soil samples recovered during drilling of the bedrock vapor extraction well boreholes. The contingency involves continuing the boring to the lower limit of observed contamination and installing a well screen to the total depth of the boring. However, the boring will not extend beyond 100 feet total depth.

Recoverable ground water in the claystone bedrock at the 903 Pad test site is not expected. Borings advanced through the claystone near the 903 Pad during previous investigative efforts recovered only dry to moist soil samples. It is possible, however, that the vacuum induced by the vapor recovery wells will result in the accumulation of residual soil moisture in the well. This potential deviation from expected conditions will be directly measured using an electronic water level indicator. The contingency will involve retrofitting the vapor recovery wells with ground water extraction pumps. Ground water extracted during pilot testing will be transported to the South Walnut Creek Basin Treatment System as discussed above.

**Table 4-1
Observational/Streamlined Approach
In Situ Vacuum Enhanced Vapor Extraction at 903 Pad (IHSS 112)**

| Expected Conditions | Potential Deviations | Mechanisms to Identify Deviations | Contingency |
|--|--|--|---|
| RI data provides sufficient information to place extraction and injection well | RI data does not provide sufficient information to place vapor extraction and injection well | Analysis and interpretation of RI data | Plan and conduct soil probe survey to provide additional information |
| Limited VOC contamination bedrock | VOC contamination extend deep into bedrock | Direct observation (staining and odor) and measurement (OVA) of soil boreholes samples | Advance boring to maximum depth of contamination (limited to 100 feet) |
| No recoverable groundwater in bedrock | Recoverable groundwater in bedrock | Direct measurement | Retrofit existing probe extracts and injection well with groundwater pump |
| No free-phase solvents in recovered groundwater | Free-phase solvents are present in recovered groundwater | Direct observation | Install phase separator unit |
| Radionuclides not present in stream | Radionuclides present in stream | Analysis of spent HEPA filter media | Retain HEPA filters |
| GAC adsorption cost effective (based on VOC treatment technology) | GAC adsorption not cost effective (based on treatment technology due to high VOC concentrations) | Sampling and analysis of stream | Install clean air intake upstream from pump to reduce VOC concentrations Evaluate feasibility of pretreatment by thermal oxidation |
| All OU2 contaminants from present recovered groundwater condensed (VOC radionuclides including Pu, Am, U, and metal) | All OU2 contaminants from present recovered groundwater and condensate | Sampling and analysis of recovered groundwater and condensate | Use most appropriate RFP treatment system to process recovered groundwater and condensate |
| Groundwater recovery rates ≤ 1 gpm | Groundwater recovery rates > 1 gpm | Direct observation | Use most appropriate RFP treatment system() to process recovered groundwater and assess potential tank truck transport |
| VOC concentrations extracted ≥ 1 ppm (field measurement) | VOC concentrations extracted < 1 ppm (field measurement) | Direct measurement | Abandon proposed test Assess feasibility of conducting alternate test |
| Pilot operation of in situ m-enhanced probe system deemed to be beneficial | Pilot operation of in situ m-enhanced probe system not deemed to be beneficial | Analysis of pilot test data with respect to evaluation criteria (Section 4.3.2) | Post-pilot operation conducted test |

DNAPLs are not expected to accumulate in the alluvial or bedrock wells. There is, however, uncertainty in this expectation, and it is conceivable that accumulation of DNAPLs in the wells may occur. The bedrock wells, for example, may receive DNAPLs from pools perched on the bedrock. The presence of free phase liquid contaminants in ground water extraction wells will be determined by visual inspection of the recovered ground water for an immiscible phase. The contingency to respond to this deviation will involve retrofitting the ground water storage system with a liquid phase separation unit installed between the extraction wells and the storage tank.

Although not expected during vapor extraction system startup, it is conceivable that radionuclide contaminated particulates resulting from disturbed soils along the length of the extraction wells may be entrained into the vapor stream. HEPA filters are included in the vapor treatment process for particulate removal. Filtration protects the GAC against fouling and ensures that radionuclides are not discharged from the system. Spent HEPA filter media will be sampled and analyzed for the presence of radionuclides. If, after several weeks of system operation, analysis of spent filtration media establishes that radionuclide-contaminated particles are not present in the vapor stream, HEPA filtration will be removed from the process, allowing a greater vacuum to be pulled on the subsurface. If analysis indicates the presence of radionuclides, however, HEPA filtration will be retained. In either event, real time radiation monitoring will be conducted.

It is expected that GAC adsorption will provide cost effective recovery of vapor phase VOCs. This is strictly a function of the VOC mass recovery rate observed during the pilot study. Based on the mass recovery rate, the feasibility of stand alone GAC adsorption will be compared to condensation and thermal oxidation. Condensation involves chilling the vapor stream to liquify VOCs. The liquid stream is recovered and sent off site for recycling. Residual VOCs in the vapor stream are removed by GAC adsorption. Thermal oxidation involves immediate destruction of VOCs extracted from the subsurface.

4 3 3 Evaluation of Remedial Approach

4 3 3 1 Effectiveness

The proposed subsurface action at the 903 Pad test site provides an alternative to excavation and disposal of VOC contaminated soils. VOCs recovered by the GAC adsorption units are subsequently thermally desorbed and destroyed at an off site GAC regeneration facility. During the regeneration process a small quantity of ash may be generated which requires land disposal. The action is also expected to generate sludge from treatment of contaminated ground water and condensate at the South Walnut Creek Basin Surface Water Treatment Facility. This sludge may require land disposal and/or on site storage as a hazardous mixed waste. Likewise spent HEPA filtration media may also require land disposal or on site storage as a hazardous mixed waste. However generation of spent HEPA filtration media is expected to be minimal and only during the initial weeks of operation. Management of treatment system residuals according to RFP standard operating procedures will eliminate exposure risks.

Vapor phase recovery is an efficient method for reducing contaminant mobility and volume. By addressing free phase source contamination a reduction in the amount of contaminant available to dissolve into the ground water ultimately results in reduction of the volume of contaminated ground water migrating from the test areas. A reduction in toxicity is also achieved by recovery and destruction of VOCs. Vapor phase recovery may be implemented using relatively simple cost effective and reliable equipment. As discussed in Section 3 there are no ARARs for remediation of subsurface soils. ARARs do exist however for treatment and discharge of any ground water recovered during the IRA. Proposed use of the South Walnut Creek Basin Surface Water Treatment Facility (EG&G 1991f) is expected to achieve ARARs associated with ground water treatment.

4 3 3 2 Implementability

Vacuum enhanced vapor extraction is a technically feasible remedial action for OU2. The simplicity of design, fabrication using commonly available materials, ease of maintenance and potential for cost-effective operation make *in situ* vacuum-enhanced vapor extraction an attractive

remedial technology Vapor extraction is a proven technology that has been successfully applied at many sites In unconsolidated formations vapor extraction has been successfully implemented in both coarse and fine grained material The alluvial material at the proposed test sites is expected to be coarse grained and consist of sand gravel and lesser amounts of silt and clay The bedrock material at the proposed test sites is consolidated and its permeability to air flow has not been quantified Both sandstone and claystone bedrock is expected to have relatively low permeabilities when compared with the alluvium however bedrock permeability is expected to be high enough to permit a measurable vapor flow rate Performance of the proposed systems will be demonstrated by calculating contaminant mass recovery rates based on vapor flows and contaminant concentrations Regeneration services for the GAC adsorption units are readily available and special labor skills are not necessary to construct and operate the vapor extraction and treatment equipment

Factors limiting the success of *in situ* vacuum enhanced vapor extraction at the 903 Pad include low formation permeability and amount of residual free phase contamination in the subsurface A review of existing data suggest that low formation permeability will not be a limiting factor in the alluvium however bedrock permeability may be low Confirmation of source area locations will be critical to the successful implementation of this technology as an interim or final action Should additional data become available during the Phase II RI suggesting a more promising test area interim remedial efforts may be redirected to another site

As noted in Section 4.2 CERCLA evaluation criteria include assessment of a proposed remedial action with respect to public acceptance Several aspects of the proposed Plan should receive favorable public acceptance For example the information collected during the IM/IRA could expedite final remedial efforts at OU2 Moreover conduct of the IM/IRA could achieve some degree of VOC source removal and subsequent destruction of recovered VOCs Potential removal of subsurface VOC contamination without the need to excavate should also be received favorably In addition the proposed vacuum enhanced vapor extraction actions pose a very low probability of spreading subsurface contamination The risk of spreading VOC contamination is small because the soils affected are under negative pressure and the air sweep induced by the vacuum is collected at the extraction wells The risk of spreading subsurface radionuclide contamination is very low because they are non volatile Some public concern may result over

the proposed use of air injection to enhance VOC recovery because of the increased risk of spreading VOC contamination. Proper design of the injection and extraction systems to ensure capture of all injected air minimizes this risk. Another favorable aspect of the Subsurface IM/IRA is the use of the Observational/Streamlined Approach in planning and implementing the IRA in order to maximize data quality and quantity. Finally, use of existing RFP water treatment facilities to treat ground water and condensate should also be viewed favorably.

No permits are required for implementation of the Subsurface IM/IRA. All materials needed to construct and operate the proposed interim remedial system are commonly available. During the installation of extraction wells, approximately 6 cubic yards of drill cuttings (waste soil) will be generated. This material may be classified as hazardous mixed waste. Extracted ground water will be treated at existing RFP facilities. Therefore, administrative feasibility of the proposed interim action appears high.

4.3.3.3 Environmental Impact

Commitment of Resources

The vapor extraction system proposed for the Subsurface IM/IRA at the 903 Pad will not require construction of additional treatment facilities but will require commitment of resources (equipment and material) to install approximately six extraction wells with component HEPA filters, GAC units, water collection systems, and monitoring devices.

Treatment of contaminated subsurface water from OU2 will result in an incremental increase in site pickup and deliveries of spent GAC units and replacement units and chemicals for the pretreatment of water. If the pilot testing phase is successful and the vapor extraction system is expected to operate for a year or more, deliveries will be spread out over the course of the year and will be handled by one of the existing Plant chemical suppliers. The very small number of shipments involved for both the GAC units and the chemical treatment system will result in an insignificant impact to human health.

Off site transportation impacts associated with the shipment of dewatering sludge to a mixed waste disposal site will be very low as determined in DOE (1990b). Relatively low concentrations of contaminants, the physical form of the waste, disposal site acceptance criteria and compliance with DOT packaging and transport requirements all contribute to very low health risks from incident free shipment and accident events.

Transportation Impacts

The proposed subsurface water collection system involves transportation activities during installation and routine operations. Installation transportation activities will primarily involve the movement of equipment for drilling, well installation, material deliveries for installation, and potential off site disposal of excavated soils resulting from drilling. Routine operations will require the transfer of collected water to the South Walnut Creek Basin Treatment System, periodic inspection and maintenance of the pumps and collection systems, and occasional off site shipment of dewatering sludge to a low level mixed waste disposal site. Potential health effects from fugitive dust during installation will have negligible impacts as discussed earlier in this section. Given the limited extent of transportation activities associated with the collection system and the health effect estimates presented in Appendix E, transportation health effects are predicted to be very small. Additional discussion details are provided in Appendix E.

Wetlands

Wetlands areas have been identified near the 903 Pad proposed action site. These wetlands are fed by several seeps that are located in two areas, approximately 1,000 feet to the southeast of the site and approximately 1,200 feet to the north of the site. These seeps typically have flows that fluctuate seasonally and normally remain below 2 gpm. Many of these seeps dry up during periods of low recharge.

Dewatering activities at the 903 Pad are predicted to result in a water extraction rate of 1 gpm or less. Inasmuch as there are no technologies for effectively conducting vapor extraction when ground water is present, removal or collection of the water is a necessity. Ground water extraction is not expected to have a significant impact on nearby wetlands because of the small

expected flow and limited duration (3 years or less) However it is known that there is considerable variation in the water table elevations within OU2 near surface water bearing units Therefore it is possible that dewatering rates may be different than predicted and may have an indirect effect on wetlands The total wetlands area that could be affected by the proposed 903 Pad action is estimated to be less than one fortieth of an acre Suitable habitat exists in the surrounding area to accommodate any temporary wildlife displacement At the conclusion of the IM/IRA ground water flow will return to its previous levels and any temporary wetlands impacts will be naturally mitigated

Water treatment alternatives are considered in Section 4.6 If a treatment alternative is selected its purpose would be to remove contaminants from the water that might reach a drinking water source While it would be possible to reintroduce the treated water at the collection point or at the seeps thus preserving the wetland areas such a program would simply reintroduce clean water into a local ground water system that is contaminated This would contribute to an increased potentiometric surface and thus an increased potential for contaminant migration

Cumulative Impacts

Installation activities will result in increased vehicular traffic engine emissions and the number of workers The number of personnel required for the project will be a small increase to the assumed yearly additional construction loading

It is estimated that two workers will be involved in routine operation and maintenance of the vapor extraction system at the 903 Pad The same workers will also be able to operate and maintain vapor extraction system systems at Mound and the East Trenches This will have negligible impact on the number of Plant personnel In routine operations these workers will not be exposed to any levels of chemicals or waste stream pollutants that would restrict them from other assignments at the RFP

4 4 VACUUM ENHANCED VAPOR RECOVERY AT MOUND (IHSS No. 113)

This section presents a detailed description of the proposed action at the Mound Area. This discussion focuses on the expected test site conditions, proposed treatment systems, and Observational/Streamlined Approach considerations with respect to deviations in expected test site conditions.

4 4 1 Test Site Description

4 4 1 1 Test Site Selection Rationale

The rationale and criteria used for selection of the Subsurface IM/IRA test sites is discussed in Section 4 3 1 1. IHSS No. 113, a former drum storage location at the Mound Area, is the second site proposed for pilot testing *in situ* vacuum-enhanced vapor extraction. Its location within OU2 is shown in Figure 2 2. IHSS No. 113 satisfies all three test site selection criteria as discussed below.

IHSS No. 113 was used to store an estimated 1,405 drums containing primarily depleted uranium and beryllium contaminated lathe coolant (a mixture of 70 percent hydraulic oil and 30 percent carbon tetrachloride). Records do not indicate that the drums were buried (Calkins 1970). Some drums also contained Perclene (Smith 1975). Perclene was a brand name of tetrachloroethylene (Sax and Lewis 1987). Initial remediation of this site was accomplished in May 1970. It is not clear from the literature whether fluid was observed to have leaked from these drums before or during cleanup. However, a release of free phase chlorinated hydrocarbons is inferred from the chemistry of water samples collected from a monitoring well adjacent and hydraulically downgradient of IHSS No. 113 (Well No. 0174 [Figure 2 12]). Water samples collected in May 1987 and 1989 contained 528.0 mg/l and 45.0 mg/l of PCE, respectively. The solubility of PCE at standard temperature and pressure is approximately 160 mg/l, suggesting the presence of free phase PCE near IHSS No. 113. The potential for residual free phase chlorinated solvents at this site, coupled with a lack of evidence for buried drums, makes this site suitable for the Subsurface IM/IRA.

Soil sampling conducted at IHSS No 113 after the May 1970 clean up indicated 0.8 to 112.5 disintegrations per minute per gram (dnm/g) (0.4 to 51 pCi/g) activity. This contamination is thought to have been transported by wind from the 903 Pad Drum Storage Site. Nothing has been found in the literature to suggest the presence of metallic nuclear material buried at IHSS No 113.

4.4.1.2 Expected Conditions

No site specific hydrogeologic or chemical information is currently available for the area within IHSS No 113 boundaries. However, several exploratory boreholes were drilled and monitoring wells constructed near the test site. These data were used to construct a conceptual model of the site hydrogeology and contaminant type and distribution. A geologic log of the borehole drilled for monitoring well 2087 (approximately 20 feet east of IHSS No 113) which is typical of the IHSS No 113 area is presented in Appendix D. An idealized block diagram of the IHSS No 113 test area is presented in Figure 4.8. The diagram illustrates the hydrogeology and contaminant distribution expected to exist within 50 feet of the ground surface.

Sand and gravel alluvium extends to approximately 10 feet below ground surface and overlies claystone bedrock that may contain isolated or interconnected fractures. The alluvium is expected to be dry but may contain a small amount of seasonal ground water perched on the underlying claystone bedrock. The bedrock is not expected to contain recoverable ground water.

It is expected that PCE comprises the majority of the VOC contamination in the IHSS No 113 area with lesser amounts of carbon tetrachloride. A sample of ground water collected from monitoring well 0174 (Figure 2.12) located adjacent to IHSS No 113 contained PCE at a concentration that exceeded its solubility limit. The well screen crosses the alluvial/bedrock boundary suggesting that free phase PCE released at IHSS No 113 infiltrated the alluvium coming to rest on the claystone bedrock. It is likely that a small amount of free phase PCE or an emulsion of PCE and seasonal ground water flowed towards and entered Well 0174. The conceptual diagram shows the residual DNAPL in the alluvium and pools of DNAPL perched on the claystone bedrock with some infiltration of DNAPL along bedrock fractures. A review of existing monitoring well as built diagrams and ground water chemistry (Rockwell 1987a) with respect to the presence of dissolved or residual free phase chlorinated solvents in the

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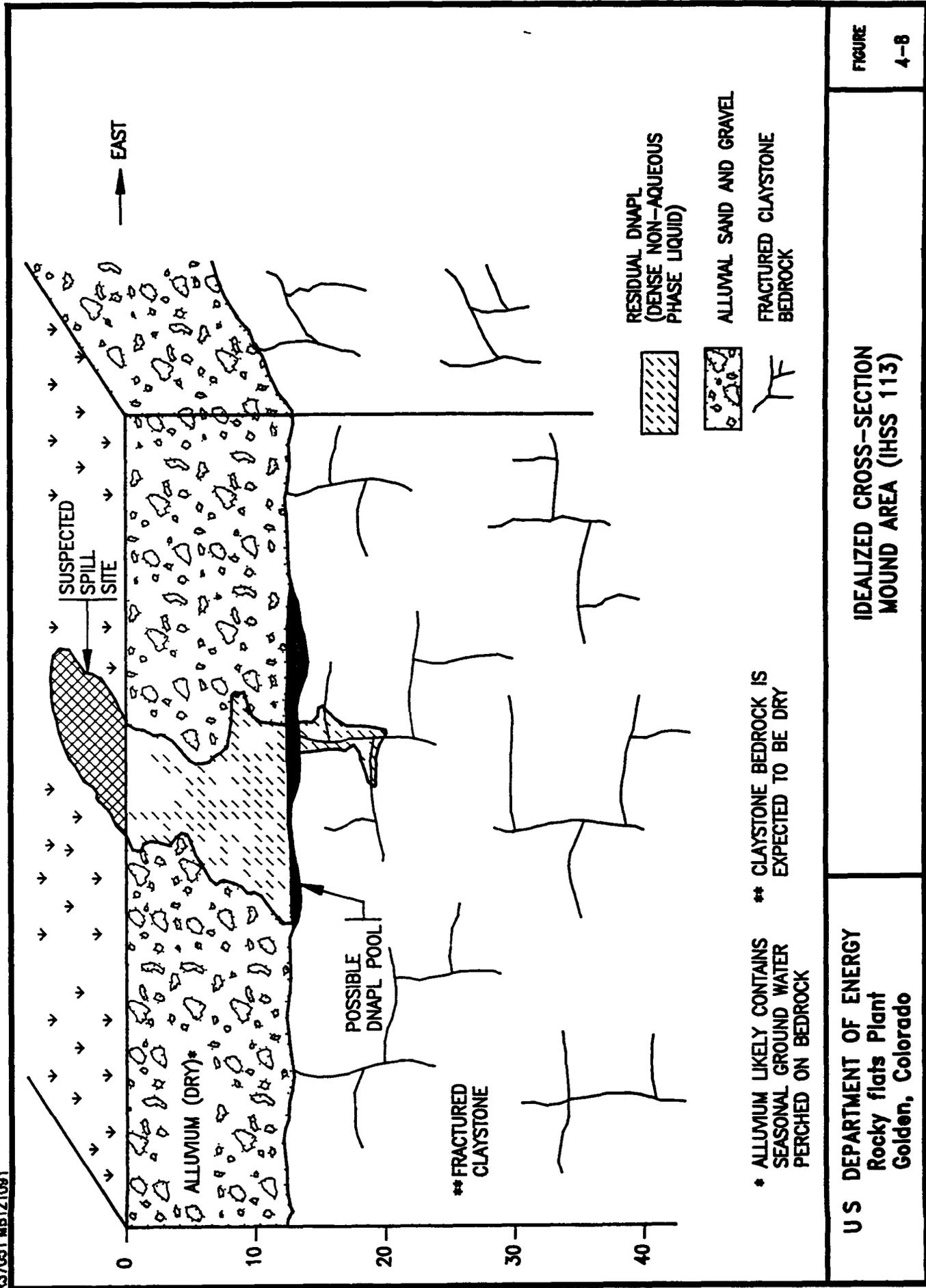


FIGURE 4-8

IDEALIZED CROSS-SECTION MOUND AREA (IHSS 113)

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claystone bedrock near IHSS No 113 was inconclusive. It is important to note that the presence of pools of DNAPL perched on the bedrock is also uncertain and may never be conclusively determined. However, the presence of very high concentrations of PCE in a monitoring well adjacent to IHSS No 113 and in light of the inventory of drum numbers and contents stored at IHSS No 113, it is reasonable to infer the presence of residual free phase chlorinated solvents in the vadose zone. This material may be mobilized during periods of high precipitation when ground water may be perched on the claystone bedrock.

4.4.2 Remedial Approach

4.4.2.1 Proposed Action Based On Expected Conditions

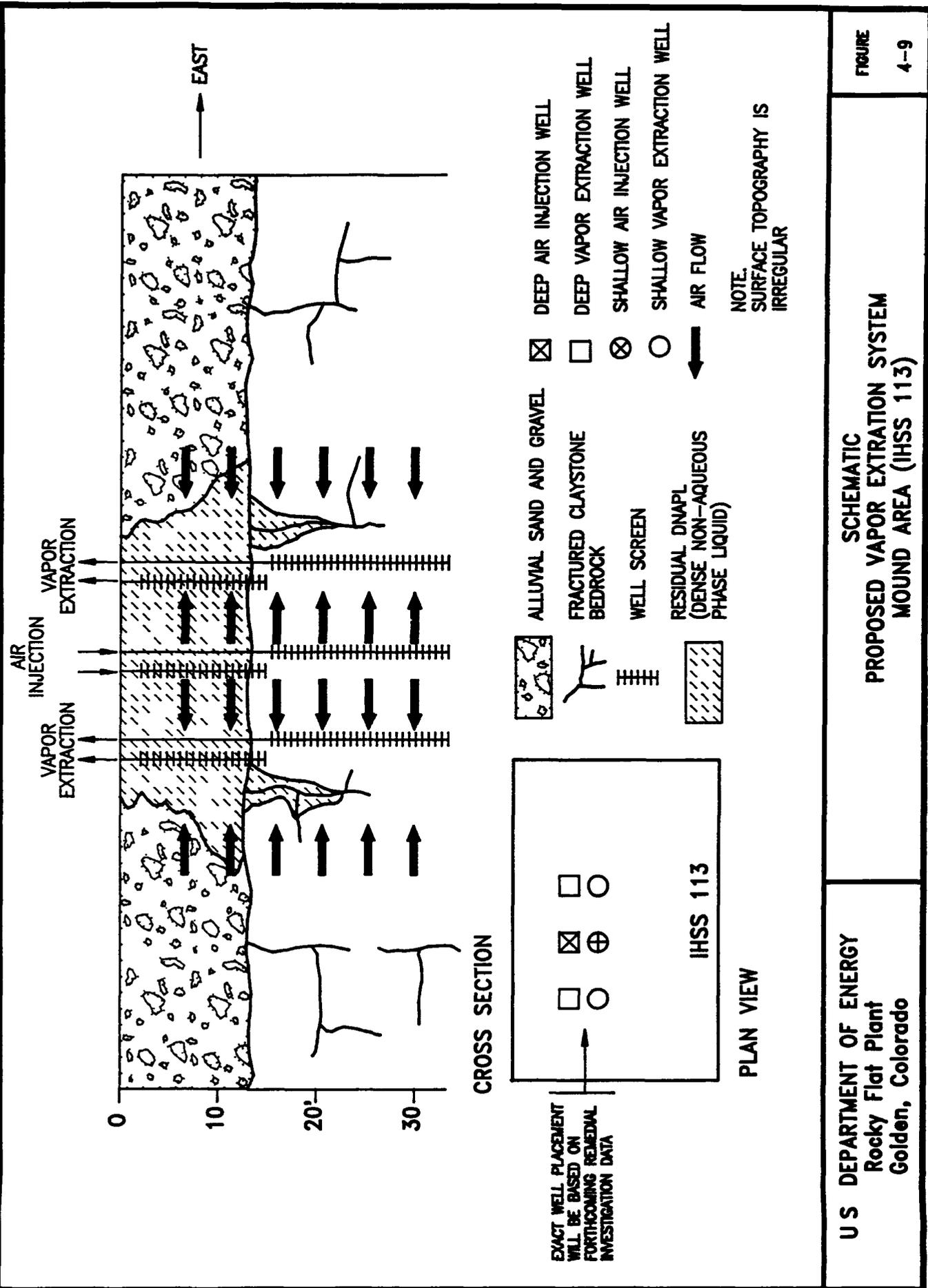
This section provides a detailed description of the interim remedial action proposed for implementation at the Mound Area test site (IHSS No 113). The proposed action is based on the idealized conceptual hydrogeologic and contaminant distribution model described in Section 4.4.1.2 and involves

- *In situ* vacuum enhanced vapor extraction for the alluvial material
- *In situ* vacuum enhanced vapor extraction in the upper portion of the underlying claystone bedrock

Vapor Extraction

Figure 4.9 illustrates the configuration of the vapor recovery system. At IHSS No 113, two vapor extraction wells will be installed in both the alluvium and the upper portion of the claystone bedrock and manifolded to one or more vacuum pump(s). The precise location of the vapor recovery wells has not been determined as there currently is no contaminant concentration data available for the area within IHSS No 113 boundaries. A Phase II RI is currently in progress at OU2 and includes the advancement of soil borings and the construction of ground water monitoring wells within IHSS No 113 boundaries. Prior to implementation of this portion of the IM/IRA, a review of available RI data will be conducted with respect to identified locations of residual chlorinated hydrocarbons. In order to prevent significant short circuiting

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SCHEMATIC
PROPOSED VAPOR EXTRACTION SYSTEM
MOUND AREA (IHSS 113)

FIGURE
4-9

of atmospheric air to the vapor extraction wells the upper 6 feet of the well will be constructed of blank casing Should contamination be observed during drilling in the upper 5 feet of soils the well screen will extend across shallow contaminated soils but no less than 2 feet below the surface In this case an impermeable cover will be installed over the ground surface within 10 feet of the vapor extraction wells

Interim remedial efforts in the alluvium and bedrock will be isolated from each other in order to prevent cross contamination between the two distinct formations Bedrock wells will be isolated from the alluvium by the installation of steel surface casing set into the bedrock Alluvial and bedrock well construction schematics are provided in Figure 4 5 One air injection well will be installed in both the bedrock and alluvium and will be located between the vapor extraction wells These wells will be used to inject ambient and heated air into the formations to evaluate any enhancement to VOC recovery due to the additional flow and heat Ambient and warm air will be injected at a rate equal to one half of the combined extraction rate This is to insure that injected air does not further disperse vapor phase contaminants in the vadose zone Under ideal conditions of isotropy and homogeneity of the alluvial soils or bedrock air flow lines can be expected to form a closed loop between the injection and extraction wells given reasonably close well spacing (<25 feet) Radial pressure distribution equations (Johnson et al 1989) will be used during Test Plan development to insure that negative pressures are maintained at the boundary of the test area Static pressure monitoring wells will be installed at various distances from the well array to verify capture and to determine the area of influence of the vapor extraction system

The conceptual hydrogeologic model illustrated in Figure 4 8 shows some limited penetration of DNAPL into bedrock fractures The lack of conclusive evidence of contaminant migration into bedrock suggests the need for a conservative approach to bedrock remedial efforts For this reason it is proposed to install vapor recovery wells to a maximum of 30 feet into bedrock

Dynamic performance and effectiveness of the *in situ* vapor extraction system at IHSS No 113 will be assessed as described in Section 4 3 2 1

The proposed test site selection was based on qualitative data from the proposed test site and conditions extrapolated from quantitative data collected near the proposed test site. Should the proposed test site prove inadequate, an alternative test site will be selected. The most likely reason for poor site conditions is the absence of residual free phase DNAPL. A preliminary threshold for determining success will be concentrations of hydrocarbon compounds recovered in the soil vapor equal to 1 ppm as measured with a portable photoionization detector calibrated for the major contaminant expected at the test site. The test will be conducted for a minimum of 7 days before abandonment and new site selection. If the recovered vapor contains hydrocarbon concentrations equal to or greater than 1 ppm, the test duration will be decided while the test is in progress. In any case, test duration should not exceed three months.

Vapor Treatment

A discussion of the system proposed to treat vapors extracted from the subsurface at the IHSS No. 113 test site is presented in Section 4.3.2.1.

4.4.2.2 Observational/Streamlined Approach Considerations

A summary of the expected conditions, potential deviations, and contingencies relevant to the proposed action at Mound is presented in Table 4.2. Many of the items presented in Table 4-2 are identical for each proposed OU2 test site. Therefore, this section will address only those items that are unique to the Mound test site. The reader is referred to section 4.3.2.2 for a detailed discussion of the items common to all OU2 test sites.

The Mound test site is unique in that no recoverable ground water is expected in either the alluvium or bedrock. The potential deviation would be the presence of a saturated thickness greater than 3 feet in the alluvium and/or an accumulation of ground water in the bedrock vapor extraction wells. This potential deviation from expected conditions would be identified by direct measurement with an electronic water level indicator. In this event, the existing wells would be retrofitted with ground water recovery pumps. Ground water recovered during pilot testing would be transported by tank truck to the South Walnut Creek Basin Surface Water Treatment Facility for treatment.

**Table 4-2
Observational/Streamlined Approach
In Situ Vacuum Enhanced Vapor Extraction at Mound (IHSS No 113)**

| Expected Conditions | Potential Deviations | Mechanisms to Identify Deviations | Contingency |
|---|--|--|---|
| RI data provides sufficient information to place vapor extraction and injection wells | RI data does not provide sufficient information to place vapor extraction and injection wells | Analysis and interpretation of RI data | Plan and conduct soil vapor survey to provide additional information |
| VOC Contamination limited to upper 30 feet of claystone bedrock | VOC contamination extends deep into bedrock | Direct observation (including a direct odor) and measurement (i.e. OVA) of soil borehole samples | Advance boring to lower limit of contamination or 100 feet total depth |
| Non-recoverable alluvial bedrock groundwater | Recoverable alluvial bedrock groundwater | Direct measurement | Retrofit existing vapor extraction and injection wells with groundwater pumps |
| Non-free phase solvents recovered groundwater (if any) | Free phase solvents present in recovered groundwater (if any) | Direct observation | Install phase separation unit |
| Radionuclide contamination detected present in vapor stream | Radionuclide contamination detected present in vapor stream | Analysis of specific HEPA filter media | Retain HEPA filters. |
| GAC adsorption is cost effective vapor treatment technology (based on VOC concentrations) | GAC adsorption is not cost effective vapor treatment technology due to high VOC concentrations | Sampling and analysis of vapor stream | a. Install clean air intake upstream of vacuum pump to reduce VOC concentrations b. Evaluate feasibility of vapor treatment by thermal oxidation or condensation |
| VOC concentration extracted vapors ≥ 1 ppm (field measurement) | VOC concentration extracted vapors ≥ 1 ppm (field measurements) | Direct measurement | a. Abandon proposed test site b. Assess feasibility of considering an alternative test site |
| Post pilot operation of in situ vacuum enhanced vapor extraction system demonstrated | Post pilot operation of in situ vacuum enhanced vapor extraction system demonstrated | Analysis of pilot test data with respect to evaluation criteria (Section 4.3.2) | Post pilot operation not conducted at test site |

4 4 3 Evaluation of Remedial Approach

4 4 3 1 Effectiveness

Evaluation of the proposed IRA at the Mound Area with respect to CERCLA effectiveness criteria is essentially the same as the effectiveness evaluation presented in Section 4 3 3 1 One difference however is the elimination of treatment system sludge production and associated land disposal since ground water is not expected to be recovered at the Mound Area test site

4 4 3 2 Implementability

Evaluation of the proposed interim remedial action at the Mound Area with respect to CERCLA implementation criteria is the same as the implementability evaluation presented in Section 4 3 3 2

4 4 3 3 Environmental Impact

Commitment of Resources

Commitment of resources for the vapor extraction system proposed for the Subsurface IM/IRA at Mound will be virtually identical to that of the 903 Pad described in Section 4 3 3 3 This level of commitment will be low and will not have a significant impact on RFP operations

Transportation Impacts

Transportation impacts for the Mound vapor extraction system are virtually identical to those described for the 903 Pad in Section 4 3 3 3

Wetlands

Wetlands areas have been identified near the Mound proposed action site These wetlands may be fed by surface seep flow and are located in two areas approximately 1 000 feet to the north

of the site (seeps) and approximately 1 000 feet to the northwest of the site (seeps and South Walnut Creek) These seeps typically have flows that fluctuate seasonally and normally remain below 2 gpm Many of these seeps dry up during periods of low recharge South Walnut Creek flows range from 5 gpm to 60 gpm

Dewatering activities at the Mound are not expected to result in any significant water collection therefore no impact on nearby wetlands is expected However it is known that there is considerable variation in the water table elevations in near surface water bearing units at OU2 Consequently it is possible that dewatering may be necessary at Mound and this may have an indirect effect on nearby wetlands The total wetlands area that could be affected by the proposed Mound action is estimated to be less than one fortieth of an acre Suitable habitat exists in the surrounding area to accommodate any unlikely wildlife displacement At the conclusion of the IM/IRA ground water flow if affected will return to its previous levels and any temporary wetlands impacts will be naturally mitigated

Water treatment alternatives are the same as those described for 903 Pad in Section 4 3 3 3

Cumulative Impacts

Cumulative impacts are expected to be the same as those described for the 903 Pad

4 5 VACUUM ENHANCED VAPOR EXTRACTION AT EAST TRENCHES AREA (IHSS NO 111.1)

This section presents a detailed description of the proposed interim remedial action at the East Trenches Area This discussion focuses on the expected test site conditions proposed treatment systems and Observational/Streamlined Approach considerations with respect to deviations in expected test site conditions

4 5 1 Test Site Description

4 5 1 1 Test Site Selection Rationale

The rationale and criteria used for selection of the subsurface IM/IRA test sites is discussed in Section 4 3 1 1 IHSS No 111 1 (Trench T-4) burial site at the East Trenches Area is the third site proposed for pilot testing *in situ* vacuum enhanced vapor extraction Its location within OU2 is shown on Figure 2 2 IHSS No 111 1 satisfies all three test site selection criteria as discussed below

A review of the literature revealed little specific information about the historical use of IHSS No 111 1 The available information describes waste disposal activities at the East Trenches Area as a whole To summarize the burial trenches in this area were used between 1954 and 1968 for the disposal of sanitary sewage sludge contaminated with uranium and plutonium and approximately 300 flattened empty drums contaminated with uranium (Illsley 1983) However IHSS No 111 1 is not expected to contain flattened drums Figure 2 2 identifies those trenches where drums were observed or detected by magnetometer survey

Based on this description one would not expect to find significant concentrations of chlorinated solvent However a water sample collected in May 1988 from a monitoring well 3687 (Figure 2 13) adjacent to IHSS No 111 1 contained 221 8 mg/l of TCE The solubility of TCE is 1 100 mg/l at standard pressure and temperature The concentration of TCE in the water sample represents a significant fraction of the TCE solubility limit suggesting the possibility of residual free phase TCE near IHSS No 111 1

Although the radiation content of the sewage sludge reportedly ranged from 382 pCi/g to 3 590 pCi/g (Owen and Steward 1973) there are no reports of metallic nuclear material deliberately buried in IHSS No 111 1 The only other material reportedly buried in IHSS No 111 1 is plutonium and uranium contaminated asphalt planking from the solar evaporation ponds (Illsley 1983) The potential presence of residual free phase TCE coupled with a lack of buried drums and metallic nuclear material makes IHSS No 111 1 a suitable test site for this IM/IRA

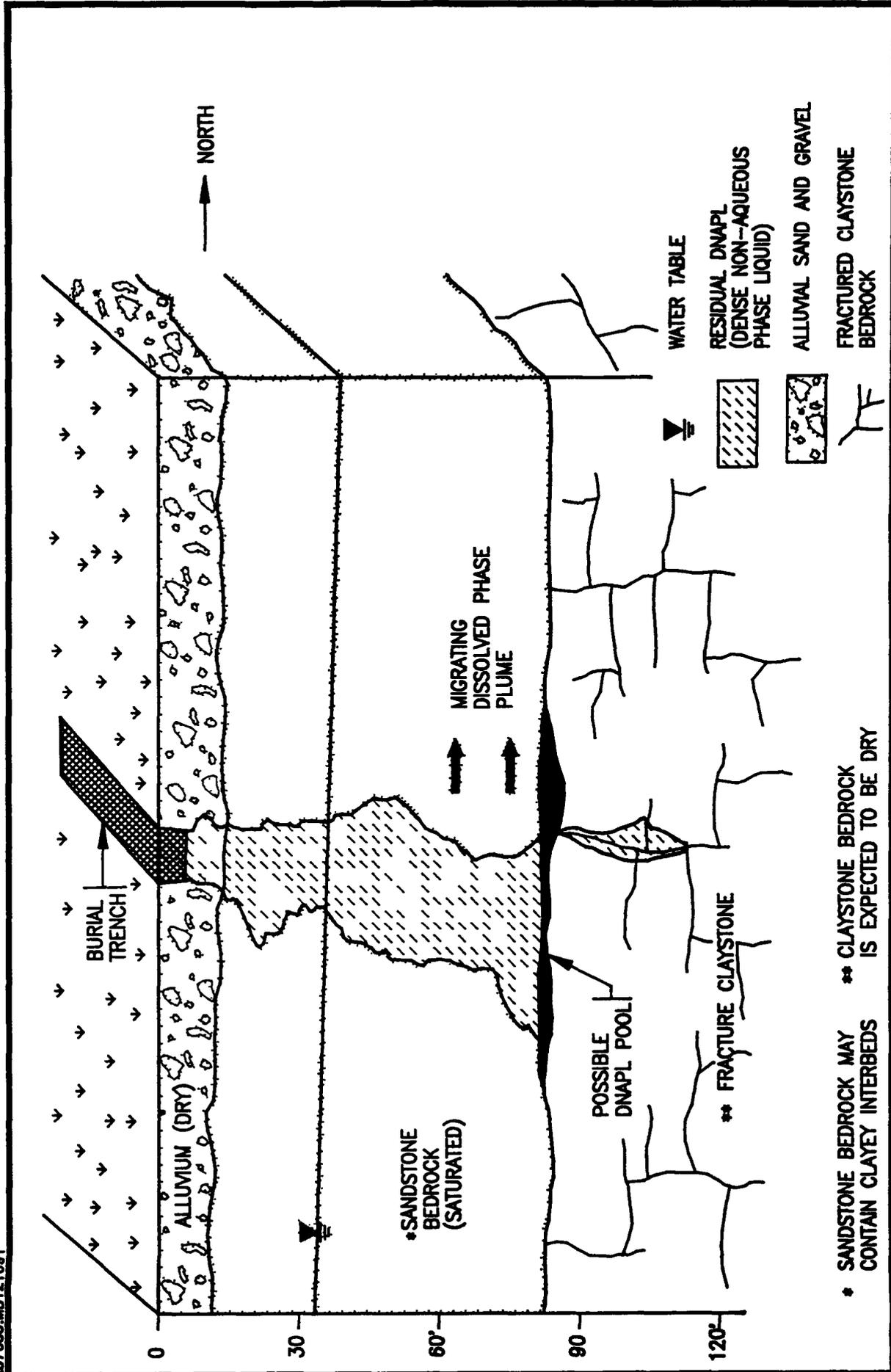
4 5 1 2 Expected Conditions

No exploratory borings have been advanced through IHSS No 111 1 however two borings were advanced approximately 40 feet north of the trench Monitoring wells were constructed in these boreholes (Wells 3587 and 3687) (Figures 2 13 and 2 15 respectively) and geologic water level and chemistry data are available These data were used to construct a conceptual model of the site hydrogeology and contaminant type and distribution A geologic log of a borehole advanced for monitoring well 3687 (typical of the test area) is presented in Appendix D An idealized block diagram of the test area is presented as Figure 4 10 The diagram illustrates the hydrogeology and contaminant type and distribution within 120 feet of the ground surface

Sand and gravel alluvium extends to approximately 10 feet below ground surface and overlies primarily sandstone bedrock At Well 3687 (Figure 2 13) an 11 foot thick interval of sandy claystone was reported directly underlying the alluvium A fine to medium grained sandstone underlies the sandy claystone and extends to at least 75 feet below ground surface The sandstone is underlain by claystone which may contain isolated or interconnected fractures Unconfined ground water is expected to be encountered at 35 feet below ground surface in the sandstone Bedrock geology varies in the area immediately surrounding IHSS No 111 1 Based on geologic logs of nearby soil borings claystone underlies the alluvium south of IHSS No 111 1 and sandstone underlies the alluvium to the west

TCE is expected to be the primary contaminant at this test site A sample of water collected in May 1988 from Monitoring Well 3687 contained 221 8 mg/l which represents 20 percent of the TCE solubility limit This well is screened in the sandstone bedrock The high concentration of TCE within 40 feet of IHSS No 111 1 suggests the presence of residual free phase TCE in the soils and aquifer underlying this burial trench The block diagram (Figure 4 10) shows the downward migration of DNAPL through the unsaturated alluvium and sandstone leaving a zone of residual free phase solvent Because the solvent has a specific gravity greater than 1 0 the solvent is shown migrating downward through the saturated zone coming to rest in structural depressions on the claystone and migrating a short distance along fractures in the claystone The presence of pools of DNAPL on the claystone is by no means

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IDEALIZED CROSS-SECTION
EAST TRENCHES (IHSS 1111)

FIGURE
4-10

certain Well cemented zones within the sandstone may have stopped its migration or the capacity of the sediments overlying the claystone to absorb DNAPL may exceed the volume of DNAPL released from the trench It is important to note that residual DNAPL and/or pools of DNAPL have not been observed at IHSS No 111 1 or at OU2 in general However it is reasonable to infer its presence by extrapolating from nearby ground water chemistry physical properties of the contaminants and historical activities at OU2

4 5 2 Remedial Approach

4 5 2 1 Proposed Action Based On Expected Conditions

The section provides a detailed description of the interim remedial action proposed for implementation at the East Trenches test site (IHSS No 111 1) The proposed action is based on idealized conceptual hydrogeologic and contaminant distribution model described in Section 4 4 1 2 and involves

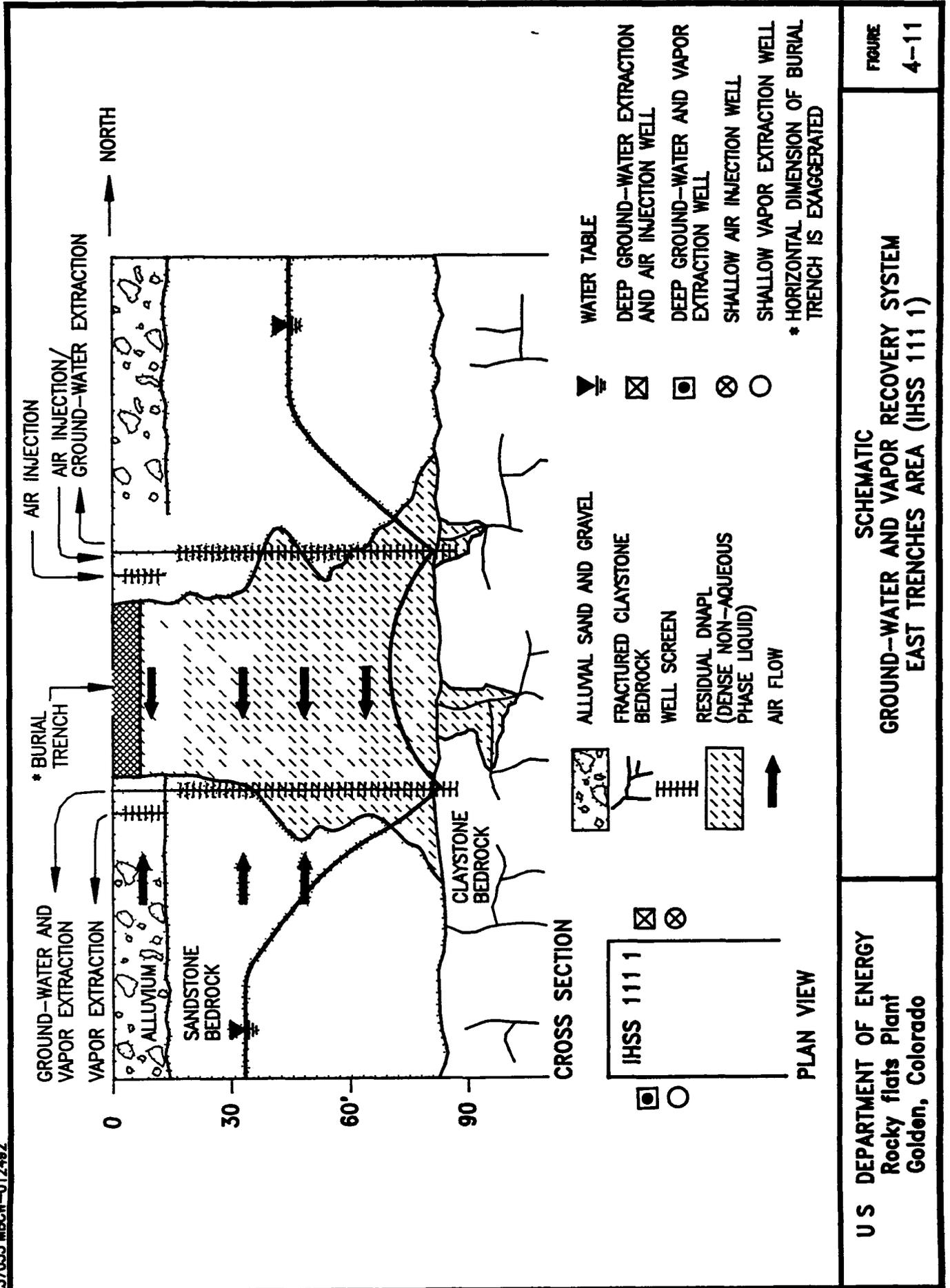
- *In situ* vacuum enhanced vapor extraction for the alluvial material
- *In situ* vacuum enhanced vapor extraction coupled with ground water depression in the sandstone bedrock

Vapor and Ground Water Extraction

The claystone will not be addressed in this action The depth to claystone at the test site is many times deeper than at other proposed OU2 test sites Therefore it is less likely that recoverable contamination has penetrated to claystone Figure 4 11 illustrates the configuration of the vapor recovery system in cross section and plan view

Two vapor extraction wells will be installed in both the alluvium and the sandstone bedrock One pair of alluvial and bedrock wells will be installed on either side of the burial trench Because materials were buried in the trench and historical records of material type and quality may be inaccurate it was believed appropriate to avoid drilling through the trench itself The Phase II RI that is currently in progress at OU2 includes the advancement of two soil borings

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within IHSS No 111 1 Prior to implementation of this portion of the IM/IRA a review of available RI data will be conducted with respect to the presence of residual DNAPL or buried drums at this location

Remedial efforts in the alluvium and sandstone will be isolated from each other in order to prevent cross contamination between the two distinct formations Sandstone wells will be isolated from the alluvium by the installation of steel surface casing set in sandstone Alluvial and sandstone well construction schematics are presented as Figure 4 5 One alluvial well will be used for vapor extraction and the second well installed on the opposite side of the trench will be used as an ambient or heated air injection well to induce an air sweep under the trench Both sandstone wells will be fitted with ground water depression pumps in order to expose any residual DNAPL held in the sandstone by capillary forces One sandstone well will be manifolded to a vacuum pump The second well installed on the opposite side of the trench will be used to inject ambient and heated air to induce an air sweep through the test site For reasons discussed in Section 4 3 2 1 bedrock wells will extend several feet into the claystone bedrock This is to allow for the collection and recovery of free phase DNAPL should it be encountered at the sandstone/claystone interface

The proposed test site selection was based on qualitative data from the proposed test site and conditions extrapolated from quantitative data collected near the proposed test site Should the proposed test site prove inadequate an alternative test site will be selected The most likely reason for poor site conditions is the absence of residual free phase DNAPL A preliminary threshold for determining success will be concentrations of hydrocarbon compounds recovered in the soil vapor equal to 1 ppm as measured with a portable photoionization detector calibrated for the major contaminant expected at the test site The test will be conducted for a minimum of seven days before abandonment and new site selection If the recovered vapor contains hydrocarbon concentrations equal to or greater than 1 ppm the test duration will be decided while the test is in progress In any case test duration will not exceed three months

Vapor and Ground Water Treatment

A discussion of the systems proposed for treatment of vapors and ground water extracted from the subsurface at the IHSS No 111 1 test site are presented in Section 4 3 2 1

4 5 2 2 Observational/Streamlined Approach Considerations

A summary of the expected conditions potential deviations and contingencies relevant to the proposed action at East Trenches is presented in Table 4-3 Many of the items presented in Table 4 3 are identical for each proposed OU2 test site Therefore this section will address only those items which are unique to the Mound test site The reader is referred to Section 4 3 2 2 for a detailed discussion of the items common to all OU2 test sites

The East Trenches test site is unique in that ground water is expected to be present in sandstone bedrock within 35 feet of the surface However available data suggest considerable variability in bedrock geology near the test site Therefore a potential deviation from expected conditions would be the presence of claystone or interbedded sandstone and claystone under the proposed test site This condition may result in a lack of recoverable ground water The mechanism to identify this deviation would include visual observation of soil samples recovered during drilling and by establishing the presence or absence of water in the extraction wells using an electronic water level indicator The contingency would involve abandoning the ground water pumping effort and performing a vacuum enhanced vapor recovery action similar to that proposed for the Mound Area test site

4 5 3 Evaluation of Remedial Approach

4 5 3 1 Effectiveness

Evaluation of the proposed interim remedial action at the East Trenches Area with respect to CERCLA effectiveness criteria is the same as the effectiveness evaluation presented in Section 4 3 3 1

**Table 4-3
Observational/Streamlined Approach
In Situ Vacuum Enhanced Vapor Extraction at East Trenches (IHSS 111 1)**

| Expected Conditions | Potential Deviations | Mechanisms to Identify Deviations | Contingency |
|---|---|---|---|
| RI data provides sufficient information to place vapor extraction and injection wells | RI data does not provide sufficient information to place vapor extraction and injection wells | Analysis and interpretation of RI data. | Plan and conduct soil vapor survey to provide additional information |
| No recoverable alluvial groundwater | Saturated thickness greater than 3 feet | Direct measurement | Retrofit existing alluvial wells with ground water pumps |
| No free phase solvents in recovered groundwater (bedrock alluvium) | Free phase solvents are present in recovered groundwater | Direct observation | Install phase separation unit |
| Saturated depth constant within 60 feet of the surface | No groundwater within 60 feet of the surface | Direct observation of recovered soil samples during drilling and measurement of water level in completed well | Eliminate groundwater depression portion of proposed action |
| Radionuclide-contaminated particulates present in vapor stream | Radionuclide-contaminated particulates present in vapor stream | Analysis of specific HEPA filter media. | Retain HEPA filters |
| GAC adsorption is cost effective vapor treatment technology (based on VOC treatment) | GAC adsorption is not a cost effective vapor treatment technology due to high VOC concentrations | Sampling and analysis of vapor stream | a. Install clean air intake downstream of vacuum pump to reduce VOC concentrations b. Evaluate feasibility of vapor treatment by thermal oxidation or condensation |
| All OU2 contaminants of concern present in recovered groundwater and condensate (VOCs, radionuclides, inorganic P, Am, U, d metals) | All OU2 contaminants of concern present in recovered groundwater and condensate | Sampling and analysis of recovered groundwater and condensate | Use most appropriate RFP treatment system to process recovered groundwater and condensate |
| Groundwater recovery rates ≤ 1 gpm | Groundwater recovery rates > 1 gpm | Direct observation | Use most appropriate RFP treatment system(s) to process recovered groundwater and assess pipeline vs tank truck transport |
| VOC concentration in extracted vapors ≥ 1 ppm (field measurement) | VOC concentration in extracted vapors < 1 ppm (field measurements) | Direct measurement. | a. Abandon proposed test site b. Assess feasibility of considering an alternative test site |
| Post pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is determined to be beneficial | Post pilot operation of <i>in situ</i> vacuum-enhanced vapor extraction system is not determined to be beneficial | Analysis of pilot test data with respect to valuation criteria (Section 4.3.2) | Post pilot operation not conducted at test site |

4 5 3 2 Implementability

Evaluation of the proposed interim remedial action at the East Trenches Area with respect to CERCLA implementation criteria is the same as the implementability evaluation presented in Section 4 3 3 2

4 5 3 3 Environmental Impact

Commitment of Resources

Commitment of resources for the East Trenches vapor extraction system will be very low and virtually the same as that described in Section 4 3 3 3 for the 903 Pad

Transportation Impacts

These will be similar to the 903 Pad vapor extraction system impacts. Given the limited extent of transportation activities associated with the collection system and the health effect estimates presented in Appendix E, transportation health effects are predicted to be very small. Additional discussion details are provided in Appendix E.

Wetlands

Wetlands areas have been identified near the East Trenches proposed action site. These wetlands are associated with South Walnut Creek and Pond B 1 that are located approximately 800 feet to the north of the site. South Walnut Creek has flows which fluctuate seasonally, ranging from 5 to 60 gpm.

Dewatering activities at the East Trenches are predicted to result in a water collection rate of 1 gpm or less. Inasmuch as there are no technologies for effectively conducting vapor extraction when ground water is present, removal or collection of the water is a necessity. This is not expected to have a significant impact on nearby wetlands because of the small expected flow and the limited duration (3 years or less). However, it is known that there is considerable variation

in the water table elevations in near surface water bearing units at OU2. Therefore it is possible that dewatering rates may be different than predicted and may have an indirect effect on wetlands.

The total wetlands area that could be affected by the proposed East Trenches action is estimated to be less than one twentieth of an acre. Suitable habitat exists in the surrounding area to accommodate any temporary wildlife displacement. At the conclusion of the IM/IRA ground water flow will return to its previous levels and any temporary wetlands impacts will be naturally mitigated.

Cumulative Impacts

Cumulative impacts of the vapor extraction system at the East Trenches will be the same as for the 903 Pad described in Section 4.3.3.3.

4.6 DESCRIPTION OF ALTERNATIVE WATER TREATMENT FACILITIES

The Subsurface IM/IRA considers the use of existing or planned RFP water treatment facilities for treatment of contaminated ground water and condensate associated with operation of the proposed vapor extraction systems at the 903 Pad Mound and East Trenches Areas. The final selection of the RFP treatment system(s) that will be used to support the Subsurface IM/IRA will be based on the actual contamination observed in the recovered ground water and the results of performance testing each of the treatment systems. However for the reasons discussed in Section 4.3.2.1 the DOE wishes to retain the South Walnut Creek Basin Surface Water Treatment System as the preferred system at this time. Modifications to this initial strategy may be made as part of the observational/streamlined approach (see Tables 4.1 and 4.3 regarding ground water treatment).

This section describes each of the RFP treatment facilities with respect to operation contaminant removal capabilities and available processing capacity. The RFP water treatment facilities include

- South Walnut Creek Basin Surface Water Treatment System
- 881 Hillside Ground Water Treatment System
- Building 231B GAC Adsorption System/Building 374 Evaporation System

4.6.1 South Walnut Creek Basin Surface Water Treatment System

The South Walnut Creek Basin Surface Water Treatment System is being constructed as part of an IM/IRA at OU2 (EG&G 1991f). The system includes chemical precipitation/microfiltration and GAC adsorption units for removal of radionuclides, metals, and VOCs from surface water. Installation of the GAC adsorption portion of this treatment facility has been completed and operation began on 13 May 1991. Installation of the chemical precipitation and microfiltration units was completed on 24 April 1992 and system startup occurred on 27 April 1992.

The South Walnut Creek Basin Surface Water Treatment System is illustrated in Figure 4.12. Chemical treatment involves addition of iron salts and lime to cause coagulation and flocculation of suspended particulates present in the wastewater to produce a filterable ferric hydroxide precipitate or floc. Since the predominant state of radionuclide and metal contaminants in natural waters is particulate, these inorganic contaminants will be removed through enmeshment in the ferric hydroxide floc (EG&G 1991f). Removal of radionuclides and metals existing in a soluble state may also be achieved during chemical treatment by adsorption to the floc. The floc will be removed from the process stream by cross flow membrane filtration. The membrane filter is in a shell and tube configuration with the membrane located on the inside of the tubes. Water is pumped through the filter tubes and water passes through the membrane (i.e., permeate) under the force of the process operating pressure. The filters are designed so that clean water will pass through the membrane in a direction perpendicular to the main process flow (i.e., cross flow filtration). Flow not passing through the membrane will be recycled to the concentration tank. A fraction of the recycle slurry will be bled from the process for solids

removal by gravity separation and pressure filtration. The filter press cake is expected to be approximately 30 percent solids by weight and will be stabilized with the addition of portland cement. The cross flow filter permeate will be neutralized by the addition of sulfuric acid and will be further processed by GAC adsorption units for removal of VOCs as described below. Figure 4.12 shows that the GAC Adsorption Treatment System for the South Walnut Creek Basin surface water treatment system consists of two on line GAC units and two on line standby GAC units. Each GAC unit is 60 inches high and 87 inches in diameter and contains 2,000 pounds of GAC. The on line units are operated in series (i.e. lead and polishing positions). Once the GAC in the lead unit is determined to be spent, it is taken out of service. The GAC unit in the on line polishing position becomes the new lead unit and one of the on line standby units is placed in the on line polishing position. Rotation of the GAC units into the lead, polishing, and standby positions is accomplished by changing the open/closed configuration of the process valves. Physical movement of unspent GAC units is not necessary during this procedure. The spent GAC is replaced with a new unit containing virgin GAC. The newly installed unit is immediately placed in the on line standby mode. Spent GAC will be analyzed for the presence of radionuclides and for toxicity by the EPA Toxicity Characteristic Leaching Procedure (TCLP). Results of these analytical tests will determine if spent GAC from this process may be regenerated or must be managed as a hazardous mixed waste. As of this writing, the process has not yet generated spent GAC.

The South Walnut Creek Basin Surface Water Treatment System was designed to continuously process surface water influent at a rate of 60 gpm. This flow rate corresponds to the design flows established for the South Walnut Creek Basin IM/IRA surface water collection systems. However, design flows are maximum anticipated surface water flows for the collection systems and influent flows from the South Walnut Creek Basin sources will, on the average, be substantially less than 60 gpm. For example, GAC Adsorption System operating data for May and June 1991, two relatively high precipitation months, indicate that on the average the South Walnut Creek Basin sources have produced less than 50 percent of collection system design flows. The unused processing capacity could be used to treat ground water and condensate generated by the Subsurface IM/IRA.

4 6 2 881 Hillside Ground Water Treatment System

The 881 Hillside Ground Water Treatment System is currently being installed under the ground water IM/IRA for OUI. The system was designed to treat ground water recovered at the 881 Hillside Area. The rate of ground water recovery is expected to be approximately 5 to 10 gpm and the ground water contaminants of concern include VOCs, metals, and uranium. The treatment process operating plan includes treatment of collected ground water at the process design rate of 30 gpm during one 8 hour shift per day. The equipment remains idle throughout the remaining two shifts. Ground water and condensate generated by the Subsurface IM/IRA therefore be treated during one of the remaining 8 hour shifts.

Figure 4 13 shows that the design of the 881 Hillside Ground Water Treatment System includes UV/ peroxide and ion exchange unit operations. A pumped feed system will be used to inject a 50 percent hydrogen peroxide solution into the wastewater influent line. The surface water/hydrogen peroxide mixture will then pass through an in line static mixer before entering the UV oxidation reactor. In the reactor, the mixture is exposed to UV light where VOCs are oxidized to carbon dioxide and water.

The effluent from the UV oxidation reactor will then be pumped through fabric filtration units to remove any suspended solids that may be present in the processing stream. Dissolved uranium and metal contaminants will then be removed by the anion and cation exchange units respectively. Regeneration of the anion exchange resin will not be required because of the high affinity and capacity of the resin for uranium. The expected life of the anion exchange units is greater than 30 years at the expected influent flows and uranium concentrations. Although other anions (e.g., chlorides, sulfates) will initially be adsorbed to the resin, the preferential adsorption of uranium will result in displacement of the other anions. The spent resin will ultimately require solidification and disposal as a low level hazardous waste. The cation exchange resin has a high affinity for high molecular weight metals (e.g., mercury, copper, lead). It is assumed that unlike the anion exchanger, the cation exchange resin will require regeneration. Effluent from the ion exchange column train is stored in holding tanks pending laboratory analysis results. Upon verification that contaminants have been removed to achieve the effluent standards established for the facility, the treated water is discharged to the SID.

4 6 3 Building 231B GAC Adsorption System/Building 374 Evaporation System

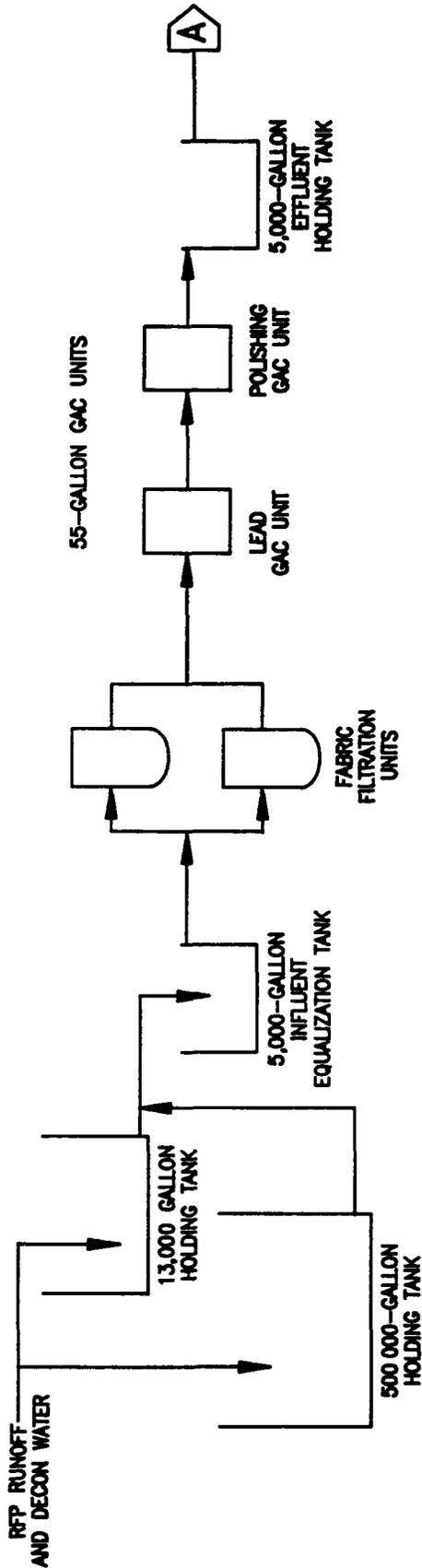
A final alternative for treatment of ground water and condensate generated by the Subsurface IM/IRA is the use of the planned Building 231B GAC Adsorption System and the existing Building 374 Evaporation System. These treatment system configurations are illustrated in Figure 4 14 and are described below in detail.

The GAC adsorption system illustrated in Figure 4 14 is planned for construction and start up near Building 231B by the end of 1992. This facility is being installed to provide VOC treatment for decontamination wastewater generated at the RFP (e.g. drill rig decontamination). Current treatment system design includes installation of a 13 000-gallon wastewater holding tank and a 5 000 gallon influent equalization tank. The 500 000 gallon wastewater holding tank shown in Figure 4 14 currently exists but is not in use. Operating plans for the 231B GAC Adsorption System include use of this storage tank for additional influent storage capacity when required. Treatment system design includes at least two fabric filtration units configured in parallel. The parallel configuration allows water to be treated with one filter on line while filtration media in the other filter is being replaced. Due to the relatively small quantities of decontamination wastewater generated annually (approximately 500 000 gallons) treatment system design includes disposable GAC units. The process will include two 55 gallon GAC units in a lead/polisher arrangement. Each 55 gallon unit is 36 inches high and 22 inches in diameter and contains approximately 165 pounds of GAC. The maximum rated flow capacity through each unit is 10 gpm. Although the fabric filtration units will remove the majority of the suspended solids from the process influent, small particulates will pass through to the GAC units. It is therefore expected that the GAC units will be contaminated with particulate radionuclides and thus require disposal as a hazardous mixed waste. The treatment system includes a 5 000 gallon effluent storage tank to temporarily hold processed water prior to transport to Building 374.

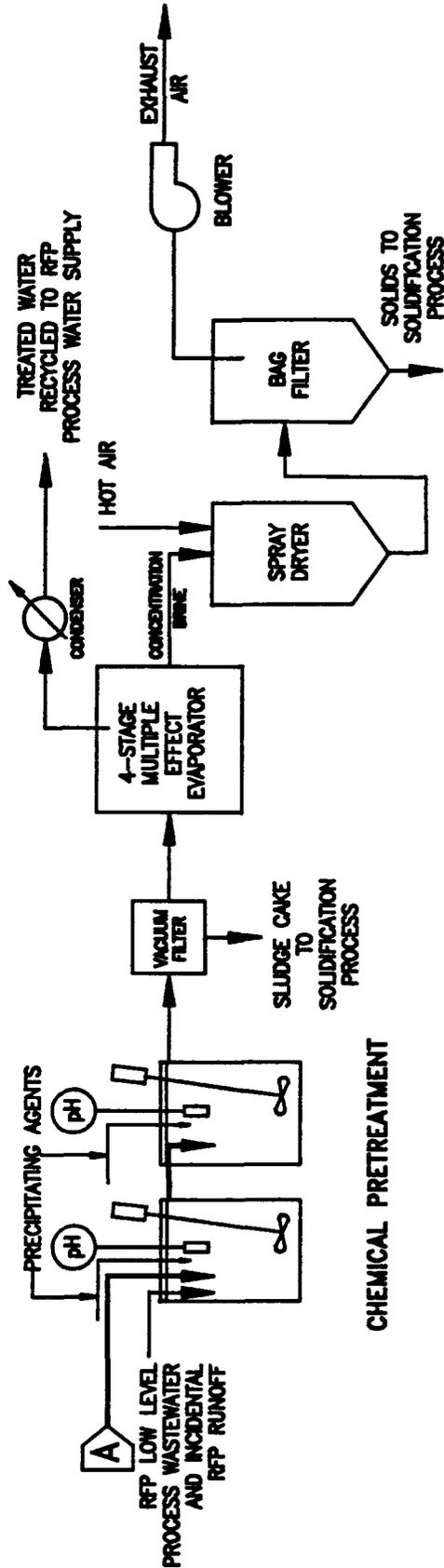
The plan of operation for the Building 231B GAC Adsorption Treatment System includes tank truck transport of decontamination wastewater to the facility, batch processing of approximately 10 000 gallons per week at a flow rate of approximately 7 gpm, and tank truck transport of the treated effluent to the Building 374 Low Level Wastewater Treatment System. The one way

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BUILDING 231B TREATMENT SYSTEM



BUILDING 374 TREATMENT SYSTEM



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

SUBSURFACE IM/IRA
BUILDING 231B GAC SYSTEM (PLANNED)/
BUILDING 374 LOW-LEVEL WASTE TREATMENT SYSTEM

FIGURE
4 14

travel distance between Building 231B and Building 374 is approximately 1 mile via 7th Street Central Avenue PA Portal #1 and west on Patrol Road

The Building 374 Low Level Wastewater Treatment System (Figure 4-14) processes approximately 12 to 15 million gallons per year of low level wastewater (i.e. < 13 500 Pci/l of radioactivity) Influent sources for this system include RFP process wastewater and incidental RFP surface waters (i.e. site runoff) The treatment system includes chemical precipitation vacuum filtration and evaporation unit operations Chemical treatment involves addition of iron salts and lime to cause coagulation and flocculation of suspended particulates present in the wastewater to produce a filterable precipitate or floc Radionuclide and metals contaminants present in the wastewater stream in a particulate state tend to become enmeshed in the floc as discussed in Section 4.6.1 The floc is then removed from the process stream by vacuum filtration The filter cake produced is approximately 30 percent solids by weight and is stabilized with the addition of portland cement The inorganic contaminants in the filtered process stream are then concentrated by a four stage multiple effect evaporator Evaporator vapors which are free of inorganic contaminants are condensed and recycled to the RFP process water supply The brine concentrate is processed by a spray dryer to evaporate the remaining liquid The resulting byproduct solids (i.e. salts) are removed from the process by a bag filter unit and subsequently solidified with the addition of portland cement The volume of solidified waste or saltcrete from this action represents a small fraction of RFP's annual production of this type of waste Storage and disposal plans for such waste were discussed in the environmental assessment for the partial closure action at the solar ponds (DOE 1991c) for which a finding of no significant impact was issued Because of the relatively low concentrations of the contaminants the solid form of the waste the protectiveness of the packaging and the compliance with applicable RCRA requirements storing these materials at the RFP or other DOE location pending disposal would not materially change the impacts assessed for this action

The treatment technologies that comprise the Building 231B GAC Adsorption System and the Building 374 Low Level Wastewater Treatment System (GAC adsorption chemical precipitation/vacuum filtration and evaporation) are well suited for removal of VOCs radionuclides and metals that may be present in the Subsurface IM/IRA ground water and

condensate In addition extra processing capacity currently exists at both facilities Although the Building 374 treatment facility often operates at its maximum capacity influent storage at Building 231B and batch processing of collected ground water and condensate allow use of the facility during off peak periods

4 7 ENVIRONMENTAL EVALUATION OF NO ACTION

4 7 1 Air Quality Impacts

The No Action Alternative will not further impact the existing air quality as discussed in the RFP Final Environmental Impact Statement 1980 (DOE 1980)

4 7 2 Water Quality Impacts

The No Action Alternative would not contain or remove radionuclides VOCs or metals from the subsurface at OU2 As a result the No Action Alternative would pose a long term release risk to the general public However short term risks associated with the No Action Alternative are insignificant because contaminated ground water is contained well within the RFP boundary and surface water discharges from the RFP are monitored and treated if necessary in accordance with the Plant s NPDES permit The No Action Alternative would require that the current quarterly site monitoring be continued

4 7 3 Terrestrial and Aquatic Impacts

The No Action Alternative will not involve any short term impacts to terrestrial and aquatic biota

4 7 4 Wetlands and Floodplains

The No Action Alternative will not involve any short term impacts to wetlands and floodplains

4 7 5 Threatened and Endangered Species

The No Action Alternative will not impact threatened and endangered species

4 7 6 Cultural Resources

The No Action Alternative will not impact cultural resources as no sites at the RFP have potential eligibility for the National Register of Historic Places (EG&G 1991a)

4 7 7 Short Term Uses and Long Term Productivity

Land within OU2 is currently undeveloped and will remain so as part of the RFP for the foreseeable future OU2 lies within the RFP security boundaries and is not accessible to the general public Therefore the No Action Alternative will have no effect on the short term uses and long term productivity of lands at OU2

4 7 8 Personnel Exposures

The No Action Alternative will have minimal impact on current workers involved at OU2 or at adjacent RFP sites Workers will continue to monitor ground water quarterly which would not present any additional impacts Because the sources of hazardous wastes would neither be removed nor controlled the possibility of contaminated ground water migrating off site would increase over time This could then become a source for public exposure in the long term

4 7 9 Commitment of Resources

The No Action Alternative will not require any additional commitment of resources

4 7 10 Transportation Impacts

The No Action Alternative will not require construction or transport of materials Therefore will be no additional on site or off site transportation activities

4 7 11 Cumulative Impacts

Because there are no additional remedial activities associated with the No Action Alternative there are no cumulative impacts relating to the environmental criteria identifiers in Sections 4 7 1 through 4 7 10

4 8 COMPARISON OF ENVIRONMENTAL EFFECTS OF RFP IM/IRAs

Table 4 4 compares the environmental impacts of the proposed Subsurface IM/IRA at OU2 with other IM/IRAs currently being implemented at RFP There are no environmental impacts associated with the No Action Alternative with respect to subsurface VOC contamination at OU2 as indicated in Table 4-4 This is consistent with the absence of any threat posed by the subsurface VOC contamination at OU2 (Section 1) Impacts in all categories from the proposed action (environmental long term public exposure worker exposure off site and on site transportation) are not expected to be significant

Table 4-4

Cumulative Impacts of Interim Remedial Actions at Rocky Flats Plant

| Impact Category | No Action Alternative | 881 Hillside Ground-Water IM/IRA at OU1 UV Peroxide Oxidation/Ion Exchange | South Walnut Creek Basin Surface Water IM/IRA at OU2 Chemical Precipitation/Microfiltration and GAC Adsorption System | Subsurface IM/IRA at OU2 Vapor Extraction System | Cumulative Impacts |
|---|-----------------------|--|---|--|--|
| Environmental Impacts Aquatic Impacts Threatened and Endangered Species Historic and Archeological Sites Short and Long Term Land Productivity Wetland and Floodplain Excavation Well Drilling | None | None | None | None | None |
| | None | None | None | None | None |
| | None | None | None | None | None |
| | None | None | None | None | None |
| | None None None | None 10 300 yd ³ None | Minimal None None | Minimal 15 yd ³ 6 yd ³ | Minimal 10 315 yd ³ 6 yd ³ |
| Long Term Considerations Interim Removal Action VOC Contamination Removal VOC Contaminant Destruction Inorganic Contaminant Removal | No | Approximately 30 years Yes Yes Yes | Approximately 30 years Yes Yes Yes | 30 years* Yes Yes No | N/A N/A N/A N/A |
| | No | Yes | Yes | Yes | Yes |
| | No | Yes | Yes | Yes | Yes |
| Exposure to General Public Construction Routine Accident | No | Yes No No | No No No | No No No | Yes No No |
| | No | No | No | No | No |
| | No | No | No | No | No |

Table 4-4 (Continued)

Cumulative Impacts of Interim Remedial Actions at Rocky Flats Plant

| Impact Category | No Action Alternative | 881 Hillside Ground Water IM/IRA at OU1 UV Peroxide Oxidation/Ion Exchange | South Walnut Creek Basin Surface Water IM/IRA at OU2 Chemical Precipitation/Microfiltration and GAC Adsorption System | Subsurface IM/IRA at OU2 Vapor Extraction System | Cumulative Impacts |
|---|-----------------------|---|--|---|--------------------|
| Exposure to Workers Construction Routine Accident | No | Negligible | Yes | Minimal | Yes |
| | No | Negligible | Minimal | Minimal | Minimal |
| | No | Yes | Yes | Minimal | Yes |
| Off-Site Transportation Construction (truckloads) Operation (loads/year) Contaminated Materials (truckloads) | None | <10 | <5 | <5 | <18 |
| | None | <5 | <5 | <5 | <20 |
| | None | Not Determined | Not Determined | 1 ^b | Not Determined |
| On-Site Transportation Construction (truckloads) Operation (loads/year) | None | <20 | <10 | <3 | <35 |
| | None | <10 | <10 | <365 | <400 |

Assuming 3 years a IM/IRA
S lid feed filter at & sp at GAC

SECTION 5 IMPLEMENTATION PLAN

This section presents the implementation plan for conduct of the Subsurface IM/IRA. Implementation involves the preparation of a Test Plan for each of the three pilot tests proposed in the IM/IRAP/EA. The Test Plans will provide all the engineering designs, performance specifications, and procedures necessary for well installation and fabrication of the vapor extraction and treatment unit. The Test Plans will also provide the necessary procedures and guidance to successfully execute the pilot tests. Following completion of each pilot study, a Test Report will be prepared summarizing the test data. Recommendations for post pilot study operation of the *in situ* vacuum-enhanced vapor extraction system will also be presented in each Test Report based on evaluations of the test data. Sections 5.1 and 5.2 discuss the elements of the Pilot Test Plans and Test Report, respectively.

5.1 PILOT STUDY TEST PLANS

Test Plans will be prepared to provide comprehensive and detailed guidance for conduct of the Subsurface IM/IRA pilot studies at OU 2. A Test Plan will be prepared for each of the three pilot studies (i.e., 903 Pad, Mound, and East Trenches). Although the Test Plans will be similar in format and content, each will be tailored to test specific objectives. Table 5.1 provides a preliminary outline that will be used to prepare the Test Plans. Although the final Test Plan format may differ from that shown in Table 5.1, the elements represented by each of the sections listed will be addressed.

Section 1 of the Test Plan briefly describes the purpose of the pilot study and notes its role within RI/FS activities at OU 2. The introduction will also present a summary of Phase II RI data pertinent to the pilot test that has become available since preparation of the Subsurface IM/IRAP/EA. Section 2 will discuss the scope of the pilot test. Section 3 will define the data quality objectives (DQOs) for conduct of the pilot test. DQOs will be developed based on the goals of the proposed IRA. These goals include assessment of vapor extraction as a means for removing subsurface residual free phase VOC contamination at OU2, determination of the area

Table 5-1
Subsurface IM/IRA Test Plan Outline

- I Introduction**
- II Scope of Pilot Study**
- III Data Quality Objectives**
- IV Well Design and Installation**
- V Vapor Extraction and Treatment System Design Construction and Commissioning**
- VI Pilot Test and Data Collection Procedures**
- VII Data Evaluation**

Appendices

Quality Assurance Project Plan

Sampling and Analysis Plan

Health and Safety Plan

Data Management Plan

of influence of the vapor extraction system and prediction of post pilot study system performance. Section 4 will include the specifications and engineering design drawings for completion of the vapor and ground water extraction and air injection wells. This section will specify the procedures to be followed for well installation and field engineering change requests. Criteria for well abandonment and alternative well placement will also be provided. Similarly, Section 5 will provide equipment specifications, system design drawings, and system performance specifications for the vapor extraction pilot unit. This section will also provide system start up and troubleshooting guidance. Section 6 will present detailed procedures for conduct of the pilot test. Vapor extraction and treatment system operating procedures will be specified, including system shutdown criteria. This section will also present pilot study data collection requirements. Section 7 of the Test Plan will present guidance for evaluation of pilot test data. This guidance will include but not be limited to equipment and system performance assessment, contaminant mass recovery computation, subsurface areal influence estimation, and post pilot study operation assessment.

The Test Plans will also include project specific quality assurance/quality control (QA/QC) sampling and analysis, health and safety, and data management guidance for conduct of the pilot studies. QA/QC guidance will be provided in the form of a project specific addendum to the EM Site Wide Quality Assurance Program Plan (EG&G 1991) and the ER RCRA/CERCLA Quality Assurance Project Plan (EG&G 1991). Health and safety guidance will be provided in the form of a project specific addendum to the ERHSPP (EG&G 1989). EM Department Standard Operating Procedures will also be referenced in the Test Plans when applicable.

Preparation of the first Pilot Test Plan will begin immediately after regulatory agency approval of the Subsurface IM/IRAP/EA. Draft and final Test Plans will be submitted to EPA and CDH for approval prior to implementation. The Test Plans will be available for public review, but will not be subject to formal public comment.

5.2 PILOT TEST REPORTS

A Pilot Test Report will be prepared at the conclusion of each OU2 *in situ* vapor extraction pilot test. The Test Reports will summarize the tests conducted, present test data and data evaluation results, and present recommendations for post pilot study operation of the vapor extraction systems.

Draft and final Pilot Test Reports will be prepared and submitted to the regulatory agencies for review and approval of post pilot study recommendations. The final Test Report will be made available to the public.

5.3 IM/IRA SCHEDULE

A proposed schedule for preparing the planning documents for the Subsurface IM/IRA is presented in Table 5.2. The proposed pilot tests (i.e., 903 Pad Mound and East Trenches) sequential implementation allows knowledge gained from the first test to be incorporated into the second, and so on. Table 5.2 presents specific completion dates for IM/IRA activities leading up to the startup of the pilot unit at the first test site. Due to the uncertainty associated with the actual length of time that will be required to complete the first pilot completion dates for activities subsequent to the first pilot test are listed in time durations relative to conclusion of the first pilot test.

TABLE 5-2

**Proposed Schedule
Subsurface IM/IRA
Operable Unit No 2**

| <u>Activity</u> | <u>Date</u> |
|---|------------------------------|
| Submit Draft Proposed Subsurface IM/IRAP/EA to EPA/CDH | 02 March 1992 |
| EPA/CDH comments on Draft Proposed Subsurface IM/IRAP/EA | 16 March 1992 |
| Submit Proposed Subsurface IM/IRAP/EA to Public—Public Comment Period Begins | 20 March 1992 |
| Public Meetings | 07 April 1992 07 May 1992 |
| Public Comment Period Concludes | 18 May 1992 |
| Submit Draft Responsiveness Summary to EPA/CDH | 16 June 1992 |
| EPA/CDH Comments on Draft Responsiveness Summary | 23 June 1992 |
| DOE Headquarters approves Final Responsiveness Summary Final IM/IRAP/EA and NEPA Decision (i.e. FONSI) | 19 August 1992 |
| Submit Final Responsiveness Summary and Final IM/IRAP/EA to EPA/CDH | 20 August 1992 |
| EPA/CDH Approves Final Responsiveness Summary and Final Subsurface IM/IRAP/EA | 03 September 1992 |
| Release Final Responsiveness Summary and Final Subsurface IM/IRAP/EA to Public—Two week Public Availability Period Begins | 10 September 1992 |
| Two week Public Availability Period Concludes | 24 September 1992 |
| <u>Site 1 Pilot Test</u> | |
| Submit Draft Test Plan to EPA/CDH | 29 October 1992 |
| EPA/CDH Comments on Draft Test Plan | 26 November 1992 |

TABLE 5-2 (Continued)

**Proposed Schedule
Subsurface IM/IRA
Operable Unit No 2**

| <u>Activity</u> | <u>Date</u> |
|---|---|
| Submit Final Test Plan to EPA/CDH and Complete Pilot Unit Bid Package | 12 January 1993 |
| Solicit and Complete Evaluation of Subcontractor Bids/Issue Purchase Order | 09 March 1993 |
| Finalize Subcontractor Design Drawings/EG&G Issues Authorization to Proceed | 26 April 1993 |
| Complete Pilot Unit Installation | 03 August 1993 |
| Complete Inspection and System Startup/Begin Pilot Testing | 15 September 1993 |
| Complete Pilot Study | 13 weeks after Pilot Study begins |
| Submit Draft Pilot Test Report to EPA/CDH concludes* | 24 weeks after Site 1 Pilot Study |
| EPA/CDH Comments on Draft Pilot Test Report | 3 weeks after receipt of Site 1 Draft Test Report |
| Submit Final Pilot Test Report to EPA/CDH | 4 weeks after receipt of EPA/CDH Comments on Site 1 Draft Test Report |
| <u>Site 2 Pilot Test</u> | 10 weeks after EPA/CDH approves Site 1 Final Test Plan |
| Submit Draft Test Plan to EPA/CDH | |
| EPA/CDH Comments on Draft Test Plan | 4 weeks after receipt of Site 2 Draft Test Plan |

TABLE 5-2 (Continued)

**Proposed Schedule
Subsurface IM/IRA
Operable Unit No 2**

| <u>Activity</u> | <u>Date</u> |
|--|---|
| Submit Final Test Plan to EPA/CDH and Complete Pilot Unit Bid Package | 9 weeks after receipt of EPA/CDH Comments on Site 2 Draft Test Plan |
| Solicit and Complete Evaluation of Subcontractor Bids/Issue Purchase Order | 8 weeks after completion of Site 2 Pilot Unit Bid Package |
| Finalize Subcontractor Design Drawings/EG&G Issues Authorization | 7 weeks after issuance of Purchase Order |
| Complete Pilot Unit Installation | 14 weeks after a) EG&G authorization to proceed or b) completion of Site 1 Pilot Study whichever is later |
| Complete Inspection and System Startup/Begin Pilot Testing | 6 weeks after installation of Site 2 Pilot Unit Complete |
| Complete Pilot Study | Within 13 weeks after Site 2 Pilot Study begins |
| Submit Draft Pilot Test Report to EPA/CDH | 24 weeks after Site 2 Pilot Study concludes ^a |
| EPA/CDH Comments on Draft Pilot Test Report | 3 weeks after receipt of Site 2 Draft Test Report |

TABLE 5 2 (Continued)

**Proposed Schedule
Subsurface IM/IRA
Operable Unit No 2**

| <u>Activity</u> | <u>Date</u> |
|---|---|
| Submit Final Pilot Test Report to EPA/CDH | 4 weeks after receipt of EPA / CDH Comments on Site 2 Draft Test Report |
| <u>Site 3 Pilot Test</u> | |
| Submit Draft Test Plan to EPA/CDH | 10 weeks after EPA/CDH approves Site 2 Final Test Plan |
| EPA/CDH Comments on Draft Test Plan | 4 weeks after receipt of Site 3 Draft Test Plan |
| Submit Final Test Plan to EPA/CDH and Complete Pilot Unit Bid Package | 9 weeks after receipt of EPA / CDH Comments on Site 3 Draft Test Plan |
| Solicit and Complete Evaluation of Subcontractor | 8 weeks after completion of |
| Bids/Issue Purchase Order | Site 3 Pilot Unit Bid Package |
| Finalize Subcontractor Design Drawings/EG&G Issues Authorization to Proceed | 7 weeks after issuance of Purchase Order |

TABLE 5-2 (Continued)

**Proposed Schedule
Subsurface IM/IRA
Operable Unit No 2**

| <u>Activity</u> | <u>Date</u> |
|--|--|
| Complete Pilot Unit Installation | 14 weeks after a) EG&G authorization to proceed or b) completion of Site 2 Pilot Study whichever is later |
| Complete Inspection and System Startup/Begin Pilot Testing | 6 weeks after installation of Site 3 Pilot Unit Complete |
| Complete Pilot Study | 12 weeks after Site 3 Pilot Study begins |
| Submit Draft Pilot Test Report to EPA/CDH | 24 weeks after Site 3 Pilot Study concludes |
| EPA/CDH Comments on Draft Pilot Test Report | 3 weeks after receipt of Site 3 Draft Test Report |
| Submit Final Pilot Test Report to EPA/CDH | 4 weeks after receipt of EPA/CDH Comments on Draft Test Report |

Schedule assumes 80 days for turnaround of analytical laboratory data

SECTION 6

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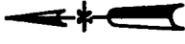
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EXPLANATION

-  INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) AND IHSS DESIGNATION
-  LOCATION OF BARRELS DETERMINED BY VISUAL INSPECTION OR MAGNETOMETER SURVEY
-  REMEDIAL INVESTIGATION AREAS



Scale 1 = 600
0' 300' 600'
CONTOUR INTERVAL = 20'

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

OPERABLE UNIT NO 2
SUBSURFACE IM/IRA

REMEDIAL INVESTIGATION AREAS AND
INDIVIDUAL HAZARDOUS SUBSTANCE
SITES

FIGURE 2 2

January 1992

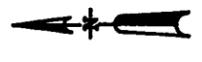


RS7M019-P1-01222/200

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)
- POTENTIOMETRIC SURFACE ELEVATION (feet above mean sea level)
- ALL DATA BASED ON MEASUREMENTS MADE APRIL 4-8, 1988 INCLUSIVE
- LINE OF EQUAL POTENTIOMETRIC SURFACE ELEVATION (feet above mean sea level)—DASHED WHERE APPROXIMATELY LOCATED
- NO DATA
- BEDROCK MONITOR WELL
- ALLUVAL MONITOR WELL
- PRE-1988 MONITOR WELL

- 5798
- 5860
- ND
- 2587 ●
- 3789 ○
- 0382 ▲



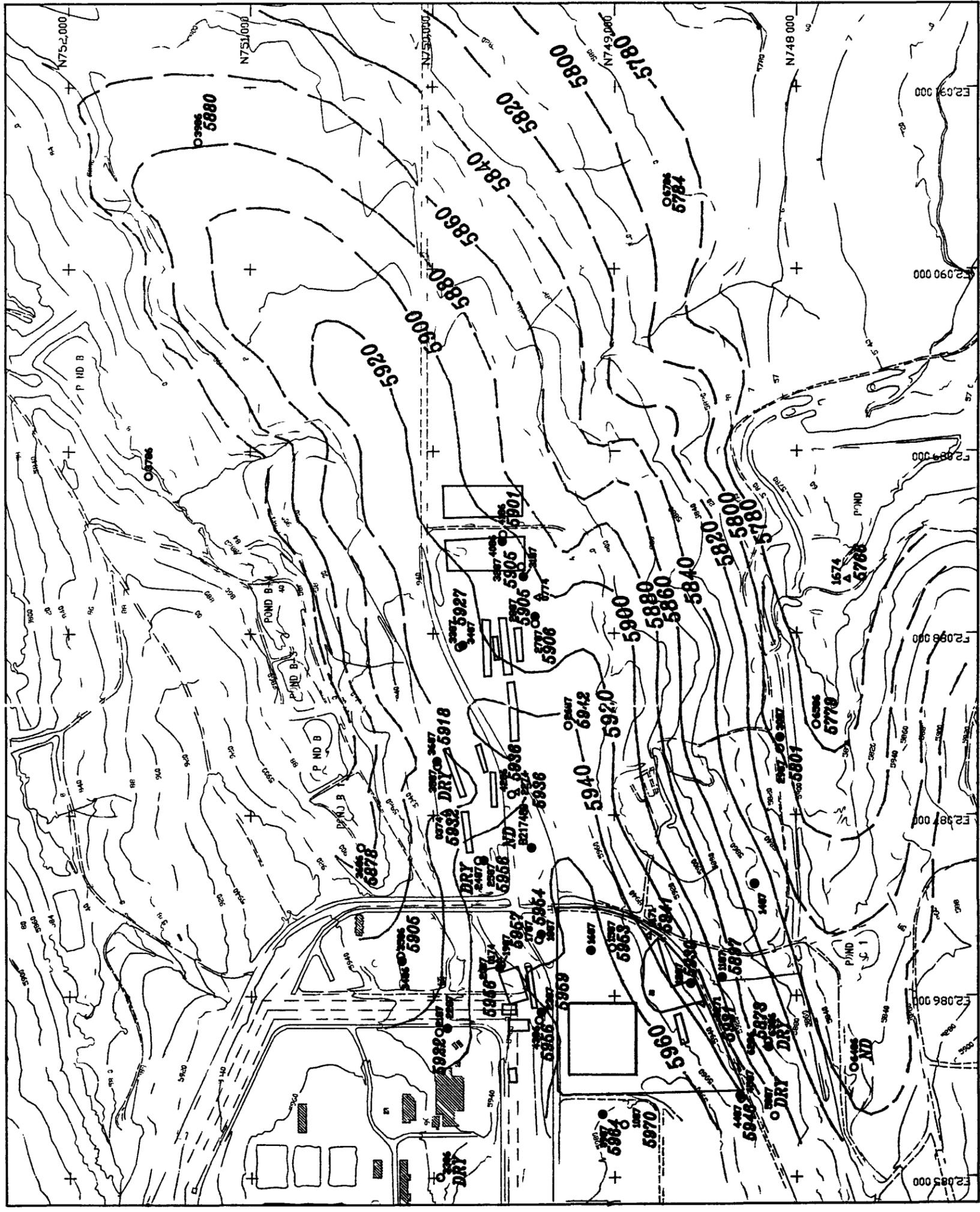
Scale 1 = 600
 0 300 600
 CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant Golden, Colorado
 OPERABLE UNIT NO 2
 SUBSURFACE IM/IRA

POTENTIOMETRIC SURFACE OF THE UNCONFINED GROUND-WATER FLOW SYSTEM

FIGURE 2 7

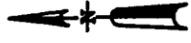
January 1992



57M030.CW-012482/800

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)
- SOIL SAMPLING LOCATION

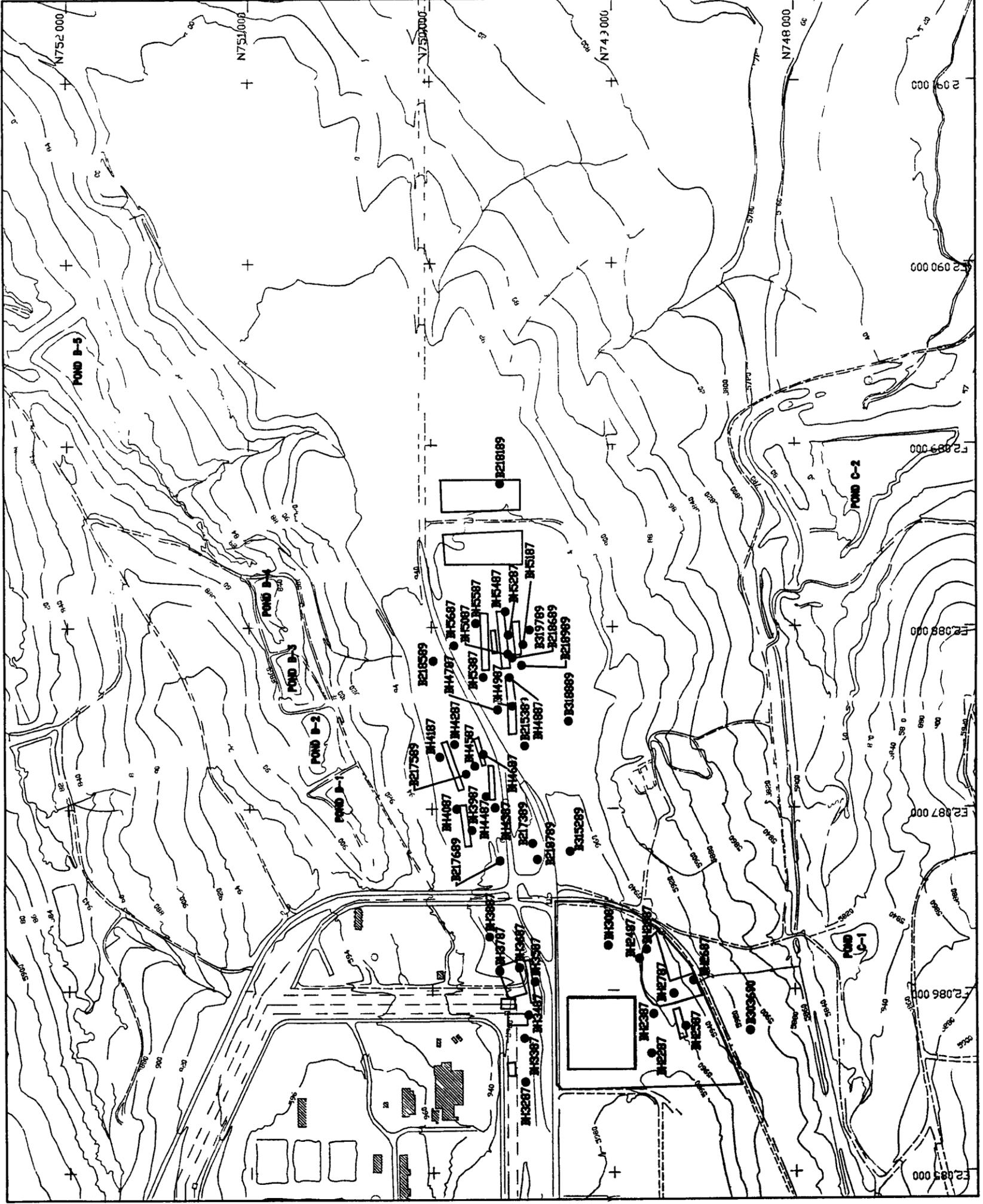


Scale 1" = 600'
0' 300' 600'
CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado
OPERABLE UNIT NO. 2
SUBSURFACE IM/IRA

SOIL SAMPLING LOCATION MAP

Revised, Mar/92 **FIGURE 2-9** January 1992



57M027AF-031792/000

EXPLANATION



INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)

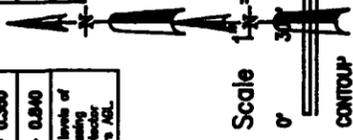


SOIL SAMPLING AND IN SITU MEASUREMENT LOCATION

| SYMBOL AND COLOR CODE FOR IN SITU SURFACE CONCENTRATION MEASUREMENTS | |
|--|-------------------------------------|
| CONCENTRATION | CONCENTRATION (μCi/m ²) |
| ● | < 0.008 |
| ■ | 0.008 - 0.080 |
| ▲ | 0.080 - 0.100 |
| ○ | 0.100 - 0.350 |
| □ | 0.350 - 0.840 |

Surface concentration levels of Am-241 were measured using high purity germanium detector (HPGe) at 100 centimeters AGL.

| AERIAL DATA PHOTO PEAK AMERICIUM-241 CONVERSION SCALE | |
|---|-------------------|
| LETTER LABEL | COUNTS PER SECOND |
| A | < 80 |
| B | 80 - 120 |
| C | 120 - 240 |
| D | 240 - 600 |
| E | 600 - 2,400 |
| F | 2,400 - 9,600 |



Scale 1" = 600'

Scale 1" = 600'

CONTOUR INTERVAL = 20'

Source: An Aerial Radiological Survey of the U.S. DOE's Rocky Flats Plant and Surrounding Area, EDC-10817-1044, May 1980.

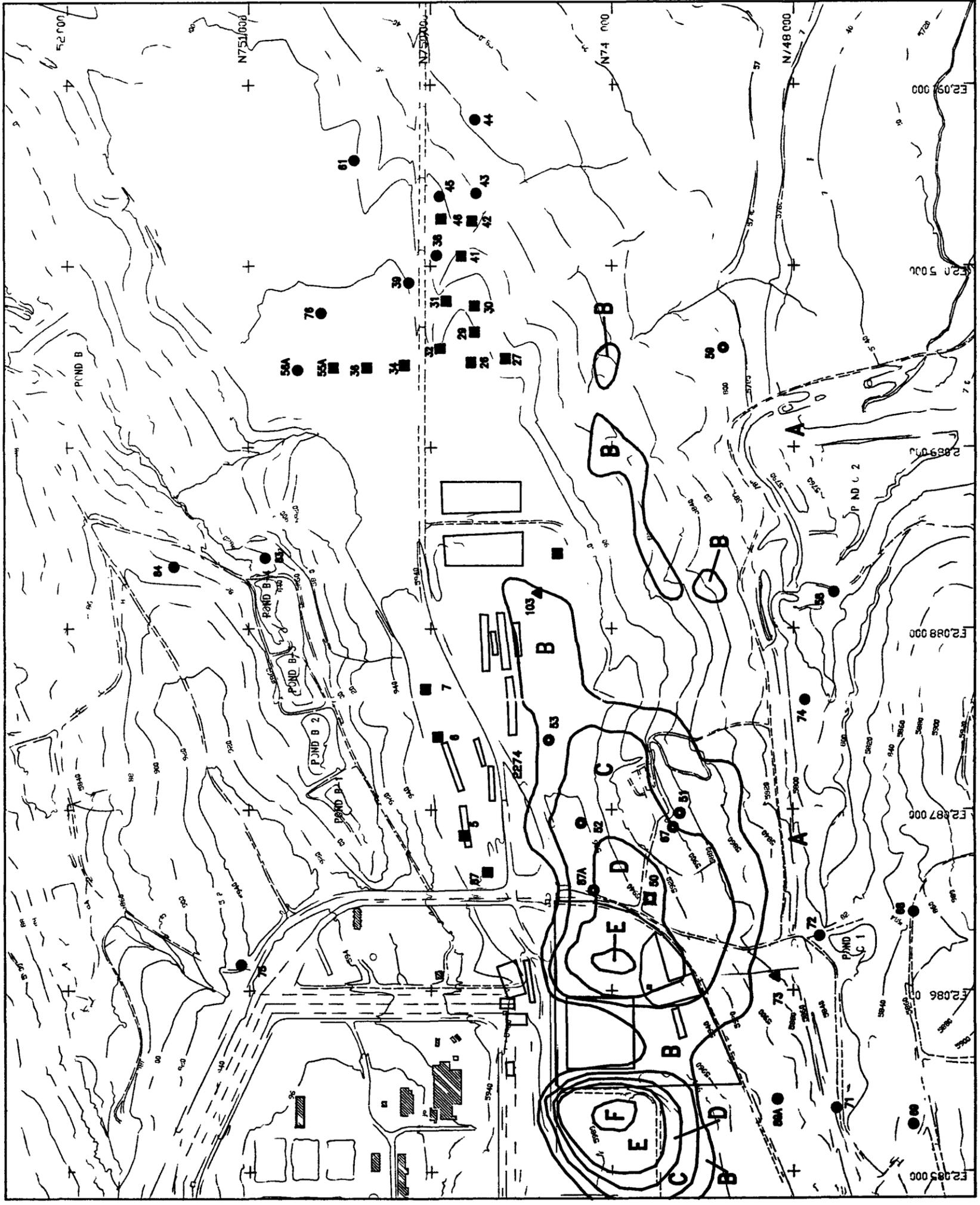
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO 2
SUBSURFACE M/IRA

SURFACE AND AERIAL AMERICIUM-241 CONCENTRATION DATA FOR THE RFP

FIGURE 2 10

January 1992

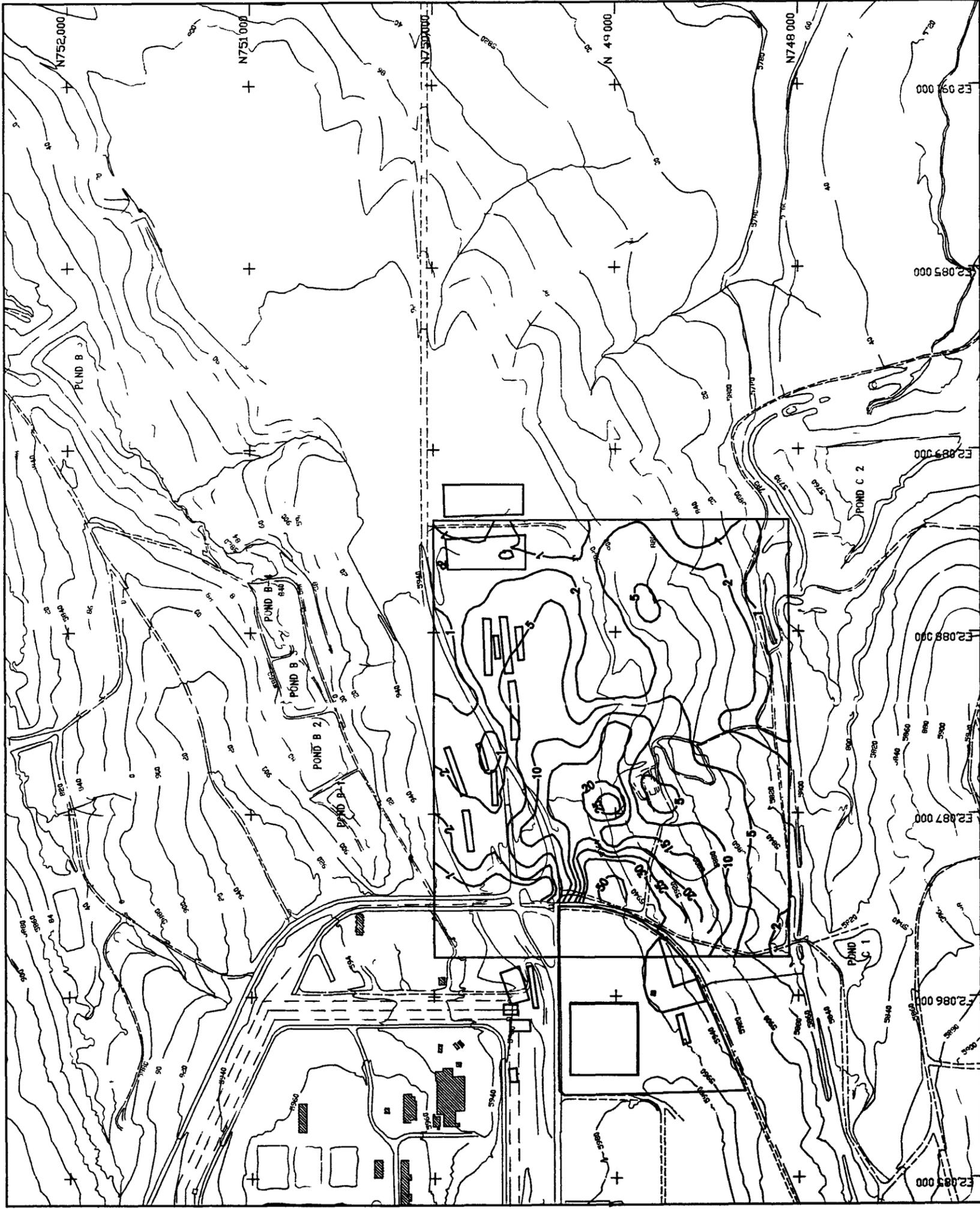


97M029-01242/00

EXPLANATION



INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)



Scale 1 = 600
0 300 600
CONTOUR INTERVAL = 20'

Source: In Situ Surveys of the U.S. DOE's
Rocky Flats Plant, EGG-10617-1129
May 1991

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

OPERABLE UNIT NO 2
SUBSURFACE IM/IRA

AMERICIUM-241
ISOCONCENTRATION CONTOURS
(pCi/g)

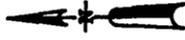
FIGURE 2 11

January 1992

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)
- LINE OF EQUAL PCE CONCENTRATION ($\mu\text{g/l}$) DASHED WHERE APPROXIMATELY LOCATED
- PCE CONCENTRATION ($\mu\text{g/l}$)
- SECONDARY DILUTION FACTOR EMPLOYED
- ESTIMATED
- NOT AVAILABLE
- NOT DETECTED
- ALLUVAL MONITOR WELL
- PRE-1986 MONITOR WELL

- 500
- 237
- D
- J
- NA
- ND
- 3789 O
- 0382 Δ

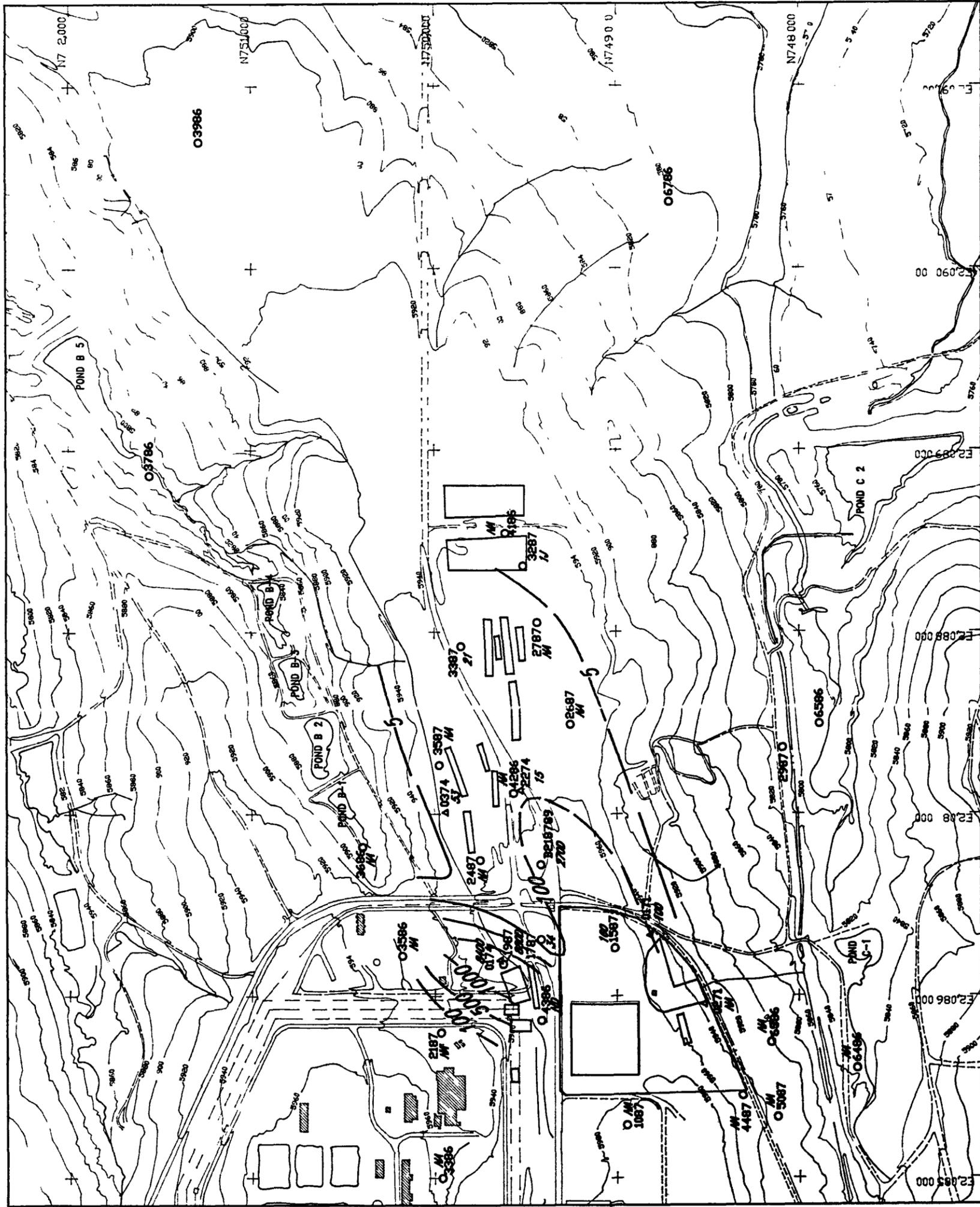


Scale 1" = 600'
 0' 300' 600'
 CONTOUR INTERVAL = 20'

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

OPERABLE UNIT NO 2
 SUBSURFACE IM/IRA

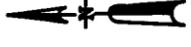
TETRACHLOROETHENE ISOPLETHS
 FOR THE UNCONFINED ALLUVIAL
 GROUND-WATER FLOW SYSTEM
 Third Quarter 1991



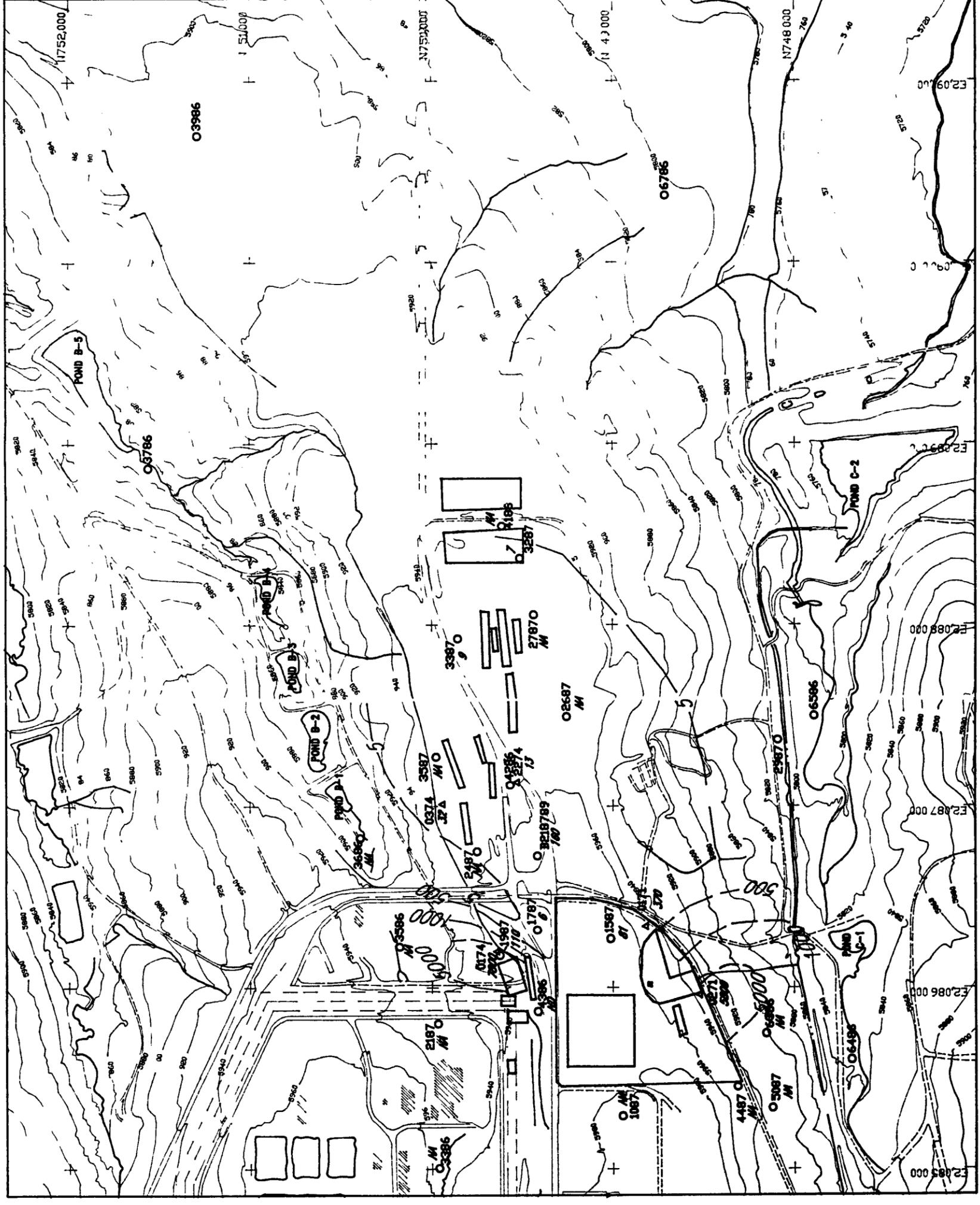
R57M022A.P1CM1-072092/800

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS) 
- LINE OF EQUAL TCE CONCENTRATION ($\mu\text{g/l}$) DASHED WHERE APPROXIMATELY LOCATED 
- TCE CONCENTRATION ($\mu\text{g/l}$)
- NOT AVAILABLE *NI*
- NOT DETECTED *ND*
- ALLUVIAL MONITOR WELL 3789 \circ
- PRE-1986 MONITOR WELL 0382 Δ



Scale 1" = 600'
 0' 300' 600'
 CONTOUR INTERVAL = 20'



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

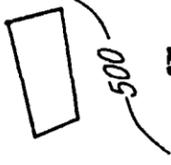
OPERABLE UNIT NO 2
 SUBSURFACE IM/IRA

TRICHLOROETHENE ISOPLETHS
 FOR THE UNCONFINED ALLUVIAL
 GROUND-WATER FLOW SYSTEM
 Third Quarter 1991

January 1992 Rev July, 1992

FIGURE 2 14

EXPLANATION



INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)

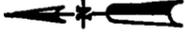
LINE OF EQUAL CCl_4 CONCENTRATION ($\mu g/l$) DASHED WHERE APPROXIMATELY LOCATED

CCl_4 CONCENTRATION ($\mu g/l$)

NA NOT AVAILABLE

ND NOT DETECTED

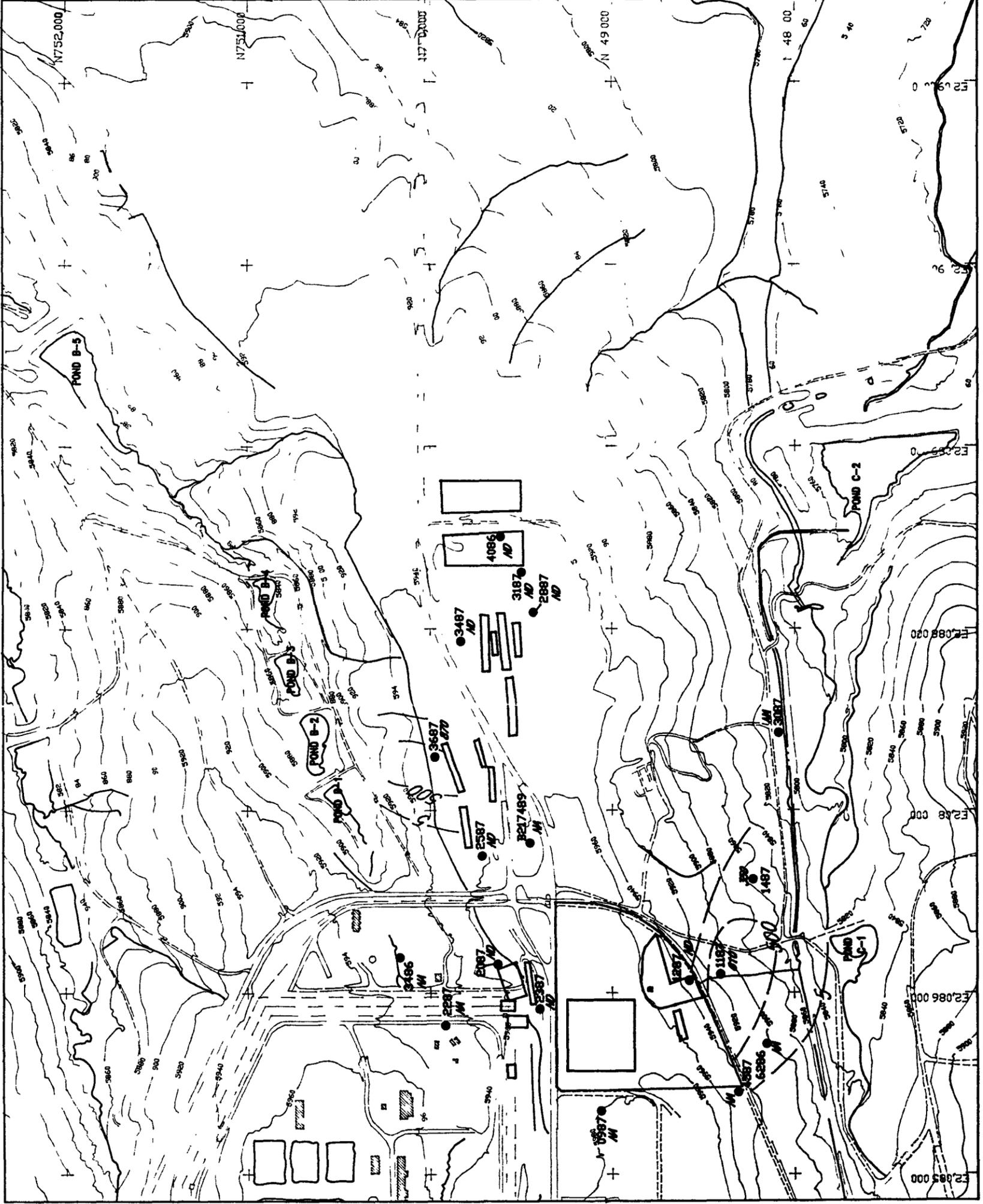
4086 ● BEDROCK MONITOR WELL



Scale 1 = 600



CONTOUR INTERVAL = 20'



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

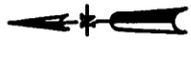
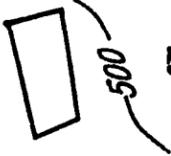
OPERABLE UNIT NO 2
SUBSURFACE IM/IRA

**CARBON TETRACHLORIDE ISOPLETHS
FOR THE UNCONFINED BEDROCK
GROUND-WATER FLOW SYSTEM
Third Quarter 1991**

937M021A/PCN-071992/800

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS)
- LINE OF EQUAL TCE CONCENTRATION (ug/l) DASHED WHERE APPROXIMATELY LOCATED
- TCE CONCENTRATION (ug/l)
- SECONDARY DILUTION FACTOR EMPLOYED
- NOT AVAILABLE
- NOT DETECTED
- BEDROCK MONITOR WELL

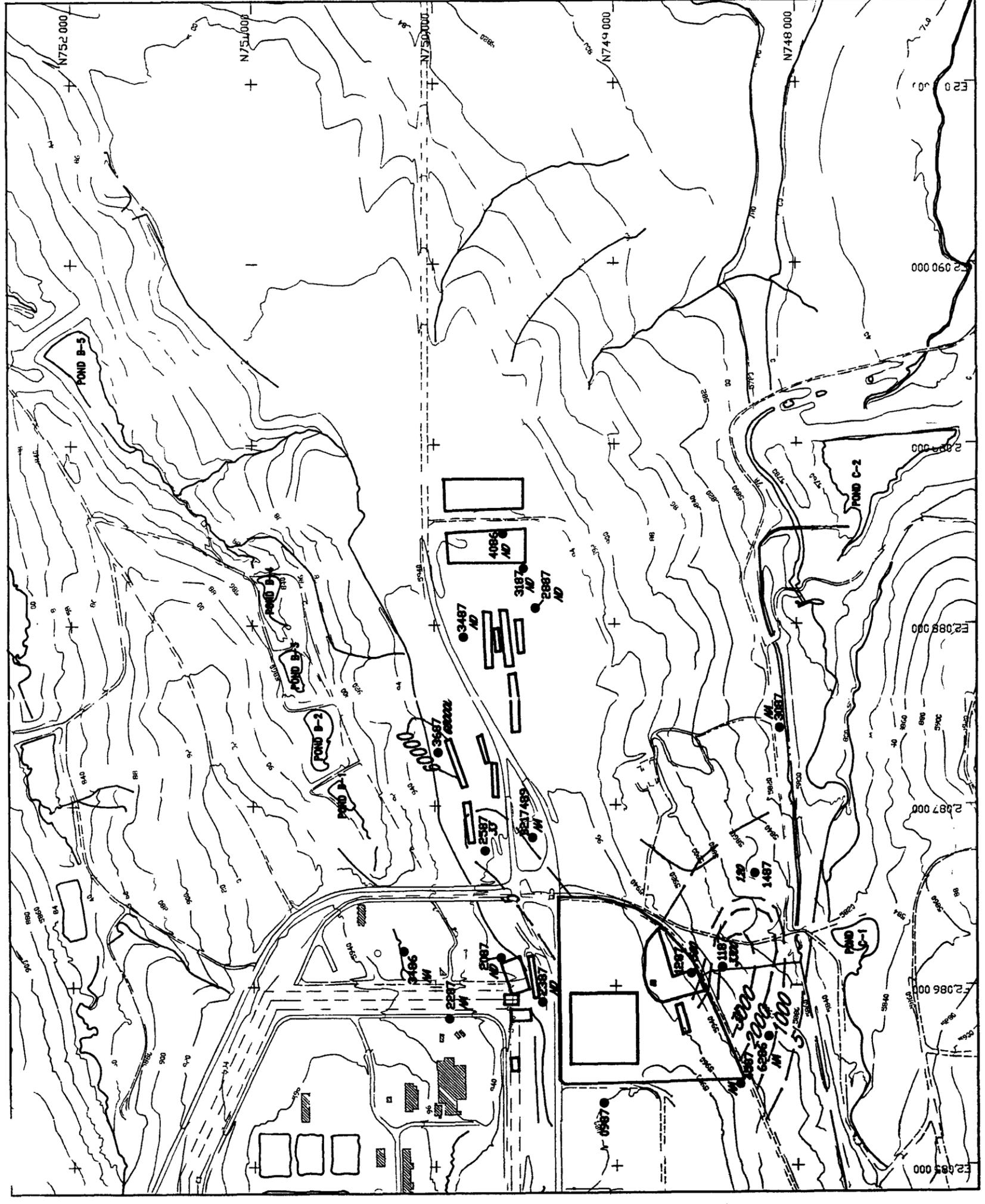


Scale 1 = 600
 0 300 600
 CONTOUR INTERVAL = 20'

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

OPERABLE UNIT NO 2
 SUBSURFACE M/IRA

TRICHLOROETHENE ISOPLETHS FOR THE UNCONFINED BEDROCK GROUND-WATER FLOW SYSTEM Third Quarter 1991



157M028A.PJ-081792/800

EXPLANATION



INDIVIDUAL HAZARDOUS SUBSTANCE SITE (HSS)



SURFACE WATER MONITORING STATION



SEDIMENT MONITORING STATION



Scale 1" = 600'
 0' 300' 600'
 CONTOUR INTERVAL = 20'

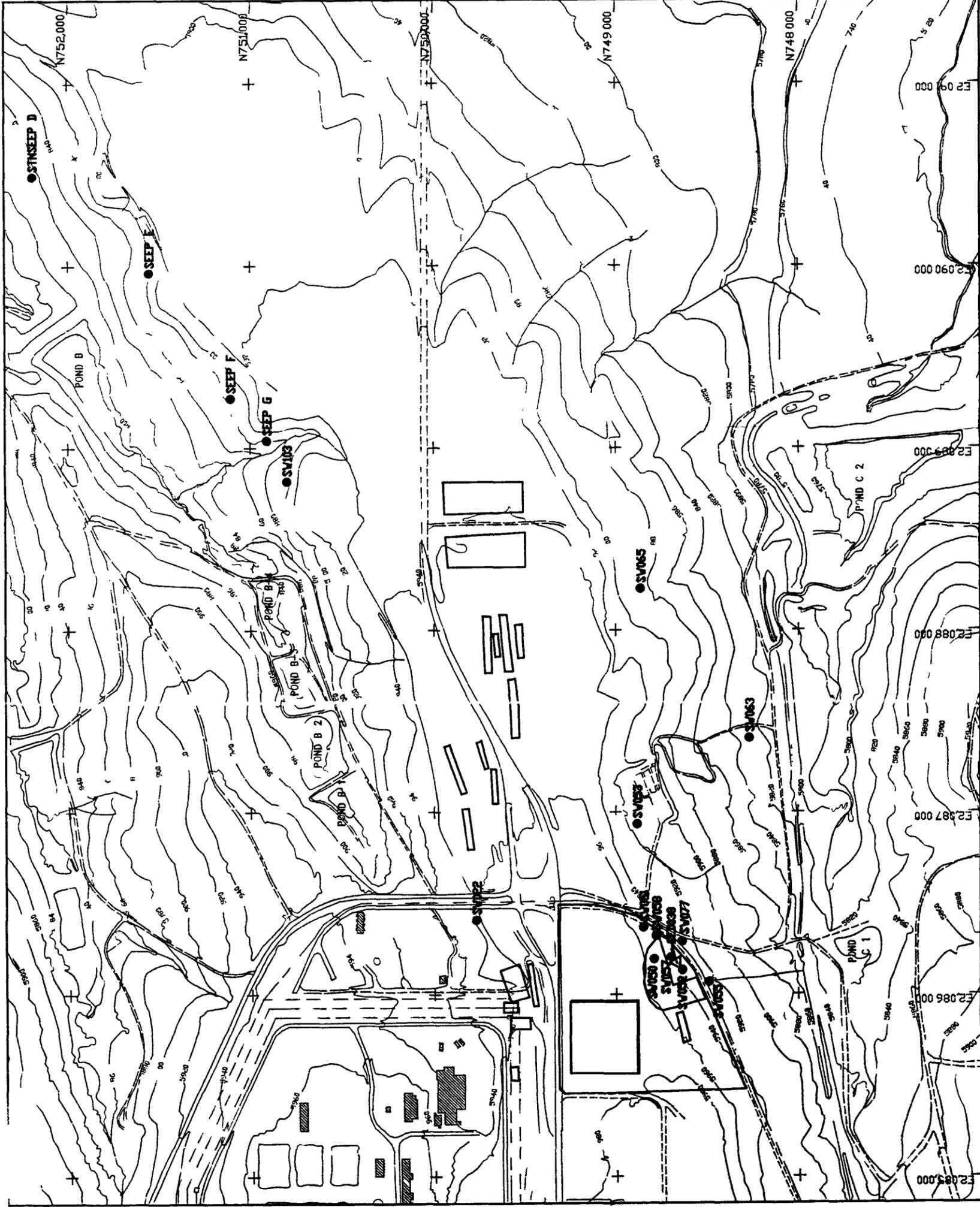
U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant Golden, Colorado

OPERABLE UNIT NO. 2
 SUBSURFACE IM/IRA

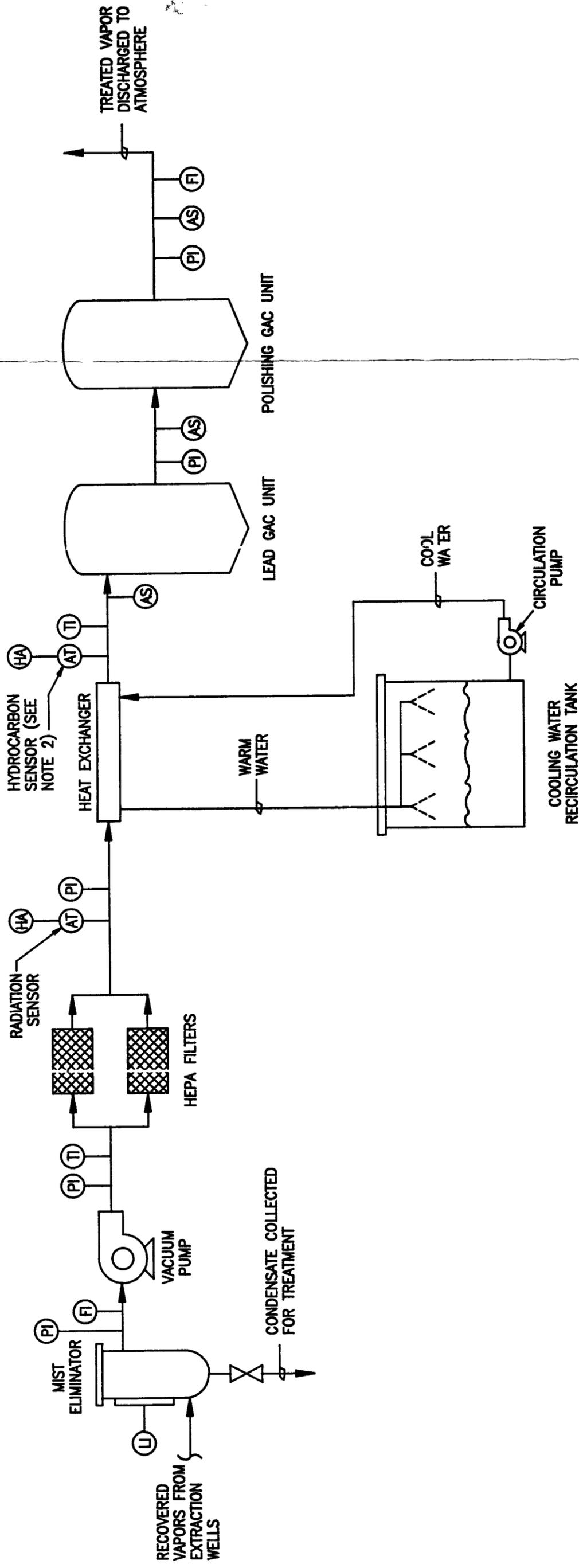
**SURFACE WATER AND
 SEDIMENT MONITORING STATIONS**

FIGURE 2 18

January 1992



574028-CF-01242/900



NOTES

- 1 VAPOR TREATMENT SYSTEM EQUIPMENT IS MOUNTED ON A FLATBED TRAILER FOR EASE OF TRANSPORT TO EACH PILOT TEST SITE.
- 2 HYDROCARBON SENSORS ARE PLACED DOWNSTREAM OF THE VACUUM PUMP IN THE SECONDARY CONTAINMENT CAVITIES OF THE PROCESS PIPING AS NECESSARY TO MONITOR FOR VOC-CONTAMINATED VAPOR LEAKS

LEGEND

- | | | | |
|------|---------------------------------|----|-----------------------|
| GAC | GRANULAR ACTIVATED CARBON | HA | HIGH ALARM |
| HEPA | HIGH EFFICIENCY PARTICULATE AIR | L | LEVEL INDICATOR |
| AT | ANALYTICAL TRANSMITTER | PI | PRESSURE INDICATOR |
| SA | ANALYTICAL SAMPLING LOCATION | TI | TEMPERATURE INDICATOR |
| FI | FLOW INDICATOR | ∇ | VALVE |

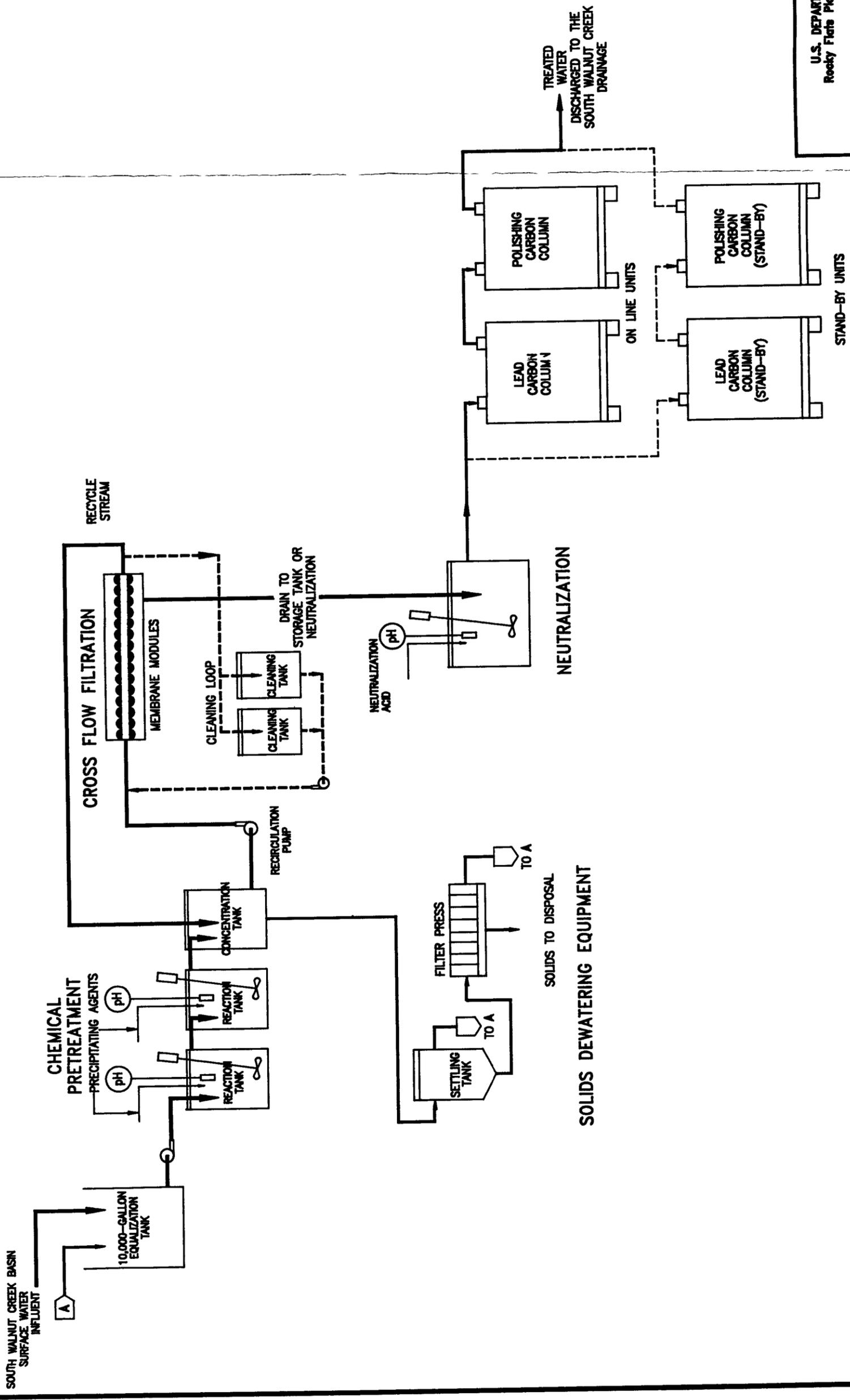
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 2
SUBSURFACE IM/RA

PILOT TEST UNIT
VAPOR EXTRACTION SYSTEM

FIGURE 4 6

January 1992

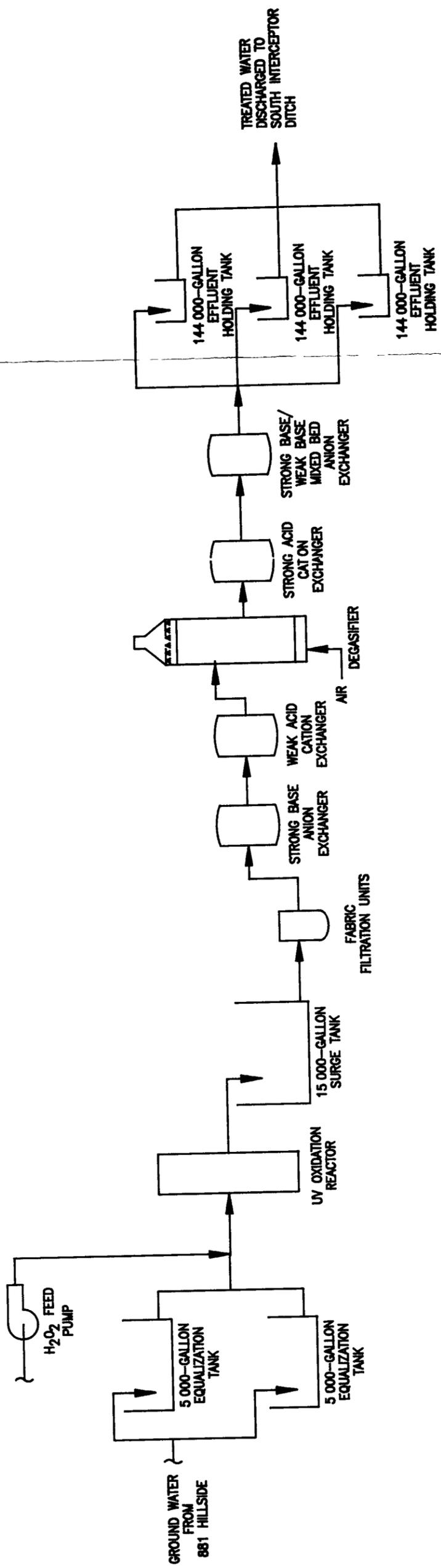


U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant Golden, Colorado

OPERABLE UNIT NO. 2
 SUBSURFACE IN/IRA

SOUTH WALNUT CREEK BASIN CHEMICAL
 PRECIPITATION/MICROFILTRATION AND GAC
 ADSORPTION TREATMENT SYSTEM

FIGURE 4-12
 January 1992



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

OPERABLE UNIT NO 2
 SUBSURFACE M/IRA

881 HILLSIDE
 GROUND-WATER TREATMENT SYSTEM
 (PLANNED)

FIGURE 4 13

January 1992